Book of Abstracts

6396 | The Effects of Nanosilica on Permeability and Porosity Reduction of Cement Composites to Prevent Environmental Pollutions

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Designing an appropriate cement slurry formulation for cementing of oil and gas wells is always a big challenge, especially in evaporite layers. Under HPHT (high pressure, high temperature) condition, these layers are prone to creep toward the borehole which may consequently result in point loads on the cement sheath. These loads are likely to cause cement failure and in some cases collapse of casing string. In addition,, application of weighting agents are reported to cause severe inhomogeneity of the slurry due to high deposition of solid contents. Field and laboratory data confirm a rather high reduction of compressive as well as tensile strength of the cement in addition to high permeability of such cement composites caused by deposition especially in the lower parts of the well. Nanosilica is a highly effective pozzolanic material. Because of its extremely fine particles it was utilized to decrease set cement impermeability and porosity and improve rheological and mechanical properties of the hardened material. The results confirm that the application of nanosilica combined with an appropriate change in the percentage of other additives highly benefits the rheological and mechanical properties of the cement. The permeability and porosity are considerably decreased over 97% and 39% respectively. Furthermore, compressive and tensile strength are improved 68% and 40% respectively. Also, other advantages are also obtained with these formulations, such as lower free water, lower setting time and lower fluid loss of the slurry. This novel cement formulation is suitable for using in some formation sections where the possibility of gas migration is very high.

6728 | Effects of Functionalized Multi-Walled Carbon Nanotubes on the Mechanical Properties of HDPE/Wood Flour Nanocomposites

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Carbon nanotubes (CNTs) have the propensity to aggregate when mixing with thermoplastic polymers, leading to inappropriate distribution in the composites and limiting the CNTs performance in polymer matrix. Therefore, this study aims at strengthening the wood-plastic composites (WPCs) performance through the application of functionalized CNTs. To meet this objective, the raw CNTs as a reinforcement at three levels of 0, 1 and 2 wt% and Maleic Anhydride grafted Polyethylene (MAPE) as a coupling agent at two levels 0 and 3 wt% were used. Also, functionalized CNTs were separately used at two levels of 1 and 2 wt%. Materials were compounded in an internal mixer (Haake) and then the samples were prepared by hot pressing. The mechanical tests including the tensile strength and modulus, and impact strength were performed on the composites based on the ASTM standard. The results showed that when the raw CNTs contents increased from 0 to 2 wt%, the tensile strength and modulus of the samples increased to 36.7% and 12%, respectively. Mechanical properties of samples were improved by adding MAPE up to 3 wt%. The dispersion of CNTs in the HDPE was increased when functionalized CNTs were applied, and the morphological properties of the WPCs containing functionalized nanoparticles were improved. The overall results showed that the best improvement of WPCs fiber-matrix adhesion was achieved when 2 wt% functionalized CNTs was added into the matrix.

6876 | The influence of machining parameters on thrust force in drilling of epoxy/ tio2 nanocomposites.

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A polymer nanocomposite is the polymer matrix with a reinforcing phase consisting of filler with one of its dimension is less than 100 nm. Because of their small size, nanofillers have a high surface to volume ratio and provide high surface energy in comparison with micro sized fillers.
Epoxy resin is a thermosetting polymer which is used in structural composites; adhesive, surface coating and electronic circuits board laminates.
The various filler are used to reinforce the polymer matrix. One of the reinforcements is TiO2. The TiO2 is extensively used in industries such as additives in plastics, agglomerates for thermal sprays, air/fuel ratio controller in automobile, energy converter in solar cells, gas sensor and piezoelectric capacitors.
Epoxy/ TiO2 nanocomposites have wide application, particularly for bio-terrorism, organic photovoltaic, fire retardant composite, composite nanomenbrance, etc.
As a results of epoxy/ TiO2 nonocomposites potential applications, there exists a strong need to understand the manufacturing process, particularly the machining of these nanocomposite materials.
Drilling is a major operation of machining, which is used for assembling of composite and nanocomposite parts. The thrust force in drilling process is a significant element in machine vibrations, chatter, and inaccuracy issues. Therefore, reduction of thrust force in drilling process can lead to better quality of the drilled hole, and finally, reduction of vibration and chatter. Shape accuracy of component corresponds to machining accuracy.
In this study, the influence of machining parameters (spindle speed and feed rate) on thrust force in drilling of epoxy/ TiO2 nanocomposites has been investigated. By changing the input parameters such as spindle speed and feed rate, the thrust force was measured. The drilling was done by HSS drill tool.
The TiO2 nanoparticles (3 wt.%) in matrix are dispersed by mechanical stirrer. Nanocomposite samples were characterized by transition electron microscopy. The experiments were done on neat epoxy and epoxy/TiO2 nanocomposite.
Analysis of variance (ANOVA) was employed to investigate the influence of machining parameters on the thrust force.

6887 | Effects of patch geometrical parameters on mechanical properties of damaged metallic structure repaired with adhesively bonded composite patch

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Composite patch adhesively bonded repair is an advanced repairing method for damaged metallic structure, and in patch designing, it is important to choose appropriate geometrical parameters, which decides mechanical properties of repaired structure. Based on 3D FEM, the model of aluminum plate with a central through crack adhesively bonded repaired with carbon/epoxy composite patch was established, which can take into account residual thermal stress and bending deformation caused by differences of thermal expansion coefficient. SIF was calculated using virtual crack closure technology and compared to evaluate effects of patch geometrical parameters on mechanical properties of repaired structure. The result show that there is optimal patch length and thickness which can make best repairing effect and an effective patch width can reduce SIF significantly, beyond which it is helpless.

6890 | Analysis of pinching motion of a finger exoskeketon actuated by electro-active polymers

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Hand exoskeletons have been developed in order to assist daily activities for disabled and elder people. A figure exoskeleton was developed using ionic polymer metal composite (IPMC) actuators, and the performance of it was evaluated in this study. In order to study dynamic performance of a finger dummy performing pinching motion, force generating characteristics of an IPMC actuator and pinching motion of a thumb and index finger dummy actuated by IMPC actuators were analyzed. The blocking force of 1.54 N was achieved under 4 V of DC. A thumb and index finger dummy, which has two and three degree of freedom at the joint of thumb and index finger respectively, was manufactured by a three dimensional rapid prototyping. Each figure was actuated by IPMC actuators, and the maximum fingertip force was 1.18 N. Pinching motion of a dummy was analyzed by two video cameras in vertical top and horizontal left end view planes. A figure dummy powered by IPMC actuators could perform flexion and extension motion of an index figure and a thumb.

6892 | Modal analysis of Frari historical bell tower in Venice: a case of masonry like composite bell tower structure

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A full 3D modal analysis, developed in linear elasticity, for masonry structure is presented. In this paper free modal analysis of Frari historical bell tower in Venice, as case study, is carried on. The bell tower studied is a masonry structure. As well known masonry is a composite material formed by bricks and mortar arranged more or less regularly and adopted for many centuries as structural material. Dynamic actions may represent the major risk of collapse of brickworks and, despite the progress achieved so far in science and mechanics, the assessment of their seismic performance remains a challenging task. Generally, masonry buildings may fail under dynamic actions following two different mechanisms: in-plane and out-of plane. The first one is characterized by shear deformations and fissures, while the second one may cause the tilting (or toppling) of entire portions of wall. Then, reliable physical and numerical models are worth of recommendation (Baraldi, Cecchi, 2014).
Here, the idea is to evaluate sensitivity of model to several geometric parameters, i.e. geometric non linearity, opening presence, different thickness of external walls. With this aim four model are proposed: i) model of external and internal walls with real geometric parameters; ii) model of the only external walls with real geometric parameters; iii) simplified model of external and internal walls represented like rectangular girder; iv) simplified model of the only external walls represented like rectangular girder. Some studies already exist on Frari bell tower (Lionello, 2011) and existing literature considers also study on vibration of tower bell based on experimental tromographic analyses (Teza G., et al., 2014).
The analysis shows interesting results, in particular: i) frequencies are strongly connected to the internal nucleus; ii) mass participation is not uncoupled and always are present both flexural and torsional mode, in because of geometric non linearity.
Considering that the frequencies are strongly influenced by the presence of the nucleus, is very important to model the whole structure because the natural frequency determines the seismic response of the building.
In because of geometric irregularities only a part of the whole mass is involved in the flexural mode and a torsional component is related to the mass participation. This changes entire structural behavior.
For this reasons, dynamic analysis must take into account actual geometry: effective thickness related to mass distribution, opening presence and effective alignment to the vertical axis.

References
Lionello A., (2011) Tecniche costruttive, dissesti e consolidamenti dei campanili di Venezia, Ministero per i beni e le attività culturali, Soprintendenza per i beni architettonici e paesaggistici di Venezia e Laguna, Corbo e Fiore
Teza G., Pesci A., Trevisani S., (2014), Multisensor surveys of tall historical buildings in high seismic hazard areas before and during a seismic sequence, Journal of Cultural Heritage, Elsevier Masson
Baraldi D., Cecchi A., (2014) Discrete and continuous models for the in plane modal analysis of masonry structures, 5th EUROPEAN CONFERENCE ON COMPUTATIONAL MECHANICS (ECCM V) E. Oñate, J. Oliver and A. Huerta (Eds).

6893 | Workability of Spray-Formed Al/Sip Metal Matrix Composites

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Si particles were in-situ generated during spray forming to form Al/SiP MMCs with 28% and 38% of of SiP and AC9A MMC containing 29 v/o of SiP. The large difference between the sizes and distributions of Sip generated by spray forming and by casting was investigated. The workability of the MMCs was studied by compressive testing. The effects of deformation temperatures and initial strain rates on the workability of the MMCs were investigated with compressive stress-strain curves. Softening phenomenon following peak stresses due to dynamic recrystallization was shown in most cases, while

continuously hardening without softening was also found. The effects of the materials, deformation temperatures and initial strain rates on the softening phenomenon were studied. The strain rate sensitivity is discussed along with the effects of deformation temperatures and initial strain rates.

6895 | Mechanical Properties of SWCNT Reinforced Composite Using Nanoindentation Analysis

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ABSTRACT
Spherical indentation tests are carried out numerically using finite element method for uniformly dispersed Single Walled Carbon Nanotube (SWCNT) in polymer matrix in which perfectly bonded CNT/matrix interface is considered. Large strain elasto-plastic analysis is performed to investigate the actual scenario of nanoindentation test. Separate finite element model has also been constructed to compare the result with Berkovich indentation.Since the wall thickness to radius ratio (t/r) of SWCNT is significantly small there is a possibility of lateral buckling which is a function of the location of indentation tip as well as the matrix strength. This study also investigates how (t/r)and the relative nanotube's position influence the mechanical properties of nanocomposite. In addition, the buckling behavior of nanotube in different polymer matrix which relates to relative matrix strength has also been investigated.

6896 | COMPUTATION OF J INTEGRAL FOR REPAIRED CRACK WITH COMPOSITE WRAP IN PIPE UNDER DIFFRENT LOADS

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Abstract :
In this study, the analysis of the behavior of circumferential through cracks in repaired pipe with bonded composite patch subjected to internal pressure, then to flexure moment is performed using three dimensional finite element methods. The methods used are based on the deformation theory of plasticity, constitutive law characterized by Ramberg–Osgood model, which allow the evaluation of the fracture criteria "J" integral. The computations were performed for elastic-plastic behaviors. The obtained results show that the presence of the bonded composite repair reduces significantly the "J" integral, what can improve the lifespan of the pipe.
Keywords:
Elastic–plastic, fracture mechanics, Pipe, crack, bonded composite repair, J integral, finite element method.

6908 | Numerical homogeneisation using a projected fiber technique for the analysis of mechanical properties of short fiber reinforced composites

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Natural fibers as reinforcement for composites with thermoplastic matrices are currently exploited in place of glass and/or other synthetic materials, particularly in non-structural applications. The main advantage of employing natural fibers is that these are biodegradable and renewable, and exhibit low cost, low density, high toughness and good thermal resistance. Moreover polymer materials reinforced with natural fibers (hemp, flax, sisal, wood-fiber, yute, alfa, miscanthus ...) can combine satisfactory mechanical properties with a low specific mass. So far studies on the properties of natural fibers based composites have been the subject of a large number of papers and reviews, especially during the last decade. Prediction of macroscopic properties of composite materials (Young's modulus, Poisson's ratio, shear modulus,..) from those of components is one of the main objectives of modeling. The mechanical behavior of such materials under loading derives from active mechanisms inside their components and at the interfaces, as well as from the arrangement of these components. The prediction of macroscopic behavior from these data uses complex operations of scale change which represent the interaction phenomenon between components. The micromechanical approaches are the first ones to be proposed in the literature, for estimating elastic properties of short fiber reinforced composites. Most of models known from the literature are based on two basic assumptions: the matrix and fiber are linearly elastic and a random distribution of fibers. Use of numerical methods to compute the elastic properties, particularly the finite element analysis, is often devoted to composites with fibers having well defined orientations (Unidirectional, Woven, etc…), but rarely for materials with randomly distributed short fibers.
Motivated by computing elastic properties of natural fiber reinforced composites, requiring relatively less computing time, a multi-scale projection fiber approach, using a special finite element procedure which is associated with a random distribution of small natural fibers, is proposed in the present work. It takes into account of geometrical and mechanical properties of the composites components. A microscopic truss element is used to model the reinforcements. The corresponding degrees of freedom are projected on those of the resin matrix. Performances of the final composite specific finite element, labeled "Reinforced Triangle Element (RTE)", are studied across numerical results of the elastic properties which are compared with the experimental properties, obtained from normalized tensile tests. Two types of composites are used: PP with white Hemp fibers and PP with Hemp straw. Despite of 2D representation of the elastic behavior by the proposed specific element RTE, the corresponding results appear to be quite in agreement with those obtained experimentally, particularly for composites PP with hemp straw reinforcements.
The proposed approach is a first attempt to compute mechanical properties of reinforced natural short fiber plastic composites, from those of their components (fibers and matrix). It brings an added value by controlling stress behavior of the fibers in deformed configuration: an important data for a future analysis of the interface damage between fibres and matrix). It could be considered as alternative technique to micro-mechanical approaches (Mori-Tanaka, Hashin and Shtrikman, ...).

6909 | Piezomagnetic - Piezoelectric composite prepared by high energy ball milling for magnetoelectric applicationns.

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Composite materials of spinel CuZnFe2O4 ferrite (CZF) and barium titanate BaTiO3 (BT) were prepared by using high energy ball milling technique. The

X-ray diffraction (XRD) patterns of the composite system (1-x) CZF + (x) BT (x = 0, 10,20, 30, 40, 50 ,60, 70, 80, 90 and 100%), confirmed the composite preparation with two phases, the piezomagnetic and piezoelectric phases. The results of scanning electron microscope (SEM) measurements show nearly homogeneous microstructure with good dispersion of BT grains as well as the presence of some pores. The IR broadening of the absorption band which depends on the population and distribution of cations at A and B sites varied by increasing BT content. The rate of a change of a dipole moment of the Fe-O bond for both tetrahedral and octahedral sites decrease by increasing BT content. The molecular character of the composite changed by introducing BT. The increase of ESR resonance field Br may be due to the decrease of internal field and porosity by increasing BT content .After 40 hrs ball milling CZF spinel phase was formed, the intensity of peaks belongs to ferrite phase increased after calcination which still lies in the range of nanoscale. From ESR the value of Br increase by increasing BT content due to the decrease of internal field and porosity Value of ΔBpp increase by increasing of BT content .The ΔBpp is considered as indicator to the electric loss, this results is very useful in the core transformer at high frequency region.Magnetic properties of the material is diluted by the presence of BT phase from the reduction of magnetic permeability. The sample x=40% BT has maximum value of magneto electric coefficient, which make it good candidate for sensor fabrication of electromagnetic wave pollution.

6910 | SMART IMPACT PROTECTIVE SPACER TEXTILE COMPOSITES

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Protective materials against impact have widely been used in protective clothing and equipment. However, the mostly used protective materials found in the market are foams and rigid plastics or composites which have very low comfort property. In this study, a new kind of smart composites having both high protective performance and comfort property was fabricated with the use of 3D warp knitted spacer fabric structure as reinforcement and a newly developed impact protective microgel (IPM) as matrix. Impacting tests with different impact energies were conducted using a drop weight impact testing machine to evaluate their protective performance. The testing results show that the use of IPM can significantly enhance the protective performance of the 3D spacer fabric structure. The new composites can be used to replace the currently used protective materials in protective sportswear, hip protectors and other cases where the impact protection is highly required.

6911 | Post-environmental exposure residual flexural strength of carbon nanofiber reinforced syntactic foams

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Hollow particle filled composites known as syntactic foams presently find numerous applications in high moisture and high temperature environments. Such composites are mainly used for their high energy absorption capabilities under compressive loading conditions because particlesa re load bearing elements under compression. However, their tensile and flexural strengths are usually low. Carbon nanofiber (CNF) reinforcement is attractive in these composites because of the possibility of increased tensile and flexural strength without changing density. In the present study, syntactic foams containing 0-50 vol.% glass microballoons (GMB) and 0-5 wt.% CNF reinforcement were exposed to accelerated weathering by immersion in 90°C water for two weeks and characterized for their residual flexural properties. Most of the present applications of syntactic foams are in the fields of deepsea vehicle structures and thermal insulation of underwater pipelines, where syntactic foams are immersed in water for long durations. Understanding the environmental degradation of such materials is highly desired. The results show that in the worst performing composites, a maximum weight gain of 3.5% and 10% was observed for CNF/epoxy composites and CNF/syntactic foams. The syntactic foams tested were observed to generally decrease in strength after weathering. Extensive scanning electron microscopy is conducted on the specimens. It is found that the soda-lime borosilicate glass particles used in the study degrade due to moisture absorption. Leaching of sodalime content results in severe degradation of particle-matrix interface, which lowers the strength of the composite.

6912 | Virtual Testing Architecture for Prediction of Effective properties of Particulate Composites

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Particulate composites comprise of filler material (often spherical in shape) and a matrix medium. These type of composites are widely useful in many structural applications. It is crucial that comprehensive understanding of the three dimensional mechanical response of particulate composites are developed. Traditionally, laboratory-level experiments have been used to determine the mechanical response but such experiments are limited by cost, complexity and inability to replicate certain experiments. Therefore, in the last two decades, a drive towards virtual testing schemes has become popular in academic literature. These virtual testing schemes employ a completely numerical approach to determine a holistic set of mechanical responses for a given test material. In order to predict accurately, these virtual tests employ robust geometric models of the test material, with realistic material models, adequate boundary conditions and a robust homogenization strategy. It is believed that in the near future, virtual tests will replace a significant number of traditional laboratory experiments. In spite of the practical importance of particulate composites, there is a limited range of mechanical data of its three dimensional response especially using a computational approach. There are no existing virtual testing schemes for particulate composites. There is therefore a need to develop a robust virtual testing architecture for prediction of effective properties of particulate composites. Such a framework should be scalable for prediction of nonlinear constitutive responses of a given particulate composite.

This study has developed a computational virtual testing architecture for predicting effective properties of particulate composites. A particulate composite made up of SiC filler in an alumina matrix was used in this work. The test composite was modelled first by considering perfect bonding between the matrix and filler constituents and subsequently the effect of interphase region was assessed too. The role of different boundary conditions types (namely Dirichlet, Neuman and Periodic Boundary Conditions) were investigated as a parametric study of the applicability of the virtual testbed for the particulate composite. The virtual testbed was found to be a representative architecture for prediction, using micromechanical modelling approach, the holistic range of 3D effective properties of particulate composites. The paper concludes by presenting parametric studies on mesh dependency, critical RVE size for representative prediction of all effective properties of the composite, etc.

6916 | The Role of different fiber orientations, thicknesses and temperatures on the transverse shear damping effect of

Polypropylene honeycomb sandwich structures

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This paper reports the impact of the in-plane load of different fiber orientations (0°, 30°, 45°, 60° and 90°) in fiber reinforced polymer (FRP) skins under different thicknesses of the skins and of the Polypropylene honeycomb (PPHC) core and different temperatures (30° C to 80° C, with incremental steps of 5° C) of the sandwiches on the transverse shear damping of the Polypropylene honeycomb sandwich using experimental and theoretical studies. The damping loss factor of the sandwich increases, as huge transverse shear deformation of the soft honeycomb core is imposed by a large in-plane load of the FRP skins. At the 0° fiber oriented sandwich, a large loss factor value results without losing its natural frequency (stiffness), as the increase in the thicknesses of the skins and core leads to a large shear deformation in the transverse direction at the impact load, the damping loss factor of the sandwich also increases.

Due to the higher in-plane strength of skins and lower transverse shear strength of the honeycomb core, the loss factor of the 0° fiber oriented specimen also increase sharply with the increase in temperature. The values of both the damping loss factor and the natural frequency/stiffness are the maximum at 0° fiber orientation in the skins under different temperatures of the sandwich specimen. Hence, the 0° fiber oriented sandwich specimen is more desirable, than the other fiber oriented specimens at all temperatures. The impulse technique has been employed to calculate the natural frequency and loss factor values of the sandwich specimens. The natural frequency, and loss factor values have also been calculated theoretically, using Blevins's formula for natural frequency, and Yim et al 's transverse shear effect respectively.

6917 | Preparation and Properties Study of Electrospun Porous Nanofibers

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Because of ultra high specific surface and unique properties, porous materials, which are potentially of great technological interest for the development of electronic, catalytic and hydrogen-storage systems, invisibility device (e.g. stealth plane, stealth clothes), and others, have been caught much attention recently. Pore structure and connectivity determine how porous materials perform in applications such as adsorption, separation, filtering, catalysis, fluid storage and transport, electrode materials or as reactors. Electrospinning has been recognized as a simple and efficient technique for the fabrication of polymer nanofibers. The porous structure further enlarges the specific surface area and enhances the hydrophobic property of the electrospun nanofibers, which alters the performance of the electrospun nanofibers greatly.
In this paper, electrospun porous nanofibers were prepared by controlling solvent system, electrospinning parameters and weight ratio in polymer blend. And the properties of obtained nanofiber mats were investigated. Theoretical analysis and experiment research were carried out to research mechanical mechanism of electrospun porous nanofibers, and could be used to optimize and control the porous structure.
To research the formation mechanism of electrospun porous nanofiber, a simplifying gas-liquid two-phase flow model was established. Based on the model, the effects of various spinning parameters on quality of product, such as the number of nanopores and diameter, will be systematically carried out. With the increase of the volume flow rate or the decrease of the applied voltage and the collect distance, the diameter of nanofibers decreased. The theoretical analysis results were further verified according to the experimental data. In addition, Bernoulli equation was used to study the electrospinning “splaying” process. As the jet accelerates and thins in the electric field, radial charge repulsion results in splitting of the primary jet into two filaments in the electrospinning process, we call this phenomenon as splaying. We found the ratio of pore width to pore length is varied along with the variation of the internal pressure of the jet, and the internal pressure of the jet increases with the velocity of the charged jet decreases. When the radial charge repulsion becomes larger the primary jet splitting into two filaments, the ratio of pore width to pore length decreases, the pores of the fiber will collapse.

6940 | The Use of Splicing Swimmer Bars as Shear Reinforcement in Reinforced Concrete Beams

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The Use of Splicing Swimmer Bars as Shear Reinforcement in Reinforced Concrete Beams

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Abstract

Shear failure is considered unsafe mode of failure in reinforced concrete beams, and should be avoided. Design codes recommend providing sufficient shear reinforcement in the form of regular steel stirrups. The main function of the regular stirrups is to add shear resistance to the reinforced concrete beams in addition of providing support to the longitudinal reinforcing bars. Swimmer bars are new type of shear reinforcement. They are small inclined bars welded to short transversal bars at the top and bottom in order to provide additional lateral stiffness to the swimmer bars forcing them to form plane-crack interceptor system instead of bar-crack interceptor system. The major problem with this kind of swimmer bars is the welding, in terms of quality, reliability and the long term effect on the beam behavior. In this study, splicing swimmer bars are used to replace the need for welding at the same time providing an effective tool for shear reinforcement in reinforced concrete beams. Several beams will be tested in the lab. The results of regular stirrups, welded swimmers bars, and spliced swimmer bars will be discussed and presented. Cracks will be monitored and recorded during the beam test as the applied load increases. Beam deflection will also be studied for the three different types of shear reinforcement.

6941 | Investigating the Use of Super Absorbent Polymer as Water Blocker in Composite Concrete Structures

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Investigating the Use of Super Absorbent Polymer as Water Blocker in Composite Concrete Structures

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Abstract
Adding super absorbent polymer (SAP) to the concrete mix as an admixture improves many concrete properties in its both stages; fresh concrete and hardened concrete. The SAP adds plasticity to the concrete mix and provide internal source of water that can be released slowly which, in turn, helps in concrete curing. The amount of SAP that can be added to concrete varies depending on the targeted concrete properties. In this study, concrete strength will be targeted along with water blockage capability. Previous study showed that the increase in the amount of SAP in concrete reduces the water flow through the concrete members at constant water pressure. In this study, the water pressure will be measured, at specified amount of SAP added to the concrete mix, just before the total blockage stage. The relationship between the water pressure and the water flow rate through the concrete composite member of specified parameters will be discussed and presented. Parametric study will be conducted using several test samples.

6942 | Behavior of overlapping Cold Formed Z-Beams

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Abstract
The plain Z-section is one of the most common cold-formed steel purlins in use for roof systems. Its lapping ability provides continuity, and double thickness material at the support regions results in greater performance and more economical designs. Four different types of purlin systems may be found in modern roofs with different degrees of continuity; single span, double span, multi-span with sleeves and multi-span with overlaps is the most popular.
Four verification cases: simple and overhanging beams are conducted, using a Finite Element Method (FEM) to investigate the structural behavior of lapped connections over the internal supports in multi-span cold-formed steel Z purlin systems with overlap. Results are compared with AISI code and pervious experimental works and good agreement is achieved.
In this research study, The moment resistance of overhanging Z-purlin with different thickness (1.5,1.6 and 1.8mm) ,different heights (142,172,202 and 232 mm) and overlap lengths (0.1L to 0.5L ,where L is the overhanging length) are investigated under combined bending and shear using ANSYS14.00. For each lap length, thickness and height, models were also conducted with and without straps either restrained compression flanges or not.

Key words: Cold Formed – overhanging beams – Z-beams - Finite Element – lateral torsional buckling – distortional buckling

6943 | Preparation and Characterization of Biodegradable Nanocomposite Films

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Earlier work has shown that biodegradable starch-based bulk composites present a more environmentally friendly and economical alternative to the non-biodegradable petroleum-based ones in several applications, including food and beverage packaging. The aim of this work is to investigate the viability of producing biodegradable starch-based composite films reinforced with clay nanoparticles for possible application in food packaging and similar applications.
The materials used in this investigation are commercial quality native corn starch, natural sodium Montmorillonite (Na+ MMT) clay particles (7 μm), glycerin and distilled water. A film casting technique was used to produce pure starch and nanocomposite films. Preliminary work has shown that 30 weight percent glycerin and 5 weight percent clay give optimum results. In the case of pure starch films, the starch was mixed in a domestic mixer with the glycerin and the mixture was sealed in polyethylene bags for three days at room temperature and 50% R.H. to facilitate the permeation of glycerin molecules into starch molecules. About 5 gm of starch-glycerin mixture were weighed and placed in a beaker, then 150 ml water was added to the mixture forming a solution. The solution was stirred using magnetic stirrer for 10 minutes and heat was then applied gradually until 85º C and the stirring was continued for 10 more minutes. The solution was then cooled to 70º C and poured into Teflon molds. The films were formed and peeled off from the molds after 36 hrs. In the case of the nanocomposite films, the clay particles were added to the starch solution during the initial stirring stage.
Six samples of each composition were tested according to ASTM D882-02 using Instron Universal testing machine equipped with a load cell of 1kN. The films were cut into rectangular strips (1.5x10) cm and conditioned for three days at room temperature and 50% R.H before mechanical testing. Specimens were tested at 50% R.H, 18ºC and crosshead speed of 10 mm/min. SEM was used to examine the fracture surface and FTIR and X-Ray techniques were used to investigate structural changes.
The pure starch material showed a tensile strength value of 10.7 MPa. The composite films reinforced with Na+ MMT clay particles showed a tensile strength of 18.2 MPa, which is 70.2% increase over the pure starch. The elongation at break has decreased as a result of adding clay particles; with the pure starch films showing 6.48% elongation at break and the Na+ MMT composites showing 4.86, a decrease of 25%. The pure starch showed a value of 435 MPa for Young's modulus while the Na+ MMT composites showed a value of 1450 MPa an increase of 233.3%.
SEM images showed starch plasticization for the pure granules through film casting. Moreover, no clay agglomeration was detected in the fracture surfaces of the composites.
Infrared spectra show that there is a general shift of the characteristic bands to lower frequencies, indicating an enhancement of the interactions between the starch, clay and plasticizer, resulting in composite films with stronger hydrogen bonds.
The plasticized starch showed different crystallinity type than the pure granules; the film cast samples showed a combination of VH and EH types. Moreover, clay addition is believed not to have adversely affected the crystallinity of the plasticized starch because no significant retrogradation was recorded after the introduction of clay particles. Incorporating Na+ MMT in the starch matrix resulted in intercalated structures, which increased the value

of d001 by 51% compared to the pure starch matrix.
Based on the results of this investigation, it can be concluded that the processing conditions and the amount of plasticizers were adequate to convert starch into thermoplastic material which was evidenced by SEM morphology and XRD. The addition of Na+ MMT resulted in composites with improved mechanical properties compared to the pure starch matrix. Introducing 5% Na+ MMT particles into the starch matrix resulted in intercalated structures without adversely affecting starch crystallinity. The presence of water in film casting technique led to better mechanical properties for the reinforced composite films. This is believed to be due to the role of water molecules in enhancing the interactions between starch with plasticizer and plasticizer with clay as revealed by the IR results, where the formation of new stronger hydrogen bonds in the composites were observed.

6944 | FATIGUE LIFE OF WELDED JOINT REPAIRED WITH CFRP UNDER CYCLIC TENSILE LOADING

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A major cause of failure observed in wind turbine steel towers is fatigue due to turbulent wind loads and dynamics associated with the rotation of blades. Wind turbine steel tower consists of many welded joints such as Shell to shell welds (Circumferential and Meridional), Shell to flanges or tower base welds. All these welded joints are weak points for fatigue resistance. Several research studies in the last decade showed the capability of externally bonded Carbon fiber reinforced polymer (CFRP) materials to extend the fatigue lifetime of steel members. These researches indicated that CFRP retrofitting can decrease stress intensity factor at fatigue crack tip. However, most contents are focused on steel members and discussions on welded joints are limited. The progress in studying the use of CFRP in strengthening of different welded joint increased. Previous researches demonstrated that fatigue failures in welded joints occurred as a result of fatigue growth of cracks emanating from the weld root or from the weld toe depend on weld defects. This paper reports an experimental study on the effectiveness of using CFRP sheets on extending fatigue life of welded joints. Specimens were cruciform fillet weld steel joint loaded with different stress range values. They are repaired by double-sided bonding CFRP sheets with CFRP stiffener. Experimental results show that the application of composite patches prolongs fatigue life. This paper also presents the effect of using CFRP in enhancement of stress Intensity factor at crack tip. Stress intensity factors (SIFs) of mode I (KI) at the crack tip were numerically investigated to evaluate joint performance. Finite Element analysis was used to determine Stress Intensity factor using contour J-integral method. Several parameters were considered during KI investigation such as, effect of crack depth, Elastic modulus of CFRP, Elastic modulus of Adhesive and CFRP thickness. Welds tend to be regions of weakness in a structure because of poor material properties, which vary throughout the weld and heat-affected zone (HAZ), so residual stresses, were considered in the Finite Element analysis. The validation processes of the current calculations have been shown.

6947 | Crack problems in heterogeneous media

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In this paper we consider the problem of heterogeneous solids within the framework of the linear theory of elasticity. The heterogeneous solids include multilayered media, multiple inclusions, circularly cylindrical layered media. The analysis is based on the technique of analytical continuation and the method of successive approximations. It is shown that the solution, either in plane elastostatics or anti-plane elastostatics, for an infinite domain with multiple circular inclusions, may be obtained from the solution of the corresponding homogeneous problem merely by substitution into a simple algebraic expression. This relation is universal in the sense of being independent of the loading considered. Several crack examples associated with multiple circular elastic inclusions under remote shear load and three-phase composite under remote tensile load are considered to demonstrate the use of the present approach.

KEYWORDS: multiple inclusions, analytical continuation, successive approximations

6951 | Buckling Behaviours of Functionally Graded Polymeric Thin-Walled Hemispherical Shells

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This paper investigates the static buckling behaviours of Functionally Gradient Polymeric Material (FGPM) shells in the form of hemispherical segment. A new FGPM model based on experimental was considered to investigate the buckling problem of thin-walled spherical shells loaded by the external pressure. The spherical shells were formed by FGPM which was produced adding the two types of graphite powders (PAM96/98 and PV60/65) into epoxy resin. The graphite powders were added to the epoxy resin as volume of 3, 6, 9, and 12%. The area percent of graphite distributions were observed by light microscope and calculated by image processing program. After that Halpin-Tsai and Paul models were used to determine the elastic moduli of the parts of FGPM. The detailed static buckling analyses based on the above material models were performed by using finite element method for the hemispherical FGPM shells. The influences of the types and volume of graphite powders on the buckling behavior of the FGPM structures were investigated. The buckling loads of hemispherical FGPM shells based on Halpin-Tsai and Paul models were compared with those determined from the analytical solution of non-graphite condition existing for homogeneous material model. The comparisons between this material models shows that Paul model is overestimated. Besides, the critical buckling loads were predicted and their mode shapes were presented. The higher critical buckling loads were estimated for the PV60/65 graphite powder due to the compatible of the PV60/65 graphite powder with resin.

Keywords: Hemispherical thin shells, functionally graded polymeric materials (FGPMs), external pressure, static buckling, finite element analysis (FEA)

6957 | Spring-back Prediction of CRFP Composite Laminate Ribs

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The manufacturing of carbon fibre reinforced plastics with autoclave induces spring-back. Such deviations from the desired part shape complicate matters during the assembly phase. Indeed, during assembly of the deformed parts internal stress level increases, therefore decreasing the life cycle of the part. Given the high manufacturing rates required today, efficient simulation methods are needed by the aerospace industry to increase the quality of the manufactured parts and be cost effective at the same time.
The spring-back phenomenon is produced by the induced stresses during cure. The stresses generated during curing-cooling cycle come from 3 different mechanisms: chemical [1], thermal [2] and tool-part interaction [3]. A new model was proposed by the same authors to predict the spring-back of carbon/epoxy laminate composite [4]. An original method was developed to obtain the in-plane and out-of-plane shear stress due to the ply stretching and tool-part interaction respectively. Firstly, ply stretching is obtained using a specific Coefficient Thermal Expansion (CTE) on the ply adjacent to the tool. From this, the in-plane stress is concentrated near the interface as experimentally demonstrated [5]. Secondly, the tool-part interaction is modelled from a single layer of elements associated with an orthotropic linear behaviour coupled with an out-of-plane shear stress failure criterion. Finally, a specific method was proposed to determine these 3 parameters thanks to the literature [6]. The simulation results were validated from the experimental test results on flat unidirectional composite carbon/epoxy laminates. Indeed, the model facilitates the warpage prediction and the effects of the laminate thickness and size were also validated.
In this work, the FE model proposed by the same authors is used to predict the spring-back of an L-shape carbon/epoxy composite laminate. The study is part of a joint project with Aerospace Malaysian Innovation Centre and an aerospace structure manufacturer CTRM Malaysia. The scope of this study is focused on varying the angle of an L-shaped sample and observing the effect on the spring-back. A manufacturing campaign on different angle of L-shape specimens; 30; 45 and 90 degree with its spring-back measurement are carried out in order to determine the effect of angle to the warpage/springback deformation.
In simulation, first, the material parameters of laminate, interface and tools found from previous study on flat laminate are employed as initial values. Upon comparing with L-shape spring-back measurement/experimental values, the effect of angle can be proposed accurately in order to understand the physics phenomena behind it. With further simulation-experimental comparison, the FEA model can be proposed as a tool to predict the spring-back deformation for any L-shape laminate. The FEA model becomes a good base for further application on real aircraft parts such as ribs made of laminate composite to predict its global spring-back deformation.

[1] Olivier P.A. A note upon the development of residual curing strains in carbon/epoxy laminates. Study by, thermomechanical analysis. Compos Part A; 37 (2006): 602-616.
[2] Parlevliet P.P, Bersee H.E.N, Beukersa A. Residual stresses in thermoplastic composites - a study of the literature. Part III: Effects of thermal residual stresses. Compos Part A; 38 (2007): 1581-1596.
[3] Twigg G., Poursartip A., Fernlund G. An experimental method for quantifying tool–part shear interaction during composites processing. Compos Sci. and Technol; 63 (2003): 1985–2002.
[4] Mezeix L., Nasir M.N.M., Aminanda Y., Rivai A., Ali K.M. Parameter study of tool-laminate interface through simulation for composite manufacturing using autoclave process. Applied Mechanics and Materials.
[5] Darrow J.R. D.A. and Smith L.V. Isolating components of processing induced warpage in laminated composites. Journal of Composite Materials; 36 (2002): 2407.

6960 | Ultrahigh strength and tough Fe-based bulk metallic glass composites fabricated by tilt casting

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The Fe77Mo5P9C7.5B1.5-based bulk metallic glass composites (BMGCs) with ex-situ added micro-sized Ta particles were successfully fabricated by arc melting and tilt casting process in an argon atmosphere. These BMGCs were found to exhibit distinct thermal properties in comparison with their base alloy counterpart. In addition, the particle size of ex-situ added Ta particle was revealed to decrease from 25 μm into sub-micron after melting and casting processes. This indicates that some reaction occurred between the Ta particles and Fe-based alloy melt during the melting process. Based on the results of XRD analysis and SEM examination with EDS mapping, two crystalline phases were revealed co-existing in the amorphous matrix. One is the micron-sized alpha-iron precipitate and the other is TaC hard phase with dimension of several microns. Both of these two crystalline phases distribute randomly in the amorphous matrix of the Fe-based BMGCs. Nevertheless, the results of compression test show that the compression plasticity exhibits an increasing trend with ex-situ added Ta content. The optimum performance, 8% compressive failure strain and 3 GPa fracture strength, occurs at the Fe-based BMGC rod with ex-situ added 13 vol.% Ta particles at room temperature. In addition, the toughness of more than 70 MPa$\sqrt{m}$ can be obtained for this Fe-based BMGC.

6962 | Enhanced plasticity of MgZnCa based bulk metallic glass composites

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MgZnCa bulk metallic glass (BMG) has become a potential candidate for bio-implants because of its high bio-capability and self-degraded ability. However, inherent the brittleness of Mg-based BMG, it leads to many restrictions on medical applications. Hence the importance of toughening mechanism which restricts the propagation of shear bands by in-situ or ex-situ particles is essential. In this study, a series of Ti particles reinforced

Mg58Cu28.5Gd11Ag2.5 metallic glass composite (BMGC) rods with a diameter of 2–4mm have been successfully synthesized by injection casting method in an Ar atmosphere. The glass forming ability (GFA) and mechanical properties of these Mg-based BMGCs have been systematically investigated as a function of volume fraction of Ti particles. The results show that the compressive strength can be improved from 655 MPa to more than 800 MPa by adding 20-50 vol% 75-105 microns Ti particles. In addition, the failure strain can reach to 7.5% for the Mg-based BMGC with 50 vol% Ti particles. Overall, the results of microstructure of composite and toughening effect of these MgZnCa-based BMGCs will be discussed in detail.

6963 | A design approach for the development of connections between FRP bridge decks

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The use of fibre reinforced polymer (FRP) bridge decks has gained an increasing interest as a competitive alternative to traditional decking solutions. Even though the use of FRP decks started in the early 1990s, the uptake of these decks has been slow in bridge construction and there remains a need for research in diverse technical areas to promote the widespread use of these decks. One such area is the detailing and design of deck panel level connections which enable rapid on-site assembly. The design of connections in FRP decks is a somewhat complex process, which should take account of not only the structural performance and durability of the joint but also the ease of application and the tolerances this necessitates. It should therefore be regarded as a process in which the client, the designer, the manufacturer and the contractor are all involved. This process has been applied in the design of a novel joint configuration for panel level connections presented in this study. The collaboration between the client, designer, manufacturer and contractor led to the development of a connection concept, in which expectations originating from the views of all the parties were included. In this way, a concept focusing on meeting the requirements of all parties was designed.

6965 | Dispersed Nanographite Particles by Ultrasonication for Portland Pulverized Fly Ash–Cement System (Class F)

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Highlights from research results
• The effects of extremely dispersed nG in solution by ultrasonication on PPFA–C system are examined.
• Ultrasonicated-nG solution which is 2-3 μm diameter disk–shaped and pure carbon cell powder is added with and without ultrasonication into the PPFA–C system.
• Absorbance spectra of ultrasonicated–nG solution, the Ca(OH)2 contents, the setting times, the rheologies, and the compressive strength gains are monitored.
• Ultrasonicated-nG solution causes to decrease the thixotropy of cement paste between PFA particles, and so cement and PFA particles keep reacting each other.
• Ultrasonicated-nG solution speeds up the setting times and increases the strength gains for PPFA–C system and pure Portland cement system.
• Ultrasonicated-nG solution causes considerably short setting times for PPFA–C system.
• Ultrasonicated-nG solution also causes considerably higher strength gain for PPFA–C system than that of pure Portland cement and conventional class F pulverized fly ash-cement.

Abstract
Researchers have used the class F fly ash– pulverized fuel ash (PFFA)– as a constituent of blended cement or in combination with pure Portland cement due to pozzolanic activity of the pfa. In either case the normal proportion of PFFA is 20–35% of the total cement (Berry and Malhotra, 1980; Al-Ani and Hughes, 1989; Lam et al., 1998; Joshi and Lohtia, 1999; Han et al., 2002). Portland pulverised fuel ash cement (PPFA–C) is manufactured by burning a precisely specified mix of raw materials containing lime, silica, alumina and small quantities of other materials to form a clinker and then inter–grinding that clinker with pfa and gypsum (calcium sulfate), the latter being added to control the setting. The following benefits can be obtained with the use of Portland pfa cement in mortars, concrete, grout and screed compared with the pure Portland cement at equal water–to–cement ratio (Virtanen, 1983; Idorn and Henriksen, 1984; Malhotra, 1990; Bilodeau and Malhotra, 1992; Bilodeau and Malhotra, 2000): – improved workability and cohesion; – reduced bleeding; – enhanced resistance to sulfate attack; – enhanced resistance to chloride ingress; – more effective resistant for damaging alkali–silica reaction. Although the class F fly ash has got pozzolanic activity on cement, the drawbacks of using pfa in pure Portland cement are as follows (Halstead, 1986; Langey et al., 1992): – increased setting time; – reduced early strength. There is a need to make better these negative effects than ever, and hence this research is planned to try to overcome the effects by extremely dispersed nanographite (nG) solution prepared ultrasonication. In this paper, Portland pulverized fly ash–cement (PPFA–C)systems blended nG powder and ultrasonicated-nG solution are developed. Pulverized (Class F) fly ash, nanographite, and ASTM type I cement are used to prepare appropriate PPFA–C combinations (35% FA + 65% ASTM I + 0.22% ultrasonicated-nG or nG powder). Pastes and mortars are also prepared by PPFA–C and pure Portland cement. Experimented properties of PFFA–Cs and pure Portland cements are the absorbance spectra of ultrasonicated–nG, the Ca(OH)2 contents, the setting–times, the fluidities, and the compressive strengths according to present international standard methods and liturature knowledge. Research results indicate that the use of ultrasonicated-nG solution is shown to be favorable in terms of absorbance spectra, the Ca(OH)2 contents, the setting–times, the rheologies, and the strength gains at early ages.

Keywords: Ultrasonication; Nanographite; Class F pulverized fly ash; Absorbance spectra; Rheology; Thixotropy; Coagulation; Compressive strength

6966 | Ti-Cu-Ni-Si Phase diagram in Ti-rich region

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There are four phases equilibrium, Ti3Si-Ti2Cu-Ti2Ni-Ti5Si3, Ti3Si-Ti2Cu-Ti2Ni-Ti, TiNi-Ti2Cu-Ti2Ni-Ti5Si3, were found in the Ti-Cu-Ni-Si alloy system at 800 oC. This study was performed by means of equilibrated alloys and diffusion couples. Electron microprobe analyses were used to determine the phase compositions and phase relationships. The solubility ranges of the intermetallic phases were determined. Since the four phases equilibrium form as tetragonal, the equilibrium phase relationships will be presented as 3D picture.

6967 | Effect of variation of density on onset yield of rotating FGM disks

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In this paper, using Tresca's yield criterion, a closed-form solution to determine location of yield in rotating disks made of functionally graded materials (FGMs) is presented. The material properties are assumed to vary according to power law functions and the Poisson's ratio is assumed constant. In the present work, rotation and variation of material properties are considered simultaneously. To the best of authors' knowledge, in previous researches which onset of yield is investigated, variation of material density is ignored, while density is not constant in FGM rotating disks. Our results show that the density variation has a significant effect on the stress distributions.

6968 | Collapse mechanism under in-plane loadings of calcareous masonry panel retrofitted with fiber reinforced composite

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An experimental study of the mechanical behaviour of calcareous brick masonry elements under in-plane increasing loads is presented in this paper. The study is mainly oriented to the identification of the elementary mechanisms involved in the response of masonry elements retrofitted with carbon fibre reinforced polymers (CFRP) under normal and parallel to bed joint compression and diagonal compression. Masonry specimens are reinforced or repaired with a grid of C- FRP. For comparison, some of the specimens were tested up to failure without reinforcement, others were reinforced with CFRP

The retrofitted panels exhibited and enhancement of the collapse load up to 10-20% in respect to the URM panel as well as of the axial deformation capability. The stiffness longitudinal modulus slightly increases because of the buckling of the vertical strips otherwise the transversal stiffness modulus greatly increases due to the effectiveness of the to the horizontal strips
At failure, the retrofitted panels have shown similar pattern regardless by the in plane loading direction. Stretching of the horizontal strips increased the tendency for web splitting of the masonry; at failure wide cracks ran in a stepped pattern through the wall thickness, however, the integrity of the walls at ultimate stage was ensured by the FRP reinforcement.

6975 | New approach to finite element modeling of dynamic tests with Hopkinson pressure bars applied to composite materials

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Composite materials are increasingly being used as a substitute for metallic materials in many technological application like aeronautics, aerospace, marine, armour, automotive and civil engineering applications. Many of these applications, the structure is subjected to high impact loading. The mechanical behaviour of composites being dependent on loading rate, knowledge of constitutive models is of interest of scientists and designer.
The strain rate sensitivity of glass fibre reinforced polymer is studied by testing a single laminate configuration. The compressive material properties are determined by testing the laminate systems with different orientations from low to high strain rates. Samples of cubic geometry are tested in in-plane direction for different fibre orientations. After carrying out the dynamic tests, the aim of this study is their modelling by using finite element method. The models are used for validating material characteristics and predicting their elastic behaviour. The FEA gives results which are in coherence with the experimental values. The improved understanding of these phenomena and the development of predictive tools is part of an ongoing effort to improve the long-term integrity of composite structures under dynamic loads.

6976 | Seismic Test of Composite Beam System consisting of H-section and U-section Members

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In this research, connection of steel reinforced concrete(SRC) column and composite beam which consists of H-section and U-section members were tested under cyclic loading. An essential point of the composite beam is the structural performance of welded joint between the H-section and the U-section members. To improve the structural performance of joint of two beam members, vertical stiffeners and trapezoidal stiffenerswere used. Five full-scaled specimens were designed to study the effect of a number of parameters on cyclic performance of connections. Based on the test results, deformation capacity of the specimens with H-500 series beam and H-600 series beam were 4% and 3% rotation angle, which is the requirement for the Special Moment Frame and Intermediate Moment Frame(IMF), respectively. Test result showed that deformation capacity of connection with stiffeners between the H-section and the U-section members is greater than that of connection without stiffeners. Finally, energy dissipation capacity and strain profile of specimens were summarized.

6977 | Applications of Base Isolation Systems for Building Structures in Korea

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Korea is located in a region of low-to-moderate seismicity. Seismic isolation has been limited to relatively few building structures, although the application of seismic isolation system has become popular world, However, recently the construction of seismic isolation systems has increased because its effectiveness technology for reducing the seismic response of buildings. This paper introduces the application of seismic isolation systems for improving the seismic capacities of building structures in Korea. Here, Base isolator is made by composite materials using rubber and steel plates, which is named as laminated rubber bearing. Currently, there are some seismically-isolated buildings in Korea such as residential buildings, data center, research building, and community center and so on. Finally, a new design code for seismic isolation system of Korea is presented.

6979 | Assessment of nanoclay and Coupling agent MAPP on mechanical properties of Picea flour/poly propylene/nanoclay composite

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In this research, effect of nanoclay cloisite 30B and coupling agent MAPP on mechanical properties of wood plastic composite that produced from picea flour/ poly propylene/nanoclay inspected. For this propose, we used picea wood flour in constant level of 40%, MAPP in two levels of 2 and 4%, nanoclay in 4 levels of 0, 1, 3 and 5%. Next, wood plastic nano composite constructed by using of injection moulding method, and mechanical tests containing tensile, bending and impact performed on samples. Results showed that tensile strength and flexural strength and flexural modulus of composite enhance by increasing nanoclay and MAPP. Structural studies of wood plastic nano composite by diffraction of X-ray also showed that distribution of nanoclay particles in polymer field is intercalation, and distance of between layers increase by enhancing of nanoclay particles amount.

Key words Wood-plastic composite, Nanoclay, Mechanical properties, X-ray Diffraction, Intercalation structure

6986 | Optimization of FGM sandwich beams using Imperialist Competitive Algorithm

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Sandwich structures are used in a variety of engineering applications including aircraft, construction and transportation where strong, stiff and light structures are required. In this paper, frequency maximization of Functionally Graded Sandwich (FGS) beams resting on Pasternak foundations is investigated. A generalized power-law distribution with four parameters is considered for material distribution through the thicknesses of face layers. Since the search space is large, the optimization processes becomes so complicated and too much time consuming. Thus a novel meta–heuristic called Imperialist Competitive Algorithm (ICA) which is a socio-politically motivated global search strategy is implemented to improve the speed of optimization process. Results represent the success of applying ICA for engineering problems especially for design optimization of FGM sandwich beams.

6987 | Implementation of various higher-order shear deformation theories for free vibration analysis of functionally graded nanocomposite beams

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n this paper, free vibrations of functionally graded nanocomposite beams reinforced by Single-Walled Carbon Nanotubes (SWCNTs) are investigated. The SWCNTs are assumed to be aligned and straight with a uniform layout. The rule of mixture is applied to describe the effective material properties of the structure. Various higher-order shear deformation beam theories are applied for the analysis. The displacement fields of the proposed beam theories are chosen based on the assumption of a constant transverse displacement and higher-order variation of axial displacement through the depth of the beam. The equations of motion are derived by applying Hamilton's principle. The main purpose of this paper is to show the simplicity and accuracy of the proposed higher order shear deformation theories for free vibration analysis of nanocomposite beams. The natural frequencies of the nanocomposite structure for uniform and three types of functionally graded carbon nanotubes distributions are compared with the existing solutions to verify the validity of the theories.

6995 | The influence of the graphene additive on mechanical properties and coefficient of friction of Al2O3 composites for cutting tools application

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Advanced structural ceramics are expected to be suitable for cutting application because of their hardness and corrosion resistance at high temperatures. Especially alumina is promising material at high temperatures because of its excellent chemical stability and low price. However tribological experiments of alumina sliding against itself at high temperature show a high friction coefficient (0.8-1.2) and high wear rate. One of the method of improvement of tribological parameters are solid lubricants additives. The great chemical stability of Al2O3 at elevated temperatures—the cutting edge can reach 1100 °C in some applications— makes Al2O3 a particularly attractive material for wear resistant tool materials. Furthermore, when thermal conductivity of Al2O3 is compared to the other cutting tool materials like titanium nitrides or carbides, it is the relatively small. It has significant influence on cutting properties. Graphene, a two-dimensional, crystalline allotrope of carbon is characterised by exceptional electrical, thermal and mechanical properties. Very high electron mobility, thermal conductivity above 5000 W/mK and Young modulus around 1TPa place graphene as a promising material in many branches of

science and technology. The addition of dispersed phases to Al2O3 results in an increase in hardness of composite. An additional benefit, the adding a dispersed phases is the potential for increased fracture toughness. Except of excellent thermal and electrical properties, as a single phase the graphene shows also an excellent mechanical strength and low friction coefficient in the major crystallographic direction, so its addition can improves cutting properties of Al2O3. Alumina powder (Al2O3-α, A16SG, average grain size 0.3-0.6 μm, prod. ALCOA) has been used as a starting material. Three types of multilayer graphene powders were used as filler for alumina based composites: nanoplatelets with average flake thickness <12 nm , 30-50 monolayers, average particle (lateral) size 4.5 μm, 99.2% pure; nanoplatelets with average flake thickness <8 nm , 20-30 monolayers, average particle (lateral) size 0.5 μm, 99.9% pure,; nanoplatelets with average flake thickness <4 nm , <4 monolayers, average particle (lateral) size 1-2 μm, 99% pure. Despite the use of various mixing equipment, mixing at different speeds in water, alcohol and acetone, graphene tends to agglomerate which adversely affects the properties of the compacts. Results of the mixtures preparation will be presented. The composites were sintered using Spark Plasma Sintering – SPS at 1550 °C during 10 min under 35 MPa of uniaxial pressure during the whole cycle. Sintered specimens were disk-shaped with dimensions of 20 mm in diameter and ~5 mm in thickness. Graphene participation was 0.5wt%, 1wt%, 2wt% and 10 wt%. After grinding and ionic precision etching the surface of the sintering compacts was analyzed by X-ray diffraction method and Raman spectrometry. Modulus of elasticity (Young's modulus) were determined by a measuring the transmission velocity of longitudinal and transversal ultrasonic waves through the sample. Young's modulus is changed from 377 GPa for 0.5 wt% of graphene (4nm) up to 135 GPa for 10 wt% of graphene. The SEM and TEM microstructural analysis show that the applied pressure during the sintering process (SPS) leads to the orientation of the graphene phase and in consequence to the composite anisotropy. For a composite with 2 wt% participation of graphene, the hardness HV1 in the direction of the pressing axis is 14.7±0.5, and for the perpendicular direction to the pressing axis is 14.8±0.1 Selected mechanical and tribological properties of the graphene reinforced Al2O3 ceramic, taking into account the direction of the measurement, are presented. The properties of Al2O3 composite with graphene strongly depend on the participation of additives and number of monolayers.

6996 | Experimental investigation of bolted and hybrid connections for FRP structural members

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The use of fibre reinforced composite materials in infrastructure projects, such as bridges, has been growing. Two common joining alternatives for FRP composite members include using mechanical fasteners such as bolts and adhesive bonding. A combination of both alternatives, referred to as hybrid connections, has also been also implemented. Hybrid connections are usually used to provide fail-safe structures. However, this type of connection can offer more than robustness to the structure. It has the potential advantage of on-site assembly for bridge elements, with the parts being fixed by bolts during the bonding process, which provide fixation and stiffness until the adhesive cures. In this case, the site activities are not hindered, and the bridge opening to the traffic is not delayed. The fixation of the hybrid connections is provided by the bolt preload. A major problem in joints with preloaded bolts is the relaxation due to creep of the FRP material. One method to avoid the relaxation is to use metallic inserts in the hole, where the bolt is fastened. This is demonstrated by a number of tests conducted in bolted and hybrid connections with and without inserts, which are presented and discussed in this paper.

7001 | Mechanical properties of polylactic acid (PLA)/ recycled low density polyethylene (rLDPE) filled Nypa Fruticans (NF) fiber: Effect of fiber modification using chelator

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Nypa fruticans fiber filled biodegradable polylactic acid (PLA) and recycled low density polyethylene (rLDPE) biocomposites were prepared using Brabender Platicorder EC Plus. The effects of filler content and chemical modification on tensile properties and morphology of biocomposites were evaluated. The effect of NF content decreased the tensile strength and elongation at break of biocomposites, whereas increased Young's modulus. Ethylene Diamine Tetraacetic Acid (EDTA) were used as chelating agent and improved the treated PLA/rLDPE/NF biocomposites. It was found that the tensile strength and Young's modulus of treated biocompoites with EDTA higher than untreated biocomposites. Scanning electron microscopy (SEM) study of the tensile fracture surface of the biocomposites indicated that fiber modification with EDTA enhanced the interfacial interaction between NF and matrix.

7003 | Thermomechanical properties of nanotube/polymer composites

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Thermo-induced shape memory polymers (SMPs) are intensively investigated for applications such as packaging, heat shrink tubing, deployable structures, morphing composites, etc (1). SMPs are generally deformed at a high temperature, then cooled down under fixed strain. Reheating the material allows the polymer chains to revert toward their initial conformation. In this work, we report on the exceptional shape memory behavior of nanotube/polymer composite fibers. Their shape memory behavior can be tuned by the programming process in a surprisingly accurate way, the so-called "temperature memory effect"(2) . These materials have the capability to memorize multiple temporary shapes in a single shape memory cycle. The mechanisms underlying these behaviors and the role of the nanotubes within the polymer matrix will be discussed. Properties other than mechanical properties, which are affected by such mechanisms will also be presented (3).

References
(1) Behl, M.; Razzaq, M. Y.; Lendlein, A., Adv. Mater. 2010, 22, 3388–3410.
(2) Miaudet, P.; Derré, A.; Maugey, M.; Zakri, C.; Piccione, P. M.; Inoubli, R.; Poulin, P. Shape and Temperature Memory of Nanocomposites with Broadened Glass Transition. Science 2007, 318, 1294–1296.
(3) Grillard, F., Poulin, P., Korzhenko, A., Gaillard, P., Zakri, C., MacroLetters 2014.

7004 | Producing a safer high performance nano filler composite by unique processing of epoxy based matrix

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Primary objective of this paper is to present an optimized and controlled innovative mixing system named ultrasonic dual mixing (UDM) process for preparation of practically cluster free homogeneous distribution of different type and amount of inorganic nano-particles in semi viscous matrix of polymer and its influence on strengthening mechanism of nano-particulate composite adhesive of structural epoxy. The studies are targeted to understand the influence of various nano particles on the micro-mechanism of structural components of an epoxy based polymer affecting primarily their physical and mechanical properties. Safety of the composite is characterized through studies on their fracture mechanics property.
The studies have been carried out by selecting nano size non-metallic particles on the basis of their physical and chemical properties and compatibility with the epoxy base polymer for preparation of desired particulate composite. Different types of nano-particulate composite have been prepared by addition of varying amount of commercially available nano size inorganic non-metallic particles in suitable epoxy base polymer by using UDM process. They are made to provide improved elevated temperature strength and fracture properties to the polymer matrix. During preparation of the nano-particulate composite by the UDM process the mixing parameters affecting distribution of various types of particles in the matrix are studied to obtain a practically cluster free homogeneous mixture of the powder and epoxy base.
The amount of different types of inorganic nano particles enhancing the glass transition temperature (Tg), thermal stability and tensile properties of the nano particulate composite to a maximum has been optimized. The influence of UDM and particle reinforcement on the improvement in properties of the matrix has been compared by the fraction (%) increment in them with respect to those of the neat base epoxy. It is noted that the effect of different amount of three types of oxide nanoparticles such as TiO2 (10 wt%), ZrO2 (5 wt%) and Al2O3 (3 wt%) on the property enhancement of the matrix is significantly different where, the addition of TiO2 has been found most effective. The enhancement in tensile properties of the UDM processed neat epoxy may be attributed to the presence of hexagonally arranged and uniformly distributed nano cavities in the base matrix. Those nano cavities might act as reinforcement in the epoxy matrix and their inter-cavity spacing in nano dimensions might be responsible for restricting the movement of polymer chain segment. Combination of various toughening mechanisms such as particle pull-out, plastic void growth, plastic deformation, crack deflection and crack bridging observed in tensile fracture surfaces of all the nanocomposites are found primarily responsible for enhancement in mechanical properties. The efficient increase in the thermal stability may have attributed to the large number of obstacles to the heat flow imposed by the homogeneously distributed nano-cavities and further more by the presence of heat insulating oxide nanoparticles in the epoxy matrix.
The new observations of this work are as follows. UDM is a unique technique of mechanical processing of semi viscous polymer that can considerably improve its physical and mechanical properties. At optimum level of practically cluster free homogeneous distribution of inorganic nanoparticle (10 wt% TiO2, 5 wt% ZrO2 and 3wt% Al2O3) by UDM processing considerably improves the thermal (Tg , durability) and mechanical properties of epoxy based polymer adhesive. However, the improvement in properties is found to be sensitive to type of nanoparticle of size lying in the range of 10-30nm. The improvement in properties appears to be primarily happened due to modification of structural arrangement of the matrix along with formation of geometrically well arranged nano-cavity formation in it which also helps in distribution of particles in the mat

7005 | ANATICAL AND NUMERICAL MODELISATION OF A DYNAMIC RESPONSE ADAPTIVE MATERIAL SANDWICH BEAM

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In this article, it was studied anatically and numerically the dynamic response of an adaptive material sandwich beam, clamped-free, delimited by two skins aluminum 7075T6, firstly subjected to a variable magnetic field perpendicular to the skin of the beam, and secondly to a harmonic excitation by magnetic force applied at the free end. Our main objective is to predict the effect of the intensity of the current flowing through a coil on several dynamic factors. The maximum amplitude of resonance and the variation of the loss factor as a function of structural stiffness are adjusted simultaneously by the application of different magnetic fields. The results of both methods are compared.

7006 | Application of Optimizing Genetic Algorithm to Prestressed Concrete Beams

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Structural design process is distinguished by the implementation of scientific knowledge and economy to achieve a safe, serviceable, durable, reliable, economical and aesthetically pleasing structure. Genetic algorithm will be used, which is derived from natural selection and the rules of natural genetics, to design for the most efficient prestressed concrete section. Optimum section of simply supported prestressed concrete beam will be used as an application of this algorithm. The basic dimensions of the prestressed beam will be the variables. An index will be introduced to measure quantitatively the degree of satisfaction for the presented solution. Every gene can have its own index, and the accumulative value of all genes produces a general index of the trial. The optimization process will take into consideration several economic factors in addition to the rate of change in the material and labor cost with time.

7009 | THE SHEAR BEHAVIOR'S CHARACTERIZATION OF LIMESTONE MATERIAL BY ANALYSIS OF THE FRACTAL DIMENSION

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The limestone material's fragmentation characteristic is analyzed from the direct shear test results. Indeed, these tests provide useful information's as

regards shear stress (τ) and the fractal dimension of the material's fragmentation subjected to shear. It was observed that the characteristics of the crushing limestone grains vary in terms of fragments produced. Before and after each grains fragments, samples were sieved mechanically and a fractal analysis is, then, performed for each sample, and for the selected grains. The objective of this work is to connect the fractal dimension with different mechanical properties measured at the shear box.

7012 | Diamond composites with ternary carbides bonding phase from Ti-Ge-C system

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Abstract

As a new class of carbides and nitrides the MAX phases offer fundamentally new directions to creation the structure and properties of ceramics for emerging applications. In this paper we present a new trends for application diamond matrix composite with ceramic bonding MAX phase from Ti-Ge-C system. Polycrystalline diamond compacts (PCD) are usually produced by means of high pressure–high temperature (HP-HT) sintering. This technique always introduces strong structural stresses in compacts, which might result in their self-fragmentation or graphitization of a diamond. This disadvantageous effect might be relieved by a ceramic bonding MAX phase with properties between ceramics and metal.
Direct Self Propagating High Temperature Synthesis, SHS technique was used for producing the MAX phases from titanium, germanium and graphite. The Ti3GeC2 milled powder was mechanically mixed, in the range 10 to 30 wt%, with 3-6 *μ*m commercial diamond powder (MDA, De Beers) and compacted into disks 15 mm in diameter and 5 mm high. The compacts were sintered at the high pressure of 8□0.5 GPa and high temperature of 2230 □50 K in a Bridgman type toroidal apparatus for 30 s. The amount of the bonding phase affected the mechanical properties: Vickers hardness from 20.0 to 40.0 GPa and Young's modulus from 200 to 500 GPa, with their highest values recorded for 10 wt% Ti3GeC2. As the highest values of Vickers hardness, Young's modulus and the density were for 10 wt% binder phase, further properties: tensile strength, fracture toughness and friction coefficient were carried out on the DTi3GeC210 composite, Table 1.

Table 1. Vickers hardness, fracture toughness, tensile strength and friction coefficients of the 10wt% DTi3GeC2 composite.

Sample Vickers hardness Fracture toughness Tensile strength Friction coefficient Friction coefficient
HV1 [GPa] KIC [MPam1/2] σT [MPa] (for Si3N4 ball) *μ* (for 100Cr6 ball) *μ*
DTi3GeC2 37.0±0.2 8.2±0.2 303.0±20.0 0.11±0.09 0.61±0.12

Vickers hardness HV1 measured using a digital microhardness Future-Tech type FM7 is of about 40 GPa HV1. Fracture toughness of the diamond composite, at about 8 MPam1/2, is double KIC of alumina ceramics. Its tensile strength is at a good level of 300 MPa and friction coefficient 0.11 (for Si3N4 ball) and 0.61 (for 100Cr6 ball). Fracture toughness was assessed by means of the conventional method (3PB) on SENB (Single Edge Notched Beam) specimens with 1.5mm□4.0mm□15.0□0.1mm dimensions□ Tensile strength was measured by diametral compression of disks and calculated from Hertz's formula. X-ray diffraction of the DTi3GeC210 composite indicated the presence of 87.1 wt% diamond, 2.8 wt% Ge, 6.9 wt% graphite, 3.2 wt% TiC. Missing of Ti3GeC2 phase confirmed that the decomposition of this phase takes place during sintering process at high temperature (2230□50K) and high pressure (8□0.5GPa). In these conditions phase Ti3GeC2 is unstable and undergo decomposition. Addition of the Ti3GeC2 phase to the diamond provides the pseudo-isostatic conditions of the HP-HT sintering because this phase preserves the graphitization process of diamond and guarantees the homogeneity of material. SEM and TEM microstructural observations showed a good penetration of the bonding phase between diamond crystallites. The diamond grains exhibit a high density of dislocations caused by high pressure and high temperature. Preliminary tests indicate a possibility of using this material in burnishing tools for e.g. steels and aluminium alloys for improved surface integrity.

7013 | Failure analysis and numerical investigation on the induced damage when machining CFRP composites

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Machining of Carbon Fiber Reinforced Polymer (CFRP) generates a great damage of the machined workpiece. Indeed, the heterogeneity and the abrasive nature of carbon fibers make the machinability of these materials more difficult compared to the conventional metals and their alloys. Chip formation mechanisms include four types of damage modes: matrix cracking, fiber-matrix debonding, fiber breaking and inter-ply delamination. In the current work, a numerical analysis coupled with the Taguchi method has been used to identify the most significant factors and their interactions on the induced damage. The latter can strongly affect the surface roughness and considerably limits the use of these materials in many applications. In fact, the surface quality plays an important role in the improvement of fatigue life and wear resistance of composite components. For analysing the chip formation mechanisms, the damage process (initiation and growth) within the workpiece due to the degradation of mechanical properties and to predict the induced damage, a combined elastoplastic damage model has been adopted to simulate the cutting operation. The model has been implemented in Abaqus using dynamic explicit method. Satisfactory numerical results have been found and a good correlation has been obtained compared to experimental trends. Due to the complex nature of this process, we focus here on the effect of cutting parameters on surface damage of the machined component and thus wear resistance. The orthogonal Design Of Experiments (DoE) L27(313) of Taguchi has been applied to investigate the effect of the fiber orientation, the tool rake angle, the depth of cut and the tool edge radius on the surface quality of the finished product. The results reveal that the interaction between factors could be neglected and the response is greatly influenced by the fiber orientation and the depth of cut rather than the tool rake angle and the tool edge radius.

7015 | High-order wave propagation in multi-directional composite laminates

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Numerical tools for predicting the dynamical behaviour of composite structures are highly required in the field of automotive and aerospace industries. In most cases, composite materials failure is due to fatigue and fracture issues. Thus, an increasing research effort has been made in the field of Structural Health Monitoring (SHM) and wave dispersion analysis. Besides, acoustic comfort is now an imperative concern in the field of engineering and requires the numerical models to be accurate at higher frequencies. Since analytical approach suffers some drawbacks when facing heterogeneous or anisotropic materials, FEM is usually adopted. However, it yields heavy FE models and extensive computations in the medium frequency range.

For the last decade, wave-based methods were developed to perform vibro-acoustic analyses of large-scaled waveguides in a broadband frequency range. Waveguides are structures, such as beams, pipes, sandwich panels or layered shells, whose main dimensions exhibit periodicity or homogeneity in such a way that the propagation of the mechanical energy in the main direction s is privileged. In this context, Bloch's theorem can provide significant reduction of the modelling effort by leading to a spectral problem formulation, whose solutions are associated with the wave dispersion characteristics in the main directions.

Although significant advances have been made in modelling low-order Lamb waves in multi-directional layered plates, dispersion characteristics are rarely investigated using numerical models for higher frequencies. Therefore, the question arises whether these models can accurately predict wave coupling or localisation phenomena occurring into the layers in the medium frequency range. This work is concerned with the wave propagation in layered plates involving fiber-reinforced composite laminates. The wave dispersion phenomena is studied using the wave-finite element method (WFE) and compared with the results obtained in the literature. In addition, group velocities of high-order Lamb waves are studied in a broadband frequency range and the effects of wave localisation in the layers is investigated.

These results may ultimately contribute to design optimised multi-layered composite shells or skins by predicting their velocities, spatial attenuation or the propagating waves directivity.

7019 | Simple processing of aluminium alloys nanocomposites showing outstanding mechanical performances

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A simple powder metallurgy approach has been used to produce Aluminium matrix composites reinforced with nanoparticulate materials showing outstanding strength and elastic modulus. The different nanoparticles are introduced together with the Al-based matrix powder into a high-energy ball-mill and the blends are hot compacted using a uniaxial press. Thus the hardness of pure aluminium (40 HV) could be tailored to reach values of 150 HV20 with only 1 vol% of nanoparticles and up to 350 HV for a dual nanoparticulate reinforcement combining the specific strength of carbon nanotubes and silicon carbide. Furthermore, in this dual composite system, the indentation modulus amounts 120 GPa. The reinforcement principle could be extended to different aluminium alloys too. Thus, for instance, an Al6061 alloy could be hardened to above 300 HV20 just by dispersing about 6 wt% of CNT into the alloy powder and without any thermal treatment. Its compressive strength even reaches around 800 MPa after hot compaction. Alloys of the 2xxx, 5xxx and 7xxx series could also be strengthened with nanoparticulate materials. The hardness of the nanocomposites increases by 400 to 700% compared to the pure alloy without any annealing or work hardening post-treatment. Furthermore, the high flexibility of the powder metallurgy process alloys the elaboration of multi-layered or graded nanocomposite materials where the exposed surface is adapted to the external constraints. No cracks at the interface between two successive layers could be observed revealing a good interlayer bonding. This approach is not limited to aluminium based materials but can be extended to other metal matrix nanocomposites, like titanium and steel based composites.

7034 | Ultrasonic Wave Velocity, Mechanical and Thermo-physical Properties of Mortar Containing PET-Siliceous Sand Composites

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This paper presents the valorization of waste plastic bottles from polyethylene terephthalate PET to design a composite material “PET-siliceous sand” which will give a lightweight aggregate; hoping to provide solutions to meet both specific and massive applications in the field of construction. Several studies on the introduction of industrial and household waste revalorized in the field of construction summers conducted in recent years. Therefore the development of composite materials with low thermal conductivity and a reliable level of sound insulation from waste including revalorized plastic would be a more than interesting alternative to solve both economic and environmental demand.
So, to determine the effect of PET-siliceous sand composite (PSS) on the mechanical, ultrasonic pulse velocity (UPV) and thermo-physical properties of mortar, PSS was added as replacement for conventional limestone aggregate by decreasing the aggregate weights in the ratios of 25, 50, 75 and 100% by weight. Scanning electron microscope (SEM), X-ray diffraction and FT-IR analysis were used to better understand the cement hydration products of the mortar composites. Very encouraging results were obtained require particular interest and opening up opportunities for further research in the future. In

addition, the compressive strength, flexural strength, UPV and thermo-physical properties of mortar tended to decrease as the mixture proportion of PSS increased.

Key-words: PSS Composite Materials, PET-siliceous sand, Mechanical, Thermal, UPV, Characterization.

7035 | Laboratory Investigation on Rutting Resistance Performance of Micro Silica Powder Modified Asphalt

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Many researches were down to improve service life of asphalt pavement quality against vehicles dynamic loads. For this purpose, researchers investigated different ways such as changing the aggregate gradation and using of additive materials to modify bitumen and asphalt mixture. One of these ways is using of additive materials to improve of asphalt properties against dynamic loads. In the present study, the potential benefits of micro silica powder to improvement of mechanical and Dynamical properties of hot mix asphalt (HMA) have been investigated. To achieve this goal, mixtures with different content of bitumen and micro silica were prepared and repeated load axial (RLA) test on asphalt concrete mixtures were performed to evaluate resistance against rutting and creep. Also, the empirical rheological test on bitumen are penetration, softening point, ductility and viscosity, the fundamental rheological test by dynamic shear rheometer (DSR) is conducted on modified and unmodified bitumen. Finally by use of experimental results and the numerical analysis, two experimental models were performed for prediction of the creep behavior of conventional and modified asphalt mixtures by micro silica for different conditions depending on temperature and stress. The results of this investigation indicated that adding of micro silica to bitumen, had a great effect in improvement of permanent deformation of HMA. Also the results of tests on bitumen showed that adding of micro silica reduced the penetration, ductility, temperature susceptibility, and increased the softening point, stiffness and viscosity, furthermore It was found that the dynamic shear complex modulus (G*) value increases significantly across a range of testing temperatures and loading frequencies.
Keywords: Asphalt Mixture, Modified bitumen, Micro silica, Rheological properties, Creep compliance

7036 | Characterize the fatigue behavior of multidirectional hybrid laminated composite structure

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Hybrid composites are considered materials of great properties for engineering applications. Therefore
This study was discussed (dealt) with the effect of hybrid composite materials and the location of stronger layers (Kevlar and carbon fiber) with multidirectional glass fiber in the matrix (epoxy) and finding reaction expression under mechanical tests (tensile test, flexural test and fatigue test). For this reason it was made a new hybrid laminated composite .
In this work the specimens were prepared eight layers of laminate of woven fabric fibers with different orientation and direction on the resin [0#]8 and [#0,#45,#-45,#90]s. the hybrid specimens were manufactured under vacuum Bagging technique . in this study was showed that the mechanical properties and fatigue properties are increased as the relative proportion of carbon and Kevlar increases to glass in an epoxy resin.

7038 | Effect of Variable Spacing of Fibers on Geometric Nonlinearity of Composite Plate under Transverse Load

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The present study focused mainly on the effect of variable spacing between fibers on the nonlinear analysis of composite laminated plates subjected to transverse loads. The large displacement analysis of composite plate is obtained numerically, using finite element method. The analysis is based on the two-dimensional layered approach with classical and higher order shear deformation theory with five, seven, and nine degrees of freedom per node. Nine-node Lagrangian isoparametric quadrilateral elements are used for the discretization of the laminated plates. The effect of the fiber spacing, orthotropy of individual layers, through-thickness shear deformation, fiber's orientation angle were considered. Numerical results for boron/Epoxy fiber reinforced laminates are presented for the different effects of the composite plate under transverse loading. This study showed that the large displacement analysis of composite plate very sensitive for variable spacing of fibers.

7039 | Studies on Characterization of Extruded Al-SiC Composites

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Science of primary processing of Aluminium Matrix Composites (AMCs) need to be understood more thoroughly, mainly factors affecting the micro structural integrity including agglomerates in Aluminium Matrix Composites (AMCs). There is need to improve the damage tolerant properties particularly fracture toughness and ductility Aluminium Matrix Composites (AMCs). Work should be done to produce high quality and low-cost reinforcements from industrial wastes and by-products. Efforts should be made on the development of Aluminium Matrix Composites (AMCs) based on non-standard aluminium alloys as matrices. Al-SiC alloys are usually processed by Stir casting. The conventional method of processing has many limitations such as improper dispersion of Sic reinforcement. In this present study, to overcome the limitations of primary processing the alloy is secondary processed by hot extrusion. After stir casting the ingot is subjected to a secondary processing of hot extrusion. Hot extrusion requires the temperature of about 0.5Tm to 0.75Tm. Aluminium2014 alloy having melting temperature of about 550 degree Celsius is heated to about 500 degree Celsius and then hot extruded to about the ratio of 8:1. These extruded specimen undergone Impact, tension test, SEM analysis to study the nature of fracture and Microstructure characteristics were studied. Extruded specimens offer compositional flexibility, tensile properties with good strength and ductility, homogeneous microstructure.

Key words: Metal Matrix Composites, Stir Casting, Extrusion, Impact Test & Microstructure.

7042 | Nonlinear static and dynamic analysis of degenerated FGM plates and shells

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In this paper an investigation on linear and nonlinear static and dynamic behaviour of functionally graded material for sandwich and cylindrical panel plates and shells is presented. The equations of motion are solved using Newark's time integration schemes and the nonlinear formulation is based on Von Karman theory for large transverse deflection. The mechanical properties are assumed to vary through thickness direction according to the volume fraction of the constituents by a simple power law distribution. The finite element method based on nine nodes degenerated element formulation with height order shear deformation theory is used to carry out the analysis. The effect of variations of volume fractions and shell geometrical parameters are studied. Convergence tests and comparison studies have been carried out to establish the efficiency of the present model.

7043 | Reprogramming Cellular Signaling by Modifying Nanoparticle Surface Ligands

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Abstract: Modulation of a molecule’s targeting efficacy by modifying its substituting groups forms the molecular foundation of drug discovery. Similar modifications on nanoparticle’s surface ligands also alter receptors nanoparticle targets and the binding affinity. Such a human control of nanoparticle’s biological activity is demonstrated by three examples related to altering receptor bindings involved in immune response, tuning cell differentiation efficiency through modulating BMP signaling pathway, and regulating cell autophagy all by surface modified carbon nanotubes. Our findings not only reveal molecular interactions involved in cellular perturbations by nanoparticles, they also lay a solid foundation for safe nanomaterial design and future medicinal applications.

Key words: nanoparticle, cell signaling, surface modification, surface ligand

7052 | The effect of geometric and material parameters on the static behavior of laminated plates

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Fiber reinforced materials are widely used in different engineering applications due to their high strength to weight and high stiffness to weight ratios. Determination of the bending behavior of structural component made laminated composite is necessary for their design [1, 2]. The effects of some geometric and material parameters related to plate geometry and plate material on static response of the plate are investigated. The effect of lamina sequence and fiber orientation on the static response of laminated rectangular plates is also studied. The method of discrete singular convolution (DSC) is used for numerical simulation. Some parametric results have been presented for the investigation of the geometric and material parameters, lamina sequence, and fiber orientation on the deflection values of generally laminated rectangular thick plates. DSC is a relatively new numerical technique for the numerical solutions of partial and ordinary differential equations. It is also concluded that DSC has global methods’ accuracy and local methods’ flexibility for solving ordinary and partial differential equations in physics and engineering problems [3-10].

Static responses of the plates are depend on the thickness/length ratio, aspect ratio of the plate, boundary conditions, material parameters (Poisson ratio, ratio of modulus of elasticity of plate in each directions), number of layers, lamina sequence and fiber angle. These are summarized as follows:

• It is observed that the deflection for clamped boundary condition is less than in simply supported boundary condition.
• The deflection is less in case of symmetric orientation of layers than in anti-symmetric orientation for cross ply configuration.
• The deflection is generally decreased with the increasing value of length-to-thickness ratio.
• The deflection is also depending on the boundary conditions for angle-ply configuration for symmetric and anti-symmetric cases.
• The deflection value is generally decreased with the increasing value of number of layers. However, after the 8 layers, this decreasing is insignificant.
• The deflection is generally increased with the increasing value of the aspect ratio of the plate.
• Material anisotropy is also important on results. In general value of maximum deflection is generally decreased with the increasing value of the E ratios.
• The deflection is generally increased with the increasing value of the fiber angle (orientation). But this increasing also depends on the other geometric parameters and boundary conditions.

REFERENCES

[1] Reddy, JN. Mechanics of Laminated Composite Plates and Shells: Theory and Analysis, 2nd ed. CRC Press, 2003.
[2] Ferreira AJM, Roque CMC, Carrera E, Cinefra M. Analysis of thick isotropic and cross-ply laminated plates by radial basis functions and a Unified Formulation. J Sound Vib 2011;330:771-87.
[3] Zhao YB, Wei GW, Xiang Y. Discrete singular convolution for the prediction of high frequency vibration of plates. Int J Solids Struct 2002; 39:65-88.
[4] Zhao YB, Wei GW, Xiang Y. Plate vibration under irregular internal supports. Int J Solids Struct 2002; 39:1361-83.
[5] Zhao YB, Wei GW. DSC analysis of rectangular plates with non-uniform boundary conditions. J Sound Vib 2002; 255:203-28.
[6] Wei GW. A new algorithm for solving some mechanical problems. Comput Meth Appl Mech Eng 2001;190:2017-30.
[7] Wei GW. Vibration analysis by discrete singular convolution. J Sound Vib 2001; 244:535-53.
[8] Civalek Ö. Free vibration and buckling analyses of composite plates with straight-sided quadrilateral domain based on DSC approach. Finite Elem Anal Des 2007; 43: 1013-22.
[9] Civalek Ö. A parametric study of the free vibration analysis of rotating laminated cylindrical shells using the method of discrete singular convolution. Thin-Wall Struct 2007; 45: 692-8.

[10] Civalek Ö. Linear vibration analysis of isotropic conical shells by discrete singular convolution (DSC). Struct Eng Mech 2007;25:127-30.

7065 | Properties of polylactic acid (PLA)/ recycled low density polyethylene (rLDPE) filled Nypa Fruticans (NF) fiber: Effect of fiber modification using chelator

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Nypa fruticans fiber filled biodegradable polylactic acid (PLA) and recycled low density polyethylene (rLDPE) biocomposites were prepared using Brabender Platicorder EC Plus. The effect of filler content and chemical modification on tensile, thermal and morphological properties of biocomposites were evaluated. The effect of NF content decreased the tensile strength and elongation at break of biocomposites, whereas increased Young's modulus. The thermal degradation and crystallisation behaviour of PLA/rLDPE/NF biocomposites were studied by thermogravimetry analysis (TGA) and differential scanning calorimetry (DSC). The effect of NF content has decreased the crystallinity of biocomposites but increased the thermal stability. However, Tg of biocomposites decreased with increased NF content. The Ethylene Diamine Tetraacetic Acid (EDTA) was used as chelating agent and improved the properties of treated PLA/rLDPE/NF biocomposites. It was found that the tensile strength and Young's modulus of treated biocompoites with EDTA higher than untreated biocomposites. The presence of EDTA have increased the thermal stability and crystallinity of biocomposites. The total weight loss of treated was lower compared to untreated biocomposites. The crystallinity of treated biocomposites increased with EDTA modification. Scanning electron microscopy (SEM) study of the tensile fracture surface of the biocomposites indicated that fiber modification with EDTA enhanced the interfacial interaction between NF and matrix. The interaction between NF and EDTA was proven by FTIR study.

7066 | Biomechanical analysis of PEEK versus PEKK dental implant

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Background: PEEK (polyaryletherketone) and PEKK（polyetherketoneketone) are all came from PAEK (polyacryetherketone）family and has been recently used as a component of the orthopedic implant and joint. Elasticity coefficient of PEEK is lower than metal material (such as Titanium) and the material is not absorbed by the body. It has been clinically used in orthopedic, trauma and reconstructive surgery of the skull. However, researches about PEEK and PEKK used as dental implants are limited. Only few studies investigate the biomechanical effects of PEEK dental implant but there is no research compared the biomechanical effect between PEEK and PEKK made of dental implant especially on surrounding bone stress. Objective: The aim of this study is to evaluate the biomechanical effect of composite material of PEEK and PEEK dental implants by using finite element analysis (FEA). Materials and methods: This study uses computer-aided design software (SolidWorks, SolidWorks Corporation, MA, USA) to construct a model of a bone block and a implant. After obtaining all of the models by applying Boolean operations to the variables, the corresponding solid models were exported from the CAD software to the commercial FE software ANSYS workbench (Swanson Analysis Inc., Huston, PA, USA) to generate FE models. The implants and bone blocks were applied with homogeneous and isotropic elastic properties. The bottom of the bone block was fixed as the boundary conditions. The loading condition was applied on the top surface of the abutment. A vertical force and a 30 degree force of 110-N were applied on the top of the implant as loading condition. Young's modulus and Poisson's ratio for all the materials are referred from science paper and sawbones company (Pacific Research Laboratories, Vashon Island, WA, USA). Results & Conclusion: All the peak values of von-Mises stress were located on the bone near the PEEK and PEKK implants. As compared the implant stress between PEEK and PEKK implants. It was found that PEKK implant has the higher stress than PEEK implant whether vertical or lateral (30 degree) loadings. However, on the stress of bone near the implant both PEEK and PEKK implants has the similar results and shows no apparent different. Acknowledgement: This study was supported by a grant (NSC 101-2314-B-039-022-MY3) (NSC102-2314-B-075A-005) from the National Science Council, Taiwan.

7067 | ANALYSIS,DESIGNAND MANUFACTURING 0F ANKLE FOOT ORTHOSES BY USING DIFFERENT GAIT CYCLE SCENARIOS

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Ankle foot orthoses (AFOs) are prescribed to paraplegic patients with low level spinal cord injury and with good control of the trunk muscles. Examples of patients with muscle weakness or nerve damage would be those who have had a stroke, multiple sclerosis, cerebral palsy, etc.
In this work, two laminated composite materials to be used for manufacturing ankle foot orthoses (AFO) with drop foot were fabricated using vacuum molding technique. The AFOs the composite materials depended on the number of perlon layers (10 layers) with 2 layer of carbon-fiber and (10 layers) without carbonfiber. The mechanical properties of most of the KAFOs' materials were tested by tensile test , flexural bending test and fatigue machines. The number of perlon layers (10 layers) with two layers of carbon-fiber and (10 layers) without carbon fiber. The samples was measured experimentally by tensile test for both materials and plot stress-strain curves to determine mechanical properties (бy, бult , and Elongation at Break).The results showed that for ten layer of perlon бy=24.657 , бult=31.681 and for ten layer of perlon with two layers of carbon fiber were бy= 47.016, бult =55.647.
The data of gait cycle (Ground Reaction Force (GRF), and pressure distribution) were collected from one patient with drop foot due to cerebral palsy (wearing brace type AFO).
Keywords: AFO, Tensile, flexural ,Fatigue, Force plate, F-socket .Perlon - Carbon Fiber.

7068 | Synthesis and characterisation of nanostructured iron doped titania sol gel derived thin films

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Iron (Fe)-doped titanium dioxide materials are of high technological interest for many applications in the fields of catalysis, spintronics, photochemistry, gas detection and biological systems. For this reason, great efforts are recently devoted to prepare (Fe)-doped titania films without any impurity phase useful for magneto-electronic and optical devices and extensive researches are conducted on the synthesis and characterization of metal doped TiO2 nanotubes because of their novel properties such as unique shape, size confinement in radial-direction, large specific surface area and large pores volumes.
Here, we briefly report on results of a work-in progress study on the synthesis and characterisation of Fe-modified titania thin films containing different amounts of iron prepared by sol-gel procedures. The aim of the work is to investigate the influence of the Fe-concentration on the chemical composition, morphology, microstructure and optical properties of the layers. To this purpose, Fe-titania acid catalysed precursor solutions were prepared by using titanium isoproxide, and iron(III) chloride hexahydrate as precursors in the molar ratio Fe/Ti=1/360, Fe/Ti=1/60, Fe/Ti=1/30 and Fe/Ti=1/2. Coatings were grown by dipping on fused silica and (100)-Si-substrate wafers and subsequently after deposition heat-treated in air at 500°C and their chemical composition, morphology, microstructure and optical properties were investigated by means of Fourier transform infrared spectroscopy, field emission scanning electron microscopy and X-ray diffraction.
The results show the formation of pure Fe-titania nanocrystalline films where the Fe-O-Ti heterobonds formation induces a red-shift of the band gap. Moreover, the SEM-FEG observations and the X-ray diffraction measurements show that the titania films doped with low Fe-concentration are constituted of nanocrystallites made of a solid solution of Fe within the anatase-TiO2 lattice. The surface morphology of these films exhibits the granular structure of typical pure anatase titania films, where the grain size agrees with the crystalline domain size determined by XRD analyses that is between 29nm for the lowest Fe-concentration (Fe/Ti=1:360) and 35nm for Fe/Ti=1:20. On the contrary, the coatings with high Fe-concentration (Fe/Ti=1:2) exhibit a fractal surface structure; the formation of this patterned surface structure is still not well understood and further studies are necessary; it is very likely that the patterns are related to the microstructure revealed by XRD analyses that shows the formation of well defined nanocrystallites of monoclinic Fe-pseudobrookite (Fe2TiO5). The crystallographic structure is identical to that reported by M. Shiojiri and coworkers (1984) and coexist in our samples with the rutile phase of titania. However, it should be noted that the monoclinic phase of the pseudobrookite polymorph is different from the more common and frequently observed orthorhombic phase of the known ferric pseudobrookite Fe2TiO5. The typical crystallite size (diameter) of the Fe-pseudobrookite and rutile-TiO2 phases are for the process parameters used about 23nm and 17nm, respectively. The development of pure high Fe-doped titania with fractal structures could be interesting results thanks to their morphological and microstructural characteristics. In fact, the repetition of patterns at many size scales builds highly complex structures with unprecedented surface area/volume ratios. Moreover, fractal patterns also have high connectivity properties, facilitating efficient collection and transport of thermal and electrical energy. These properties make them interesting materials for potential application in devices to efficiently absorb and transfer solar energy and/or to process data with increased speed, precision and accuracy.
The investigation of the functional properties of the fractal pseudobrookite Fe2TiO5 films are now under way in our laboratories.

7071 | BEHAVIOR OF CONCRETE-GEOPOLYMER COMPOSITE BEAM

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In this works, starting with an eco-friendly logic based on natural resource development, a new inhomogeneous beam technology is proposed. In order to develop environmentally friendly construction materials, which make minimum utility of fast dwindling natural resources and help to reduce greenhouse gas emissions, a new generation of structural functionally composite beam based on concrete and geopolymer concrete reinforced by flexural bonded ‘FRP’ composite plates is introduced. The new procedure developed consists to replace the ordinary Portland cement concrete in the flexural tensile zone by a geopolymer concrete. The geopolymer concrete mix proportion is obtained by substitution of a Portland cement fraction with equivalent hydraulic clay, adjusted with various configurations of a lime slag addition according to the substituted mass. An experimental investigation is carried out on reinforced functionally graded composite beam with GFRP composite plates under flexural loading. An analytical model based on various classical beams theory namely: the first-order and the higher order theories are performed to evaluate the stresses and the strains field evolution. The test and the analytical modeling results confrontation highlight the effectiveness of this new technology in terms of strength and flexural stiffness.

7073 | HYBRID PRESTRESSED CONCRETE BRIDGES WITH CORRUGATED STEEL WEBS IN CHINA

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The hybrid prestressed concrete bridge with corrugated steel webs was developed in France in the 1980s. During the 2005s it was introduced into China and to date more than 30 bridges of this structural type have been constructed. The design is a composite structure in which the concrete webs of prestressed concrete box girder bridges are replaced by corrugated steel webs. Its distinguishing features are reduced main girder dead load, improved prestressing efficiency, and reduced labor and costs. The application of this design has recently been expanded to include longspan bridges, such as cable-stayed bridges. In addition, with a view to further streamlining of bridge construction, efforts are being made to use corrugated steel webs as structural members in launching girders. This paper introduces the prestressed concrete bridges with corrugated steel webs tending to increase in numbers.

7077 | Evaluation of Isogeometric Analysis for Homogenization of Textile Composites

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Isogeometric Analysis has quickly become an attractive and exciting research topic after the publication of the seminal paper of T.J.R. Hughes et al. in 2004. In the context of this new method, mathematical approaches of two formerly independent fields of Computer-aided Design (CAD) and Finite Element Analysis (FEA) were combined together. This new paradigm promises many opportunities to any field of science and engineering where FEA was used in numerical analysis applications formerly. By using the non-uniform rational basis splines (NURBS) which are the core technology for most of the CAD packages for FEA computations, the solutions to the problems at hand can be developed and computed within the same framework seamlessly using single data set both for model generation and analysis. Some of the outstanding attractive features of this new approach can be listed as follows, the smoothness of spline functions provide additional advantages in the cases where higher order of continuity is necessary to obtain meaningful results, isogeometric analyses also offers another new higher order refinement technique called k-refinement in addition to containing the popular hp-refinement strategies commonly used in FEA, exact geometry representation and termination of the time consuming meshing step of the product development.

During the past years researchers have been investigating and developing possible applications of Isogeometric Analysis on many sub-fields of mechanics. Among them, one possible field of interest is the continuum micromechanics of three dimensional textile composites. One of the possible application areas of this new analysis method is using it in effective material property determination of this kind of composites. In order to define the effective material properties of this type of materials with complex inner structures, a procedure called homogenization is applied via geometrical modeling, mesh generation, definition of the appropriate boundary conditions and computing the model in order to obtain the macroscopic mechanical response behavior of the textile composites. Textile composites have relatively more complex geometrical structure than unidirectional or particle reinforced composites, hence the exact geometrical representation offered by Isogeometric Analysis is an important advantage during the homogenization process. Here, within a three dimensional environment we face probably the most challenging problems in implementation of isogeometric analysis today, because widely used CAD packages model the solids as surfaces. This is an important shortcoming for the current state of the isogeometric analysis because the information obtained from conventional geometrical modeling packages does not possess the sufficient information for trivariate models.

In this work, we develop an isogeometric analysis based homogenization method for three dimensional textile composites using classical linear materials and carry out comparison and validation processes for the results we have obtained. Already established and widely used numerical continuum micromechanis methods are used as references for the evaluation of the applicability and performance of homogenization algorithms utilizing isogeometric analysis. For developing such a comparison environment, we model representative volume elements (RVE) of textile composite specimens and under appropriate boundary conditions we analyze the RVEs and obtain the effective material properties. These results are then compared with the classical FEA approaches. As the final step of the research work, the results obtained so far are discussed and possible directions for the application of Isogeometric Analysis to textile composite modeling is determined.

Keywords: Isogeometric Analysis, CAD, NURBS, Textile Composites, micromechanics, Homogenization, Effective Material Properties

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7079 | GFRP-RC Slab-Column Edge Connections with GFRP Shear Studs

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Flat plate systems are commonly used in the construction industry to take advantage of their simple formwork and the increased storey height due to the absence of beams. They, however, are susceptible to the brittle punching shear failure where the column along with a surrounding part of the slab suddenly punches through the remainder of the slab. Punching shear failure occurs as a result of the high shear stresses caused by the inevitable combination of shear force and unbalanced bending moment transferred between the slab and the column at a slab-column connection. At edge slab-column connections, relatively higher unbalanced moment transfers between the slab and the column compared to the interior ones due to the discontinuity of the slab which makes edge connections more critical to punching shear failure. On the other hand, the use of fiber reinforced polymers (FRP) bars as reinforcement for concrete structures has proved to be an effective solution to the steel corrosion problem. However, FRP bars have a relatively low axial and transverse stiffness compared to steel bars, which results in a lower punching shear capacity. Moreover, neither the Canadian nor the American standards includes design provisions regarding the design of FRP-RC slab-column connections with shear reinforcement.

This paper reports the results of an experimental investigation on the influence of glass (G) FRP shear studs with headed-ends on the behaviour of GFRP-RC slab-column edge connections. In addition, design equations regarding the design of FRP-RC slab-column connections with shear reinforcement are proposed and verified against test results. Three full-scale slab-column edge connections were constructed and tested to failure. The three connections were reinforced with the same flexural reinforcement ratio of GFRP ribbed-deformed bars. However, one connection did not have shear studs while the other two connections had shear studs at different radial spacing (0.75d and 0.5d). The typical dimensions of the slabs were 2800×1550×200 mm with a 300 mm square column extending above and below the slab. The connections were subjected to simultaneous vertical load and unbalanced moment that were monotonically applied through the column tips up to failure with a moment to shear ratio, "M"/"V" "= 0.4" .

The connection without shear studs failed in a brittle punching shear mode while the two connections with shear studs failed in a deformable flexure mode.

Keywords: FRP; GFRP; flat plate; edge; slab-column connection; punching; shear; shear studs; slab; ribbed-deformed; flexure failure.

7083 | Composite structures for offshore wind turbine application

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For the limitation of fossil fuels and other traditional energy sources, the application of alternative energy sources becomes an important subject. Wind energy is one of the promising renewable energy. In Kyushu University, an innovative wind turbine containing a wind lens is designed to augment the wind power for a given turbine diameter and wind speed. This wind turbine is aimed to work on the ocean surface planted on a floating structure. Consequently, the weight of the whole structure should be as light as possible. Carbon fiber reinforced plastic (CFRP) is a suitable material with high strength and light

weight. However, making large and complex structures using CFRP material is difficult. In our lab, vacuum assisted resin transfer molding (VARTM) process is proposed as the CFRP manufacturing process. Because autoclave, high temperature, high pressure and prepreg are unnecessary, it is possible to produce large and complex part through VARTM process. This report introduces two applications for VARTM processes. First, two novel joints made from partially un-molded CFRP plates were designed to increase the strength of joints between CFRP parts. In the partially un-molded plate, a portion of the fabric stack was molded with resin while the rest of the fabric stack remained dry. The plate was made using a manufacturing process developed from VARTM. A new double-lap joint sandwiched a normal CFRP plate between the dry fabric layers of a partially un-molded plate. The other laminated joint overlapped the dry fabric layers of two partially un-molded plates. Both joints were molded by resin transfer. Tensile testing indicated that the two novel joints were more than twice as strong as a classical double-lap joint, and half as strong as a normal, joint-free CFRP plate. Second, a wind-lens was manufactured using VARTM. A simple and low cost method for manufacturing a mold for VARTM is presented. Two-dimensional structures were used to construct a three-dimensional skeleton of a mold. Putty was then applied to the skeleton to obtain a smooth, hard, and strong surface. Finally, a high-elongation plastic film was tightly stretched and attached to the surface of the mold to ensure an airtight seal. The approach was validated by the successful fabrication of a carbon fiber-reinforced plastic part using the mold.

7084 | Amorphous/nanocrystalline ZrCu/Cu and ZrCu/Zr multilayered thin film composites with graded interfaces

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High strength and good ductility are difficult to coexist in monolithic metallic glasses (MGs), especially under tensile testing at room temperature. To solve this problem, the major improvement utilized in bulk metallic glasses (BMGs) is to incorporate some ductile metal phases in the amorphous matrix as BMG composites (BMGCs). For thin film metallic glasses (TFMGs), the toughening concept has also been developed by integrating the amorphous and more ductile metal layers as multilayered thin films (MLTFs). In this study, the thin film metallic glass composites (TFMGCs) is further developed and researched. From 1991, extensive efforts have been made to investigate the graded structures in several metal/ceramic or ceramic/ceramic thin films, such as the Al/AlN, diamond/metal, Si3N4/Al2O3, AlN/GaN composites, and so on. In 2011, Fang et al. demonstrated the tensile properties of Cu thin films with graded grain sizes; high tensile yield strength of 129±17 MPa and tensile elongation over 50% could be achieved. Inspired by these results, the amorphous/nanocrystalline multilayered system with appropriate graded interfaces might have a chance to enhance their tensile properties. The microstructure and interface response of amorphous ZrCu and nanocrystalline Cu or Zr multilayered thin film composites, with sharp or graded interfaces, are examined and analyzed. The detailed microstructure characterization of the multilayered films with graded interfaces, which varying from 20 to 100 nm thick, was performed on the ZrCu/Cu and ZrCu/Zr. The interface possesses gradient nature in terms of composition, nanocrystalline phase size and volume fraction. The extracted bending properties of the micro-scaled bending composite specimens, directly related to the graded interface property and strength are established and discussed.

7087 | Tension behavior of sputtered and evaporated thin film composites with Zn/ZrCu on flexible polyimide substrate

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For the past few years, the flexible electronics have gradually attracted much attention due to the flexible and lightweight characteristics. Within these flexible electronics, the metal films are applied as the signal connections between the different devices on flexible substrates, forming a multilayered composite structure. When the flexible electronics are experienced cyclic deformation, metal films might result in films rupture and signals decay. Therefore, the understanding and improvement of their mechanical behavior of such metal film composites coated on flexible substrates appears to be critical. The multilayer composite structure is often used to enhance the ductility of metallic glasses. The adhesion between these layers is very important. In this research, the Zn films with or without a 15 nm amorphous ZrCu adhesive layer were coated on the polyimide (PI) substrate via sputtering and evaporation processes and showed the different morphologies for this multilayered composite. The sputtered Zn film existed nanoparticle morphology with diameter of 30-40 nm, and crystalline orientation of film was close to the random powders. The evaporated Zn film showed the hexagon disc with 250-300 nm and crystalline orientation was the strong texture of (0002). The uniaxial mini-tensile test was conducted on MTS Tytron® 250 Microforce Testing system with a force transducer of 250 N at a constant speed of 36 □m/s, corresponding to initial strain rate of 3x10-3 s-1. The micro-tensile tests were conducted at ambient temperature. After tensile deformation, these Zn films with ZrCu adhesive layer did not appear the abundant micro-cracks, especially for evaporated Zn films. It is demonstrated that the 15 nm thin amorphous ZrCu membrane can act as a promising adhesive layer between PI and Zn, especially for the evaporated Zn films.

7089 | Microstructure and mechanical properties of alumina based composites containing cubic boron nitride hard particles

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Oxide-based ceramic materials are particularly important in the manufacture of tools for machining metals. Their basic components are usually Al2O3 or ZrO2. Advanced ceramics containing Al2O3 exhibit excellent properties such as high thermal resistance, good chemical stability and moderate to high mechanical strength. However, the fracture toughness of the materials is low because dislocation movement is extremely limited by their ionic and/or covalent bonds. The brittleness and poor damage tolerance have so far limited their application as advanced engineering materials especially for cutting applications [1]. A wide range of various ceramic matrix composites (CMC's), strengthened by addition of silicon carbide (SiC), titanium diboride and other hard particles to Al2O3 matrix, have been investigated to improve mechanical properties of alumina based material [1, 2, 3]. Another group of tool materials are superhard composites based on polycrystalline diamond (PCD) or polycrystalline cubic boron nitride (PcBN). The hardness of cubic boron

nitride is greater than every known material other than diamond. cBN, however, is less reactive with ferrous materials than diamond. Consequently, it has become widely used in material removal applications on ferrous workpieces [4]. PCD and PcBN superhard materials are the most expensive of all tool materials because diamond and cubic boron nitride are metastable phases and for their treatment the High Pressure – High Temperature (HPHT) conditions are necessary.
In this work an innovative approach to sintering of alumina based CMC's, containing up to 30% of cBN, using Spark Plasma Sintering (SPS), under the pressure lower by two orders of magnitude than in HPHT method, is presented. To avoid an unwelcome reverse transformation of cubic boron nitride to hexagonal, graphite-like form (hBN), which could occur at high temperatures (necessary for sintering) and relatively low pressures (provided by the SPS method), a special alumina nanopowder characterised by low sintering temperature was used. The sintering processes were conducted under 35 and 75 MPa (SPS) and for comparison under 7.7 GPa (HPHT). For each method an optimisation of sintering temperature was made. The phase composition and basic physical – mechanical properties of Al2O3 – cBN composites, sintered in various p-T conditions were investigated. The composites obtained by SPS have slightly lower properties than those obtained by HPHT but their hardness and fracture toughness are still better than for pure alumina. There was no significant formation of hBN during SPS processes. SPS is a promising alternative to expensive HPHT in the preparation of CMC's containing metastable cBN phase.
[1] Y.L. Donga et al., Fabrication and mechanical properties of nano-/micro-sized Al2O3/SiC Composites, Materials Science and Engineering A 504 (2009) 49–54.
[2] Deng Jianxin, Ai Xing, Wear resistance of Al2O3/TiB2 ceramic cutting tools in sliding wear tests and in machining processes, Journal of Materials Processing Technology 72/2 (1997) 249–255.
[3] Chonghai Xu et al., Toughening and strengthening of advanced ceramics with rare earth additives, Ceramics International 32 (2006) 423–429.
[4] J. Angseryd et al., Detailed microstructure of a cBN based cutting tool material, Int. Journal of Refractory Metals & Hard Materials 27 (2009) 249–255.

7097 | BEHAVIOR OF THE COMPOSITE CONCRETE CONTAINING POLYMER SILICATES

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Technological advancements recorded as well on the concretes and micro concretes as on the nature of composite materials allowed to as well develop the use of the concretes in various applications in public works as in the civil construction. These new materials (composite) found a broad use in the construction industry of the works (new work of reinforcement and also of repair).
The main aim of this work is to study the influence of polymer on the mechanical response of composite polymer concrete material. The experimental results make it possible to deduce from it that the incorporation of polymer and polymer silicate in the concrete matrix reinforced by metal short fibers allows, not only to improve the mechanical resistance of the composite under static and cyclic loading (fatigue strength), but also the operating conditions, by conferring to him a mechanical high efficiency compared to the ordinary concrete. The limits of endurance respectively for the heavy polymer concrete and the polymer silicate concrete are clearly improved.

7103 | High-temperature oxidation of composite material of the NiAl- TiB2 system

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The effect of the exposition time (1 min, 90 min) for high temperature (1000°C) oxidation of the NiAl-TiB2 composite material in air on the structure, phase composition and intensity of formation of oxide layers on the composite surface has been studied. The selective oxidation was observed. The initial composite structure was composed of a matrix from NiAl intermetallic containing regularly distributed grains of TiB2 titanium diboride. After oxidation of the composite on the NiAl matrix the continuous dense films were formed which correspond to the complex Al2O3 oxides and AlBO2 borate, whereas on the refractory TiB2 grains the volumetric globule-like Ti(Al)O and TiO2 oxides appeared. To determine the relationship between the thicknesses of the oxides formed after oxidation, AES-analysis was used. The thickness of oxide layers on the matrix was established, it is equal to 80 nm, while that on the TiB2 grains was equal to 560 nm. Therefore the intensity of oxide formation on boride grains is by seven times higher than that on the intermetallic matrix. These oxides can be used as solid lubricants and promote an increase of the wear resistance of materials.The developed materials are aimed at applying in the high temperature friction assemblies.

7109 | Effective behavior of elastoplastic wavy layered composites via dissipation-based homogenization

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In this communication we present an analytical homogenization method for computing the effective behavior of wavy layered composites made of elastic-perfectly plastic materials with highly contrasted properties. This method is based on the minimization of the dissipation which is expressed starting from the microstresses and the rate of internal micro-hardening "forces" and micro-plastic strains, in correlation with the micro-yield surface. The analytical expressions of the effective constitutive law, of the macroscopic yield surface and of the residual microstresses in terms of the macrostrain and the plastic microstrains are presented in the context of a strain driven localization problem. The numerical examples are compared with one semi-analytical and two computational methods.

7110 | Mecahnically and electrically stable carbon nanotube and Ag nanowire hybrid material using plasmonic welding process

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The carbon nanotube and Ag nanowire are candidate materials to replace ITO (Indium Tin Oxide) for transparent conductive material. Originally these nanomaterials are independently studied for this purpose. Recently hybrid of carbon nanotube and Ag nanowire has been emerged and reported. In this presentation, we suggest the novel approach to enhance the mechanical and electrical stability of hybrid material using plasmonic welding process. ThIs process only welded the cross junction of Ag nanowires and rest part of the naowire is not affected. After we made the hybrid thin film of carbon nanotube and Ag nanowire, we obtained the high transparency over 90% and low sheet resistance less 50 Ohm/sq. Then, we irradiated the light from halogen lamp for a couple of minute. As the result, we found the stability of the carbon nanotube and Ag nanowire hybrid was highly improved. It seems that carbon nanotubes plays role of wrapping the Ag nanowires and entangling the overall materials. When we made stretchable electrode using Ecoflex and hybrid material, the stretchability was about 500%, a record in this area. Using several measurement techniques, we figured out why this phenomena happened and what optimal condition to make the hybrid material was . This results are very helpful to several applications like transparent conductive film, stretchable electrode, flexible electrode and so on.

7111 | Characterization of local laser bonding quartz to anodic aluminum oxide

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A bonding process for quartz and anodic aluminum oxide has been developed. Material characterizations are investigated by using SEM, EDX and XRD. Localized heating is main bonding mechanism. A focused laser beam is transmitted through a quartz medium to anodic aluminum oxide to provide localized heating and bonding. At a suitable laser power, better bonding strength is obtained and pushing strength of 5 kg is comparable to a thermal bonding method. This process provides a simple bonding solution with selective bonding area and rapid processing time.

7113 | Size Effect on Shear Strength of GFRP-RC Continuous Beams without Stirrups

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The use of the non-corrodible fiber reinforced polymer (FRP) bars as main reinforcement for concrete structures to overcome the steel corrosion problem is exponentially increasing. The FRP bars, as longitudinal reinforcement, made the size effect on shear strength more pronounced than that in steel-RC beams. This effect was more significant in beams with small longitudinal reinforcement ratio. To date, there is no published research studying the size effect on shear strength in indeterminate structures reinforced with GFRP. As such, this study aims to evaluate the size effect on the shear strength of continuous beams without stirrups. The experimental results of six large-scale continuous concrete beams reinforced with glass fiber reinforced polymer (GFRP) bars are presented in this paper. The test beams had a rectangular cross section of 200 mm width and three different effective depths of 250, 500 and 750 mm. The beams were continuously supported over two equal spans of 2,800, 3,750 and 5,250 mm for beams with depth of 250, 500 and 750 mm, respectively. The test variables were the longitudinal reinforcement ratio and the effective depth of the beam. The test results showed that significant size effect was observed with increasing the effective depth in beams failed in the exterior shear span. The opposite was observed in beams failed in the interior shear span where the shear strength increased when the depth increased. Test results also were compared to the predictions of the shear design provisions in the CSA/S806-12 code and the ACI 440.1R-06 guidelines.

7114 | Microwave absorption and thermal conductivity enhancement of Epoxy-TiO2 nanocomposites

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The present study deals with the synthesis and characterization of TiO2 nanoparticle filled epoxy composites via closed mould technique. Titanium dioxide (TiO2) nanoparticles have been synthesized using sol gel technique and characterized using Scanning Electron Microscope (SEM), Transmission Electron Microscope (TEM), Brunauer–Emmett–Teller (BET) analysis, X-ray diffraction (XRD), Fourier transform Infrared (FTIR) spectroscopy, Energy dispersive spectroscopy (EDS) and Differential Scanning Calorimetry (DSC). It was found that the average particle size and specific surface area of TiO2 nanoparticles were 4.33 nm and 239.45 m2/g, with anatase being the major phase of the material. The viscosity of the molten nanocomposites was measured using cup and cylinder viscometer and the flexural strength of the cured samples was measured using 3 point bending test. It was observed that the increase in viscosity was not significant but the flexural modulus increased by almost 16% on incorporation of TiO2 nanoparticles. The polymer nanocomposites were characterized for morphology, chemical composition and thermal characteristics using SEM, HRTEM, EDS, FTIR, DSC and hot plate (for measuring thermal conductivity). DSC results showed that the glass transition temperature of epoxy increased from 69^{o}C to 85^{o}C with the addition of TiO2 nanoparticles. Hot plate analysis of the cured samples revealed that TiO2 filled epoxy showed a better thermal conductivity (0.823 W/m^{o}C) than pure epoxy (0.545 W/m^{o}C). In addition, the microwave absorption properties of the samples were measured using microwave vector network analyzer in the frequency range of 8.2-12.4 GHz (X-band) and it was found that the effective microwave absorption of TiO2 filled epoxy increased by around 53% compared to that of pure resin. Thus it can be said that this work explores new polymer nanocomposites having enhanced microwave absorption properties without compromising the ease of processing, strength and other desirable characteristics for the manufacturing of finished product.

Keywords: Titanium di oxide, solgel process, epoxy, nanocomposites.

7115 | Effects of Process Parameters on Drilling Performance of Electrically Conductive Polymer Composite

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Polymer composite materials have been used in many fields such as aircraft and aerospace industries, automotive, electrical and electronic equipments, marine and sport equipments. Each industrial sector demands different properties that the composite material must satisfy. Composite materials which are obtained by reinforcing high electrically conductive materials such as carbon black, carbon fiber, graphite, graphene, metals and metal oxides, carbon nanotubes can be employed in applications that demand the electrical conductivity besides high specific strength and stiffness properties of polymer materials. Although these composite materials can be produced by such methods as injection molding and shaping in molds, the machining methods of them especially drilling are required for the assembly operations. Various studies aimed at drilling of composite materials were conducted. However, there is a lack in literature about the examination of drilling of the particle reinforced and electrically conductive polymer composite materials. In this study, drilling of pure polymer (polypropylene) and carbon black reinforced electrically conductive polymer (polypropylene) composite material with different drill tool point angles was investigated at different cutting speed and feed values. The temperature occurring in machining zone and surface roughness of drilled holes were measured. The experimental studies were designed by using Taguchi L27 orthogonal series in order to obtain optimum drilling parameters and the effect ratios of drilling parameters were specified by using ANOVA (analysis of variance) statistical method. The effects of the carbon black reinforcement, drill tool point angle, cutting speed, and feed on the drilling of the pure and electrically conductive polypropylene were determined.

Keywords: carbon black; electrically conductive polymer; composite material; drilling; surface roughness; drill tool geometry

7117 | Evaluation on combustible characteristic for finishing material of exterior wall

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In the study, in order to evaluate the combustible characteristic for the finishing material of the exterior wall, the real scale fire test has been carried out for the aluminum composite panel and Urethane metal panel in accordance with ISO 13785-2 “Reaction-to-fire tests for facades-Part2:Large-scale test”.
In the real scale fire test, when heat and flame rises in opening of the building like windows, the combustible characteristic can be forecasted for the finishing material of the exterior wall. For the method of the fire test, the main specimen of 4.0(H) × 3.0(W) m and the support specimen of 4.0(H) × 1.2(W) are installed in the upper part of the mock up including one opening with the “ㄱ” shape. In case 800 °C flame is generated in the opening, total fire test is carried out for 25 minutes and then the temperature variation is to be measured by Thermocouple in the top of the specimen.
As a result of the real scale fire test, 987.7 °C maximum temperature has been surveyed in 6 minutes and 56 seconds after starting the test in the aluminum composite panel and 476.3 °C maximum temperature has been surveyed in 14 minutes and 24 seconds after starting the test in the urethane metal panel. As a result, it is considered that the vertical fire spread can ben restrained depending on the flame spread prevention capacity of the finishing material used to the building exterior wall.

7119 | Bio-Inspired Interphases for Composite Toughening

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Increasing fracture toughness while maintaining a high modulus and strength has been a long-time goal of materials research and development efforts. In polymer matrix composites, methods for achieving that goal have included crosslinking the matrix and admixing high modulus reinforcement phases. Because these strategies do not necessarily yield high toughness beyond what is provided by crack pinning, additions of dispersed ductile phases such as rubber or UHMWPE have also been reported; however, decreases in modulus are inevitable.
It is known that the matrix/reinforcement interphase has a significant effect on toughness. In polymer matrix composites reinforced with glass fibers or particles, a silane coating bonds the two phases and contributes to toughening. Because the interphase is often the site of failure, it has been suggested that incorporating ductility into the interphase could lead to improved survival.
Our bio-inspired approach to composite design borrows one of the toughening mechanisms utilized by nacre, namely the deformation and energy absorbing ability of the organic interphase located between the aragonite platelets. To assess the potential value of a thin deformable interphase for toughening particle reinforced composites, we first conducted finite element simulations.
We modeled a particle-reinforced zone at the tip of a crack in a standard single-edge-notch 3-point bend test specimen. A progressive degradation material model simulated crack propagation, and calculations showed that the normalized damage dissipation energy decreases as a crack interacts with particles in composites with a simulated biopolymer interphase when compared to composites with a “traditional” silane interphase. These results encouraged us to synthesize a biopolymer analogue.
β-peptide-coated particles were prepared from aminopropylsilyl-coated silica particles averaging 2 μm in diameter. The aminopropyl groups were derivatized with an NHS-activated acid carrying an N-acylated β-lactam. The N-acyl lactam functions as an initiation site for polymerization. Coverage of this activating group (10% or 100%) can be varied by dilution of the reagent with NHS-activated acetate, a blocking agent. β-lactam monomers, carrying substitution at C3 and C4 but without nitrogen substitution, were mixed with the derivatized silica and catalytic base was added. The resulting living polymers were allowed to polymerize for either 2 or 8 hours, then capped with aminopropanol and the resulting terminal alcohols were converted to methacrylates for bonding with the matrix.

Composites were compounded containing 55 v/v of glass particles functionalized with either γ-methacryloxypropyltrimethoxy (MPS) silane or a β-lactam peptide synthesized as described above, dispersed in bisphenol A-glycidyl methacrylate with camphorquinone catalyst. Test specimens were obtained by casting the mix in molds and curing using white light. After unmolding, the bars (2x3x25 mm) were tested in 3-point bending till failure.

Composite Sample by
Interphase Type σf (MPa) E (GPa) Work of Fracture (kJ/m2)

MPS 95 5.7 1.58
β–peptide 2 hours 10% coverage 69 5.4 0.87
β–peptide 2 hours 100% coverage 121 5.4 2.98
β–peptide 8 hours 10% coverage 59 5.4 0.62
β–peptide 8 hours 100% coverage 96 5.6 1.83

Results show that the β-peptide interphase increased toughness without significantly decreasing modulus.

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7124 | Analysis of the effect of aspect ratio on the fire resistance of concrete filled elliptical steel tube columns

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Elliptical Concrete-filled steel tubular(ECFT) columns are often used as the main supporting columns for high-rise buildings and has become a topic of academic concern. The past research about ECFT most focused on its ultimate strength and mechanical behavior. The experiment method which is usually expensive and time-consuming. Other research methods include combining experimental data with appropriate theory to design or calculate the structural properties, and these methods tend to have a conservative assessment of the results. Therefore, some researches have been developing finite element model to simulate and analyze the ultimate strength and buckling condition of ECFT and its component behavior. In this paper, finite element analysis is used to explore the fire behavior of ECFT during exerting axial compression load.
To study the effect of aspect ratio on the fire resistance of ECFT columns, the dimensions of steel hollow sections are 300 mm x 150 mm and 300 mm x 180 mm with thickness of 10mm and 12mm for steel tube. To consider the load ratio effect, the buckling resistance of hot finished section columns at room temperature can be calculated by the buckling curve from Clause 6.3.1.2 of EN 1993-1-1. According to the EN 1994-1-1Clause 6.7.3.5. It was used to derive the load applied to the model with different levels.
The results of fire resistance rating which were measured in minutes to represents the capability for load bearing before collapsing at high temperature. The fire resistance is derived base on the failure criteria from EN 1363-1. The failure time is given by one of the following two limits: maximum axial displacement reach L/100 mm, and maximum axial displacement velocity reach 3L/1000 mm.To assess the impact of the thickness of steel tube on the fire resistance of ECFT column with different aspect ratio, this paper adjusts the steel tube thickness in order to measure the analysis results at different thickness of steel tube. The supposed thicknesses of steel tube is 12mm, by which 10mm is the original thickness of steel tube of specimen from experiments[6]. The analysis result shows the main effect of larger thickness of steel tube under the same temperature ascending condition, including: 1. large increment of axial deformation at the initial temperature ascending, 2. shorter fire endurance time. It can be seen from the Figure that , in relation to the change rate of thickness of steel tube, increment of axial deformation and fire endurance time in the analysis result are not very significant, whose reason should lie in that steel has higher heat conduction efficiency, and after the temperature is transferred to concrete, the heat conduction rate reduces, therefore concrete has a role of heat sink during heat conduction, therefore under circumstance that the size of core concrete does not change, the thickness of steel tube does not have significant effect on fire resistance. Axial deformation velocity limit was check by EN 1363-1 criteria. The results reveals that near 30 minutes after exposed to fire condition with temperature curve, the axial displacement velocity increases but not exceed the checking limit(6 mm/min). It is also shows that 30 min after fire exposing, the displacement velocity of 10mm steel tube thickness model increases rapidly and exceed the limit of EN 1363-1 criteria. The phenomenon was checked and found that both concrete crush and local buckling occurred at that period.

7129 | Evaluation of the apparent interfacial shear strength of flax fibers and polymer matrices

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An important factor affecting the mechanical characteristics of composite materials is the adhesion of constituents which can be characterized by the interfacial shear strength (IFSS). Most of the experimental methods for evaluation of IFSS involve model single-fiber composites. By contrast, the method proposed by Bowyer and Bader is based on the analysis of stress-strain curve of a short-fiber reinforced composite in tension. In the present study, the method is modified by allowing for elastic-perfectly plastic stress transfer between fibers and matrix. The modified Bowyer and Bader method is applied to the experimental tension curves of short-flax-fiber reinforced polypropylene (PP) and starch acetate (SA) composites to evaluate the IFSS. The IFSS was found to depend on the volume fraction of fibers, the treatment to improve adhesion for flax/PP, and on plasticizer content in flax/SA. The addition of an adhesion modifying agent, maleic anhydride-grafted PP, led to an increase in the IFSS by more than 50% in flax/PP composites. However, the reduction of the apparent IFSS with increasing fiber volume fraction implies mechanical interlocking and the friction-dominated stress transfer between the fibers and matrix. By contrast, close correlation of the IFSS with the yield strength of the neat polymer, affected by the plasticizer content, in flax/SA composites suggests good adhesion, as expected for chemically compatible constituents.

7130 | An insight into advanced continuous wave and pulsed laser cutting of CFRP structures

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Fibre reinforced composite structures are recognized as having a significant lightweight construction potential for a wide variety of industrial applications. In particular, endless carbon fibre reinforced plastics (CFRP) offer great potential for the realization of lightweight structures especially in the transportation and the energy sector due to their high strength-to-weight ratio.
Today, thermoset polymers are representing the predominant kind of matrix materials. However, structures based on thermoplastic matrices are of growing interest. Compared to thermosets, thermoplastic matrix materials provide improved properties regarding formability, weldability, damage tolerance, reparability and recyclability. To enter mass markets such as the automotive sector, fast and cost-effective manufacturing processes are required for both CFRP parts based on thermoset and thermoplastic matrix materials.
The combination of two different materials, incorporating the reinforcing fibers and the polymer matrix, which provides the outstanding mechanical properties on the one hand, also results in significant challenges for the machining of these composite materials on the other hand. Conventional machining techniques such as milling or water jet cutting are associated with high tool wear or require complex water circuit handling. In addition, both techniques are not force-free.
Laser machining of CFRP provides a processing method for cutting and trimming that is force-free, wear-free, fast and automatable. However, for cutting processes the heat generated can lead to heat affected zones (HAZ) in the material. They can be distinguished by areas with vaporization or decomposition of the matrix material, delamination of the laminate and the formation of porosity. In previous publications, the authors have shown that a resulting HAZ influences the mechanical properties of CFRP structures in a certain manner.

In order to cope with required machining qualities and cycle times, laser cutting technologies providing adapted process strategies are sought. At Laser Zentrum Hannover (LZH), scientists are using both continuous wave (cw) and pulsed laser radiation for CFRP cutting investigations. Within the frame of the work presented here, a cw single mode fiber laser emitting at a wavelength of 1,080 nm as well as a fiber-guided pulsed disk laser emitting at a wavelength of 1,030 nm with a pulse length of 30 ns have been used. Both lasers are providing a maximum output power of 1,500 W. The laser radiation was guided by optical fibers to a galvoscanner system, which focused the laser beam by means of F-Theta-optics and deflects the beam across the CFRP surface.
As a comparison between laser processed and conventionally machined CFRP structures mechanical testing was performed, e.g. static tensile, interlaminar as well as in-plane shear strength measurements. An analytical model was developed which is used for a correlation between the resulting heat affected zone at the cutting edge and the corresponding mechanical properties. It turned out that by applying appropriate cutting strategies, laser processed samples can reach the reference strength and stiffness values of milled referenced specimens.

7132 | Joining of thermoplastic composites using adapted laser transmission welding techniques for aircraft applications

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Due to their superior specific strength and stiffness properties continuous carbon fibre reinforced plastics (CFRP) are gaining in importance in many industrial applications. Although thermoset polymers are representing the predominant kind of matrix materials, composites based on thermoplastic polymers are of rising interest due to their superior producibility, formability and weldability. Especially in the aircraft sector, both glass and carbon fiber reinforced high-performance thermoplastics a widely used for interior as well as for structural parts and components.
In order to cope with future rising production volumes, automatable and flexible production processes are sought-after. In this context, welding techniques are playing a decisive role at which applications are not limited to the welding of CFRP parts among themselves, but extend to the connection of various components, consisting of unreinforced and glass fibre reinforced thermoplastics, to CFRP units.
Due to its local energy input und especially its high flexibility, laser transmission welding (LTW) is an industrially established process for the joining of unreinforced thermoplastics. Now, this technology was adapted and optimized in order to realize a welding process based on continuous fibre reinforcements, and which still shows the benefits of the conventional welding process.
Hence, the subject of the work presented here is to generate fundamental process knowledge concerning the use of thermoplastic CFRP as laser absorbing part within the frame of LTW processes. Significant differences to the process characteristics known from the joining of unreinforced thermoplastics, emerge from the carbon fibre reinforcement inducing high thermal conductivity and fluctuating absorption properties for the laser wavelength. This results in an essentially altered plastification performance which is directly mirrored in the weld seam structure. Correspondingly, actions for an enhancement of the process reliability are presented, taking into account the influence of the carbon fibre reinforcement on the weld seam formation.
With a view to adequate joining application in the aircraft sector, high-performance composites based on continuous glass and carbon fiber reinforcements with polyphenylene sulfide (PPS) and polyetherimide (PEI) matrix are used.

7134 | Polymeric nanocomposites based on magnetorheological fluids, a new class of nanostructured materials

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With the increasing demand for new materials, polymer blends arise as an option for the synthesis of new polymers. Polymeric nanocomposites, a class of composites where the filler material exhibit at least one dimension in the nanometric scale (10-9 m), emerge as an alternative for new polymers. (<10% wt) [1].
While many fundamental studies have investigated how various factors influence the dispersion or aggregation of the nanoparticles, the effect of grafting on the resulting material properties has received considerably less attention [2].
Polymeric nanocomposites (PNCs) are materials obtained by dispersing nanoparticles in a polymer matrix, and, due to the large surface-to-volume ratio between the nanoparticles and the polymer, substantial property changes can be observed for relatively low concentrations of particles [3,4].
Most easily realized and cost efficient methods of obtaining polymeric nanocomposites are those based on the introduction of nanoparticles directly into a molten thermoplastic material [5,7]; mixing of nanoparticles with nanodispersed polymers, followed by melting and molding [8,9]; swelling a polymer and a nanofiller in the same solvent, followed by processing the composition from melt [7,10]; and decom-position of thermally unstable salts and other metal compounds, in a polymer melt [6,7].
Magnetic suspensions are complex fluids with remarcable property of changing their rheological properties, under the influence of an external magnetic field [11,12]. There are two classes of magnetic suspensions: magnetic nanofluids and magnetorheological fluids.
Magnetic nanofluids (MNF) are ultra-stable dispersions of nano-sized particles (usually 3-15 nm) dispersed in different carrier liquids. Ferro/ferrimagnetic particles (magnetite, maghemite or cobalt-ferrite) are magnetically single domain and are in a permanent state of magnetization, i.e. they have a magnetic dipole moment even in the absence of an applied magnetic field. On the other hand, magnetorheological fluids (MRF) are smart and controllable materials, which usually consist of micron-sized (3-10 μm) magnetizable particles, suspended in a carrier liquid such as mineral oil, synthetic oil, water, glycol or even a magnetic nanofluid.
The motivation for this research is the possibility of obtaining new nanostructured materials, by mixing the magnetorheological fluids or the magnetic nanofluids with resins, followed by the resin transfer molding (RTM) process, taking advantage of magnetic nanoparticles orientation under the action of an external magnetic field. Therefore, the anisotropy of the material could indicate a specific application of the part being processed [13,14].
Also, due to the magnetic properties of these nanoparticles, the presence of a magnetic field, during the polymerization process, opens the possibility to obtain ordered nanostructured composites [15, 16].

Bibliography

1. T. Kashiwagi et al, Polymer, 45 (2004) 881–891 ;
2. H. Chao et al, Polymer, 54 (2013) 5222–5229 ;
3. W.R. Caseri, Materials Science and Technology, 22(7) (2006) 807;
4. R. Krishnamoorti et al, Journal of Polymer Science Part B: Polymer Physics, 45(24) (2007) 3252;
5. S. S. Pesetskii et al, http://dx.doi.org/10.106/B978-0-444-59455-6.00005-2;
6. A.D. Pomogailo et al, Nauka, Moscow, (1988);
7. E.M. Natanson et al, Naukova Dumka, Kiev, (1971) (in Russian) ;
8. V.M. Buznik et al, Siberian Branch of Russian Academy of Sciences Publication, Novosibirsk, (2005) (in Russian);
9. S.P. Gubin et al, Doklady Akademii Nauk Rossii (Rep. Russ. Acad. Sci.) 388(4) (2003) 493–496 (in Russian);
10. S.P. Gubin et al, Russian Chemical Reviews, 74 (6) (2005) 489–520;
11. S. Odenbach, Colloid Surf. A 217 (2003) 171;
12. J.M. Ginder et al, MRS Bull., 23 (1998) 26;
13. N. Crainic et al, Key Eng. Mater., 230-232 (2002);
14. N. Crainic et al, Mol. Cryst. Liq. Cryst., 418 (2004);
15. N. Crainic et al, Int. J. Nanomanuf., 1 (2007) ;
16. N. Crainic et al, Int. J. Nanomanuf., 6 (2010) ;

7135 | Influence of sugar cane bagasse ash (SCBA) on the mechanical properties of cementitious composites

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In Brazil, it is estimated that the production of sugar cane for the 2013/2014 crop will be approximately 659,850 million tonnes. This is a 12% increase in the production of sugar cane when compared to the 2012/2013 crop. The bagasse is usually burned for energy production providing nearly 3% of residual ashes (6.73 million tonnes of ashes). The chemical composition, and hence the reactivity of sugar cane bagasse ash varies depending on the burning conditions, soil characteristics and the variety of sugar cane. This paper presents a study of ash from the pre-air region of the boiler, one of the four types of residual ashes obtained from an industrial plant that produces sugar and ethanol. The cementitious composites containing 0 % and 10% wt. of cement per equivalent volume of the sugar cane bagasse ashes were investigated at different curing periods. These were 3, 7, 28 and 90 days under water. Compressive strength tests, dynamic elastic modulus tests, and water absorption studies of the cementitious composites were performed. The results indicate that SCBA from the pre-air region of the boiler may be suitable for the production of cements with a low environmental impact.

7137 | Plateau Lower-Bounds to the Imperfection Sensitive Buckling of Composite Shells

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The buckling of thin FRP laminated shells are sensitive to initial geometric imperfections. A large number of geometric and material variables prohibit the traditional experiment-based lower-bound design method for metallic shells from being extended to composite ones. As an alternative, the so-called reduced stiffness method (RSM) has been applied to the lower-bound buckling of FRP laminated shells. It has been shown for shorter shells the method predicted excellent lower bounds to the nonlinear buckling loads. This paper aims to extend the study to longer shells. It is shown for longer composite shells the lower bound buckling modes generally occur in the long axial wave mode having one axial half-wave but require imperfection amplitudes of impractical largeness. Further studies of the geometric parameters identify the existence of intermediate and significant plateaus to the lower bounds. These plateau lower-bounds demonstrate the importance of the short axial wave modes having more than one axial half-wave, associated with the imperfection amplitudes of practical smallness. Using the plateau values and modes to predict lower bounds is suggested to provide an important alternative for improving shell buckling design.

7140 | [POSTER] Development of the Evaluation Program Based on Fire Resistance Performance Design of Steel Structure

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In order to minimize a loss of safety and property of residents from fire and apply an economic fire resistance design, advanced countries like England, Sweden, New Zealand, Japan, etc. have introduced performance design methods as early as possible. The performance design method is to design considering comprehensive issues related to the prescriptive design, alternative design, full scale model test, thermal analysis, etc. It has shortcomings that are complicate design processes and require a lot of time. However, the prescriptive design method has been used in Korea, which has shortcomings that can be designed within certain scope for the fire resistance and have short variability due to its uniformity. Although it led to raising the need for the performance design method for a long period of time, there is few case studying theory and design process on performance design method in detail applied to the actual buildings. In order to secure reliability of the theoretical formula for the verification of performance fire resistance design and comparison with full scale test result on the steel structure required for introduction at present, the calculation method of the alternative fire resistance design is required to simply evaluate the fire resistance performance for the structural members during the fire. In this regard, this report proposes the calculation method and accordingly introduces the developed design tool, applying the alternative design theory formula repetitively, simply and easily used by not only experts of the fire but also structure designers.
The steel structure is based on the time arriving at the maximum temperature in the area of the standard fire test after determining the limit temperature of the members. Accordingly, the fire resistance performance of the steel structure can be determined by comparing the limit time (hereinafter referred to as the Equivalent Fire Severity) withstanding the fire with the determined time of the fire resistance performance for the steel structure. Also, for the analysis of the fire resistance performance in all areas, the calculation is limited to the beam excluding the column, slab and wall. In case of the fire behavior in the area, the Equivalent Fire Severity is used, which is the standard to evaluate the fire resistance performance of the steel structure used in buildings considering the type and heat release rate of the combustibles, area of the opening, etc.

7141 | [ORAL] Fire resistance performance evaluation of Curtain-Wall Systems Applying Light-Weight Inorganic Panels

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For the curtain wall used in buildings, an aluminum based frame is generally used considering the light weight and processing. Also, for an aluminum composite panel applied in the spandrel area of the curtain wall, the inorganic fiber and organic materials like mineral wool and glass wool are used inside the panel to increase the fire resistance performance.
Mineral wool or glass wool, inorganic fibers, is weak to moisture based on their characteristic, sagging phenomenon etc. is generated. Therefore, it has its demerit lowering the insulation function. Also, organic materials like polyester wool is weak to the fire so, they have their limitation for their use to the buildings due to their harm to the human body caused by the generation of the carbon monoxide. Thus, the technology development of the spandrel panel is vitally required for not only the improvement of the insulation function of the existing curtain wall system but also security of the fire resistance performance.
In this study, the fire resistance performance of the curtain wall has been evaluated and its analysis method has been investigated for the fire resistance test on the curtain wall system applying the newly developed light-weight aluminum composite panel (hereinafter referred to as the development panel). Also, the fire resistance performance of the curtain wall using the existing materials has been compared and analyzed. In addition, the developed panel for application to the skyscraper has been applied to the actually used curtain wall of the skyscraper in Korea to find out the fire resistance performance. Accordingly, the test has been carried out in accordance with EN 1364-3, the fire resistance test method of the overall curtain wall system. According to EN1364-3 code, the test should be executed for interior and exterior fire each but only the interior fire scenario has been applied in the study.
Two tests considering the interior fire scenario have been carried out. In the first test, the specimen considering the glass of the curtain wall and the spandrel area has been planned but the specimen considering only the spandrel area has been planned in the second test.

7142 | A Novel Nano Particle based Composite for Water Disinfection

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Throughout the world, polymer composites have been used extensively in various applications such as chemical industries, food, pharmaceutical and biomedicine. Recent research is focused on the modification of polymer properties with the addition of different types of nano particles (NPs). In the present investigation, nano particle composite is developed and analyzed for their disinfection properties. The main focus of the present investigation is the application of nano particle composite and its derivatives in water treatment.
Polymeric nanoparticle composites (PNC) are prepared by solution casting and dried at room temperature (27-30 °C). PNC is examined using TEM and it shows the clusters of aggregated nano particles. Further, elemental analysis of the nano particle revealed that they mainly contain elemental carbon C = 91.95%, H = 0.053%, N = 0.045 % and S = 0% with rest being impurities. The UV-DRS spectrum of nano particle reveals the broadband absorption observed in addition to the absorption of nano particle in UV region at about 340 nm thus PNC appears to be a promising material capable of exploiting the solar radiation from UV-NIR region. The XRD spectra of synthesized PNC show its amorphous nature. After laboratory examinations PNC showed disinfection behavior against Escherichia coli (ATCC 25922).
In the present investigation, disinfection is compared at a temperature of 41°C by employing SODIS (Solar Water Disinfection), CNP (Carbon Nano Particles), CS (Chitosan) and newly developed Polymeric nanoparticle composite (PNC). It was found that PNC is highly effective in disinfection as compared to SODIS, CNP and CS membrane. It is about 42 times more effective than SODIS and 17 and 2.5 times more effective than CNP and CS membrane, respectively. Further, PNC required only 60 minutes for the complete disinfection as compared to 360 minutes of SODIS and 90-120, 120 minutes for CNP and CS membrane, respectively. It is further to be noted that temperature affects the bacteriostatic property of PNC against the bacteria employed in the present investigation.

Keywords: Composite, Chitosan, Nano Particle, Disinfection, E. coli, Water Treatment

7143 | Oxide nanocomposites for thermal barrier coating: synthesis and characterization

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Thermal barrier coatings (TBC) used for protection of the gas turbines hottest parts must enable modern engines to operate at enhanced temperatures that increases efficiency and improve performance of advanced gas turbines [1]. So, TBC consisting of two layers: an oxidation-resistant metallic bond coat and a porous and thermally insulating ceramic topcoat must meet severe requirements. The operation under extreme conditions leads to phase transition and accelerated sintering of yttria-stabilized zirconia (YSZ) coatings usually used as topcoat. Hence, novel complex oxides with sufficiently low thermal conductivity, high sintering resistance and high phase stability were suggested as high performance TBC topcoats [2].
In this work, nanocomposites comprised of La2Zr2O7 and LaAlO3 or LaCuAl11O19, LaMnAl11O19 were prepared and studied both as bulk materials and thin layers supported on top-coat YSZ layer loaded on Ni superalloy substrate with NiCrAlY bond coat. Particles of NiCrAlY alloy and YSZ have been deposited by detonation spraying from a hot gas stream as dry powders. Complex oxides were prepared via several methods including Pechini route, soft

mechanochemistry and microwave heating of salts mixture with carbon. Nanocomposites were prepared by ultrasonic treatment of the oxides mixture or their precursors in isopropanol with addition of surfactants. Thin layers of oxide nanocomposites were supported on YSZ/ NiCrAlY/NiCr-superalloy substrate by slip casting of these suspensions. Genesis of bulk composites and coatings texture, their composition and real/defect structure after annealing under air and argon up to 1200 oC were studied by combination of diffraction methods (high resolution SEM and TEM with EDX, XRD) and spectroscopic methods (FTIRS of lattice modes, UV-Vis, Raman, XPS, SIMS, laser-excited luminescence spectra). The thermal diffusivities of the bulk materials and supported layers were characterized by the laser flash system (Netzsch LFA 427, Germany) from room temperature up to 1273 K in an air atmosphere. For separate oxides, well-crystalline samples are obtained after sintering at 1100 oC, though surface layers are disordered due to their enrichment by smaller Zr and Al cations. In nanocomposites substantial disordering of coordination spheres of cations and residual mesoporosity remain even after sintering at 1300 oC, while redistribution of cations between phases is small. Thin nanocomposite layers on YSZ/NiCr substrates sintered up to 1300 oC demonstrate a good matching with YSZ along with smaller particle sizes of pyrochlore and perovskite phases and their higher disordering as compared with bulk nanocomposite. Good thermal shock resistance (heating up to 1100 oC) was demonstrated for this multilayer design of thermal barrier coating.

1. D. R. Clarke, M. Oechsner, and N. P. Padture, MRS Bulletin, 37(2012) 891.
2. W. Pan, S. R. Phillpot, C. Wan, A. Chernatynskiy, and Z. Qu, MRS Bulletin,37 (2012) 912.

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7145 | Effect of Nanoparticles on the Diffusion of Sea-water in USP-Glass Composites

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Glass fiber reinforced polymer (FRP) composites are increasingly becoming the material of choice for the use in marine components not only due to advantageous strength to weight ratio but also due to superior resistance to sea water and other corrosive agents. However, the aggressive nature of marine environment demands better composites with improved lifetime and performance properties which can be achieved by exploiting the well demonstrated barrier effects of nano fillers when combined with polymer. In this study, the effect of nano particles, Cloisite 30B, when combined with polymer, Unsaturated Polyester (USP), on the moisture absorption of the glass reinforced composites under the influence of the marine environment is studied. A dispersion technology is established to disperse the Cloisite 30B in USP resin and a manufacturing technology is developed for manufacturing the Cloisite dispersed USP-FRP composites. Effective dispersion technology includes 24 hrs of swelling, followed by 15 min of mechanical stirring and 45 min of Ultrasonication. The nanoparticles are dispersed effectively in the resin which is justified with the HRTEM images that show good amount of intercalation and exfoliation. For the manufacturing of composite, Vacuum assisted resin infusion method (VARIM) is used where Nano dispersed resin is infused into vacuum bagged setup of glass fiber reinforcement. Vacuum is applied and the whole system is allowed for curing. Moisture absorption study is carried out according to ASTM D570 standard using the test specimens cut from the composites manufactured. Moisture diffusion study is conducted by measuring the moisture uptake of test specimens immersed in the simulated sea water at different temperatures with different nano loadings. The effect of different loadings of nano particles ranging from 0 to 6% is studied. The moisture absorption percentage is found to decrease to around 30-40% due to nanoparticle loadings which can be attributed to the high aspect ratio of clay platelets which increases the tortuosity of the path of water molecules as it diffuses into nano composite. Five different diffusion models are attempted to describe the diffusion pattern by regression analysis. It is observed that Diffusion Relaxation, Dual Sorption and Dual Fickian model are fitting well with the experimental data although it follows Fickian model in the initial uptake region. The similar moisture absorption study is performed using the plaques made of Cloisite 30B dispersed USP without glass reinforcement and it is found that the trend is completely different which is mainly due to the predominant hydrophilic properties of the clay particles.

Keywords: Polymer composite, Ultrasonication, Cloisite, Unsaturated Polyester, Diffusion

7146 | Microstructural Characterization of the Eutectic Composites in multiferroic Ln1–xLn'' xMnO3 and M-type ferrites MCoxTixFe12-2xO19 crystals

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The investigation of microscopic phase separation in promising magnetic materials Ln1–xLn' xMnO3 (Ln = Eu or Tb; Ln' = Y or Ho) and MCoxTixFe12-2xO19 (M=Sr, Ba, x = 0÷2) crystals were carried out. The single crystals have been grown by floating zone melting with light heating [1]. The
X-ray diffraction analysis was performed on D2 Phaser diffractometer and Huber G670 highly sensitive Guinier chamber (CuKα- radiation). The chemical composition and microstructure of the samples were investigated using JSM5910-LV (JEOL) scanning electron microscope (SEM) equipped with the AZtecEnergy system for X-Ray energy-dispersive spectroscopy analysis (Oxford Instruments). The identification of crystalline phases and its mutual orientation in the neighboring phases were performed by electron backscatter diffraction on CRYSTAL device (Oxford Instruments).
Ln1–xLn'xMnO3 (Ln = Eu or Tb; Ln' = Y or Ho) crystals were shown to undergo the phase separation close to the point of concentration transition from the orthorhombic structure to the hexagonal phase [2]. The SEM studies have revealed that the crystal boules have a regular lamellar structure in form of alternating layers of the orthorhombic and hexagonal phases; this structure is a typical feature of the materials obtained by the directional solidification of eutectic composites. The local chemical and phase compositions and the unit cell parameters of the phases have been determined. The micro-structure and the orientation features of the lamellar structures for different growth conditions were described.
At hexaferrite growth, along with the high-quality (perfection) crystals, the crystals with phase separation in the peripheral parts of crystal may occur. It was shown that in case of BaCoxTixFe12-2xO19 crystals along with the main hexagonal M-type ferrite phase, BaFe2O4 additional phase was formed as an admixture. In case of SrCoxTixFe12-2xO19, SrTiO3, Sr4Fe6O13 and some Ti-enriched phases obtained as a result of directional crystallization of the eutectics may also occur besides of M-type phase. The unit cell parameters and MCoxTixFe12-2xO19 (M = Sr, Ba, x=0 - 2) chemical compositions have been determined.
Microstructural peculiarities of the compounds studied have been considered from the viewpoint of the corresponding phase diagrams and crystal structures of the co-existing phases.

1. A.M. Balbashov, S.K. Egorov, J. Cryst. Growth, 52 (1981) 498-504
2. L. D. Iskhakova, V. Yu. Ivanov, A. A. Mukhin, A. M. Balbashov, S. V. Lavrishchev, A. S. Orekhov, Cryst. Rep. 57 (2012) 618-623

7147 | STRUCTURE OF REINFORCING FILLER NETWORK DETERMINED BY ELECTRICAL CONDUCTIVITY OF THE POLYMER / CARBON BLACK COMPOSITE

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Electrical conductivity of composites of polymeric insulating matrix filled with electroconductive filler depends on a formation of conductive filler network, leading to a pronounced increase in conductivity at certain filler concentration called percolation threshold. Obviously, any change of the conductive network due to the external influence should result in a change of electrical conductivity. Thus, the changes in electrical conductivity resulting from either mechanical deformation or a change of volume due to e.g. temperature change can be used for monitoring the current state of the physical reinforcing network formed by the filler.
The principle described above was used to investigate the behavior of either vulcanized rubber or thermoplastic polycaprolactone filled with electroconductive reinforcing carbon blacks. The effect of a decrease of elongation at break in the percolation threshold region is demonstrated on composites with either thermoplastics (polycaprolactone, polyethylene, polypropylene) or rubber matices filled with conductive filler. The effects during deformation are investigated by online measurement of conductivity during mechanical deformation. Conclusions regarding the decay or reforming of the conductive network have been done and compared to the mechanical responses of the material during uniaxial tensile deformation, as indicated by stress – strain curve, or during cyclic deformation characterized by hysteresis curves. In the latter stage, regeneration of the conductive network during stress relaxation measured at constant nonzero deformation followed by recovering after release the mechanical stress was also considered.
The changes of electrical conductivity were found to be far away from simple monotonous increase / decrease during deformation. On the contrary, rather complicated dependences with several extremes on the conductivity vs deformation curves were observed. Some of these are related to Hookean part and inflex point on the stress strain curve. Yield point for composites with thermoplastic matrices is also an important parameter to consider regarding electrical conductivity. Cyclic deformation with constant or rising amplitude contributes to better understanding of more complicated mechanical responses e.g. related to Payne's effect.

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7151 | Investigation of the Poynting and inverse effects of a bilayered cylinder under axial-torsional loading

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The axial elongation of a cylinder under pure torsion is known as the Poynting effect (Poynting, 1909). Since its discovery, some natural materials such as biopolymers have been observed to contract axially under pure torsion, and this is known as the negative Poynting effect. Recently, Wang and Wu (2014) investigated the deformation of a cylinder under combined axial and torsional loading. They found that an "axial force-twist" effect is possible, i.e., the axial loading may either enhance (positive effect) or reduce (negative effect) the rotation of the cylinder caused by torsion alone. As expected, axial loading on its own will not twist the cylinder. The axial force-twist effect has received scant attention, and has been named as the inverse Poynting effect (Zubov, 2001). Furthermore, both the Poynting effect and the inverse effect are also possible in a bilayered cylinder, as reported by Wang and Wu (2014).

This work investigates the relation between the two effects in a homogeneous and in a bilayered cylinder. It is shown that these are second-order nonlinear effects, and that they can be characterized by two parameters, respectively. Each parameter is geometric-elastic, i.e., a combination of the radii of the concentric layers as well as the second-order and third-order elastic constants of the cylinder layers. The major findings are: (1) the Poynting and its inverse effects can be both positive, both negative, or they can differ in sign, (2) if they differ in sign, then the Poynting effect must be positive and the inverse effect must be negative, (3) the elastic inhomogeneity between the layers has a strong influence on both the magnitude and sign of the effects, (4) the geometric inhomogeneity (or the difference in layer thicknesses) also has a strong influence on the effects, (5) the Poynting effect depends inversely with the sextic power of the cylinder size, and (6) the inverse effect depends inversely on the cubic power of the cylinder size.

These general relations may be useful for the development and design of soft biomaterials or bio-inspired composites. The effects are also associated with the existence of second-order stresses. For example, normal stresses under pure torsion can weaken the integrity of the interface or strongly affect the non-mechanical property of a biological layer attached to a synthetic substrate. Optimization of the layer thicknesses and elasticities to reduce the stresses or the effects themselves may be possible through the use of such general relations.

References

Poynting, J.H. (1909). On pressure perpendicular to the shear planes in finite pure shears, and on the lengthening of loaded wires when twisted. Proc. R. Soc. Lond. A 82, 546-559.

Wang, D. and Wu, M.S. (2014). Poynting and axial force-twist effects in nonlinear elastic mono- and bi-layered cylinders: Torsion, axial and combined loadings. Int. J. Solids Struct. 51, 1003-1019.

Zubov, L.M. (2001). Direct and inverse Poynting effects in elastic cylinders. Dokl. Phys. 46, 675-677.

7152 | Characterization of the mechanical properties of the polymer nanocomposites and their associated interphases

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In this study, molecular dynamics (MD) simulation and finite element (FE) analysis were integrated to develop a mechanics-based multiscale approach that can derive both the global stiffness and the local load transfer on the filler surface of the particulate nanocomposites. Through MD simulations, crosslinked epoxy resin (crosslinking ratio: 0.45) and five different types of epoxy/SiC nanocomposites with embedded nanoparticle diameters ranging from 1.04 nm to 2.30 nm with the same volume fractions of 0.059 were prepared with full atomistic detail. For each model, uniaxial tensile tests were carried out to obtain the global elastic behavior of the nanocomposites and the local deformation energy distribution in the vicinity of a particle surface. Meanwhile, a three-dimensional FE model of a three-phase composites was prepared, consisting of a particle, interphase (polymer networks adsorbed on the particle surface), and matrix (polymer networks non-adsorbed on the particle surface). The unknown mechanical response of the interphase was numerically obtained through homogenization, and the geometrical boundaries were obtained through matching the deformation energy to that of the full atomic molecular model. An equivalent nanocomposite model in a continuum basis given from the present multiscale method yields an effective volume fraction and effective mechanical properties of the interphase. Hence, the virial local stresses at both the interphase and matrix regions of the full-atomic model are successfully reflected by the equivalent continuum model. Particularly, the nanoparticle size effect on mechanical behavior reported earlier was also revisited through the multiscale model. The intrinsic nature of the interphase in polymer nanocomposites is discussed in detail.

7154 | Fracture toughness improvement in ZrB2-SiC-based composites at moderate hot pressing conditions reinforced with different additives

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This paper reports on the fracture toughness improvement in zirconia (ZrO2), carbon fiber (CF) and/or micron/nano-SiC reinforced ZrB2-SiC-based composites as a result of Taguchi analyses at different processing conditions with various compositions. In this way, different ZrB2-SiC-based composites were prepared by hot pressing at moderate temperatures of 1700, 1775 and 1850 °C for 30, 60 and 90 min under a relatively low pressures of 8, 12 and 16 MPa. Fracture toughness of ZrB2-SiC-based composites have been investigated using the direct crack measurement method after Vickers indentation on polished surfaces. Highest values for fracture toughness in the ZrB2-SiC binary composites belonged to the sample that had 25 vol% nano-SiC (200 nm), sintered at 1775 °C for 90 min under 8 MPa. In the ternary systems, ZrB2 with 20 vol% SiC and 5 vol% CF, hot pressed at 1775 °C for 60 min under 16 MPa, had fracture toughness of ~6.5 MPa m1/2. On the other hand, ZrB2 with 20 vol% SiC and 5 vol% ZrO2, consolidated at 1850 °C for 90 min under 12 MPa, reached a fracture toughness of ~6.7 MPa m1/2. In conclusion, presence of SiC particles, especially nano-sized type, activates some toughening mechanisms such as crack deflection, crack branching, microcracking, crack bridging, and break of large SiC grains. More improvements in fracture toughness were attributed to the energy dissipation mechanisms of carbon fiber bridging, carbon fiber pullout or phase transformation toughening mechanism by ZrO2.

7158 | Large Volume Manufacturing of Steel-CFRP-Hybrid Structures by Prepreg Press Technology and Resin Transfer Moulding

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Due to economical and ecological constraints, the development of lightweight concepts becomes extremely important. In automotive lightweight construction especially the combination of different materials is of great interest. A promising approach in the field of multi-material systems is the manufacturing of structural parts consisting of steel metal blanks with local carbon fibre reinforced plastic (CFRP) patches. Thereby a local CFRP reinforcement is applied to a sheet metal structure by using the prepreg press technology (PPT) or resin transfer moulding (RTM). These techniques can be used for the production of load adapted automotive structural components in large volumes. Through the load adapted structure the wall thickness of the sheet metal can be reduced effectively. This leads on the one hand to a large weight saving potential of up to 50 % mainly depending on the load situation and material combination. On the other hand due to the limited usage of high-priced CFRP these components are also characterized by cost effiency.

Current research work within the scope of collaborative research projects at the Chair for Automotive Lightweight Construction (LiA) at the University of Paderborn concentrates on the investigation of hybrid materials and their processing. In particular, new manufacturing processes like the PPT are developed to make hybrid components attractive and available for automotive mass production and – in case of RTM – adapted to the specific requirements of hybrid structures. This includes, for example, trimming process chains, reducing cycle times and thus a reduction of process steps and costs. In addition, various combinations of hybrid materials are examined based on material and component tests.

In the available paper current research results in the field of the manufacturing of hybrid materials are presented. Two different processes are discussed: the PPT, where preimpregnated semi-finished products (prepregs) are directly formed into a sheet metal structure, and the RTM, where a resin is injected into a dry preform on a sheet metal surface. For both processes advantages, specific requirements like sealings, bonding, process sequences and parameters, cycle times or tool designs are illustrated and exemplified by different experimental results. At the end of the paper the processes are compared with pros and cons. Aside, possible areas of application will be considered.

7159 | Simulation and validation of a running prosthesis made of carbon fibre reinforced plastics

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Through the loss of limbs people are very restricted in their daily activities. Especially for athletes, for example in running, special sport prostheses are used. One famous example for a paralympic competitive athlete with sport prostheses is Oscar Pistorius. In most cases these prostheses are made of carbon fibre reinforced plastics (CFRP), because of the high specific strength and stiffness. Additionally the spring characteristics of CFRP are progressive which is a big advantage for sports prostheses. So it is possible to create very good and lightweight prostheses out of CFRP which are

perfecly adapted to the runner. But one essential problem is, that failures in the material are not easy to detect. In case of steel or aluminium it is possible to detect a crack at the surface of the structure. But, in case of CFRP the cracks can start at nearly any point of the structure because of fibre failure oder delamination so that the whole structure can break abruptly, without any warning. That means a huge risk for the runner, because if the prosthesis breaks while running, he will probably fall down and injure himself.
Current research work within the scope of a collaborative research project at the Chair for Automotive Lightweight Construction (LiA) at the University of Paderborn concentrates on the development of an intelligent running prosthesis. That means that a sensor is included into the running prosthesis made of CFRP and detects the strains. A data processor calculates the remaining lifetime of the prosthesis and if it is almost broken an acoustic signal warns the runner not to use it any more. The calculation of the data processing is based on an assessment of fatigue strength which is made at LiA. This assessment is split into four parts. First a linear elastic FEM simulation of the material behaviour, second the absorption of a stress-number (SN) curve for the material, third the absorption of a SN curve for the prosthesis and last the assessment of the fatigue strength.
In this paper current research results in the field of FEM simulation and validation are presented. First, the development of a test facility to display a step of the runner with the help of a hydropulser, which can be controlled by the displacement or force, is presented. Second, the material testing results to fill the material card of the FEM model are shown. Tensile and compression tests with different fibre orientation have been performed to get the most important material characteristics. Third, the FEM modell of the prosthesis, which has been created in the programm Altair HyperWorks including the constraints and contacts to replicate the test facility, are presented with the results of the simulation. Fourth, to validate the simulation results, they are compared with the results of the real prosthesis in the test facility. To get the real deformations and strains of the prosthesis, they are mapped with an optical system named PONTOS from the company GOM (Gesellschaft für optische Messtechnik). The system works with two highspeed cameras and measures the movement of optical dots, which are applied to the prosthesis before the measurement in 3D. The results of the optical measurement can be overlayed with the simulation data, so that a validation is given. These results are presented before the paper will be closed with the conclusions.

7160 | Biocomposites: Advanced bio-fuctional biomimetic composite materials containing concentrated living cells for energy and sustainability

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Biocomposites are a class of advanced materials that stabilize highly concentrated living cells in colloidal, microfluidic nanoporous polymer structures to function as biocatalysts, biocomposite devices or biomimetic leaves. Biocomposite structures will revolutionize the form, manufacture, intensity and significantly extend the stability of microbial biocatalysts for energy and environmental sustainability. Our research groups have collaborated to investigate the fundamentals of novel methods for precise deposition of live cells and colloid particles by continuous convective sedimentation assembly (CCSA), electric field driven dielectrophoretic assembly (DEP), ink-jet deposition and composite structures made of microparticles with various morphologies. Some of these structures can stabilize entrapped living cells capable of being stored desiccated for months without loss of reactivity and when rehydrated have sustained reactivity for 1,000s of hours. Our work has resulted in development of new methods to precisely assemble polymer particles together with a variety of prokaryotic and eukaryotic heterotroph or autotroph living cells that can be engineered by synthetic biology for a wide variety of catalytic functions. These assembly methods can be used to fabricate single or multi-layer bio-functional flexible 3D composite structures with very high reactivity. Some applications investigated by us include microbial biocatalytic coatings, solar energy absorbing flexible microfluidic devices that replicate the vein structure of natural leaves (prototypes of biomimetic leaves), structures formed by reactive microbial latex ink-jet inks, nonwoven biocomposite materials for hydrating highly concentrated microbes in a gas stream for gas cleaning and recycling gas-phase carbon compounds (reactive falling film biofilters) and even oil clean-up using bio self-propelled particles. Recent investigations have focused on biocomposites containing anaerobic bacteria, cyanobacteria and green microalgae for energy applications such as recycling gas-phase CO or CO2 into useful chemicals and fabricating biophotoabsorbers with photosynthetic reactivity in the form of flexible sheets comparable to natural leaves.

7167 | Effects of Damages of NSM CFRP rectangular Rods on Strengthened RC Beams

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Repairing reinforced concrete (RC) structures using composite materials has become a significantly common technique using different strengthening techniques. Among the methods available, the Near Surface Mounted (NSM) technique, which uses fiber reinforced polymer (FRP) strips or rods inserted into grooves on concrete covers [1], appears capable of solving a number of aspects, such as the susceptibility of FRP sheets or externally bonded FRP reinforcements to damage deriving from collision, high temperature and fire. This strengthening method is a promising technology for increasing the flexural and shear capacity of reinforced concrete members. The availability of strengthening NSM FRP rods having different shapes depends on many factors – bond length, dimensions of the rods used, type of FRP material employed, rods' surface configuration, groove size, etc. – and on the effects of damages both of concrete, such as crack width and spacing, and on composite material FRP. The effects of local loss of bond due to lack to adhesive between rod and concrete and bending cracking of concrete have been investigated by the authors [2] with static and dynamic tests on prototypes of RC beams strengthened with NSM FRP rectangular rods. This paper analyses the effects of damages due to symmetric notches in carbon-FRP (CFRP) rectangular rod inserted into one groove as strengthening of RC beams. Three RC beam specimens, measuring 1100mm in length and with a rectangular cross-section measuring 80mmx120mm, were built and examined experimentally through static tests and free vibration. Two beams were strengthened with NSM CFRP rectangular rods and subjected to a damage due to notches: the mid span section of CFRP rectangular rod presented the reduction only in one beam, two NSM CFRP rod sections were damaged in the other beam. Experimental static and dynamic tests were carried out to check the behavior of three RC beams specimen strengthened both with undamaged and damaged FRP rectangular rods.
Although bending tests may be adequate for describing the behavior of strengthened RC beams, this method is a destructive method; while analysis of dynamic response may be considered a convenient, non-destructive monitoring method for analysing strengthened RC beams [3]. The experimental results include both the static bending tests and the dynamic tests measuring the beams' natural vibration modes and the frequency values in the case of free-free ends. Comparison between experimental and theoretical frequency values for three RC beams and the analysis of frequency changes due to damage for bending cracking and loss of adhesion allow defining the actual behaviour of RC beams strengthened with NSM CFRP rods.

References
1. De Lorenzis L., Teng J. G. Near-Surface mounted FRP reinforcement: an emerging technique for strengthening structures. Composites Part B: Eng. 2007; 38: 119-143.
2. Capozucca R., Bossoletti S. Static and free vibration analysis of RC beams with NSM CFRP rectangular rods. Composites Part B: Eng. 2014; 67: 95-110.
3. Baghiee B, Esfahani MR, Moslem K. Studies on damage and FRP strengthening of reinforced concrete beams by vibration monitoring. Eng Struct

2009; 31: 875–93.

7171 | Synthesis, characterization, optical and antimicrobial studies of Polyvinyl alcohol-silver nanocomposites

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Silver nanoparticles (Ag NPs) were synthesized by chemical reduction of silver salt (AgNO3) through sodium borohydride. The characteristic surface plasmon resonance band located at around 400 nm in the UV–Visible absorption spectrum confirmed the formation of Ag nanoparticles. Polyvinyl alcohol–silver (PVA–Ag) nanocomposite films were prepared by the casting technique. The morphology and interaction of PVA with Ag NPs were examined by transmission electron microscopy and FTIR spectroscopy. Optical studies shows that PVA exhibited indirect allowed optical transition with optical energy gap of 4.8eV, which reduced to 4.45eV under addition of Ag NPs. Optical parameters such as refractive index, complex dielectric constant and their dispersions have been analyzed using Wemple and DiDomenco model. Color properties of the nanocomposites are discussed in the framework of CIE L*u*v* color space. The antimicrobial activity of the nanocomposite samples was tested against Gram positive bacteria(Staphylococcus aureus NCTC 7447 & Bacillus subtillis NCIB 3610) , Gram negative bacteria (Escherichia coli, NTC10416 & Pseudomonas aeruginosa NCIB 9016) and fungi (Aspergillus niger Ferm – BAM C-21)using the agar diffusion technique. The antimicrobial study showed that PVA has moderate antibacterial activity against Bacillus subtillis and the 0.04wt% Ag NPs composite sample effect was strong against Staphylococcus aureus.

7172 | Detection of nonlinear effects and damages during wind turbine blades certification tests by means of strain field pattern recognition. Comparative study: Fiber Bragg gratings vs Distributed sensing vs electrical extensometers.

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A 13.5 meters prototype of wind turbine blade for a 150 kW wind turbine machine, was designed and made of glass fiber and vinylester resin doped with carbon nanofibers. The blade was manufactured using Light RTM as a monocoque structure with a PVC foam core.

A methodology for instrumenting the blade with Fiber Optic Sensors (FOS) embedded into the structure during the manufacturing process was developed. Two different strain sensing techniques were embedded into the blade: Fiber Bragg Gratings (FBG) and a plain fiber optic for Distributed Sensing using an Optical Backscatter Reflectometer (OBR). Besides the FOS, traditional electrical extensometers were bonded to the Surface of the blade.

By using Hierarchical Nonlinear Principal Component Analysis (h-NLPCA) it is possible to perform a pattern recognition technique based on the strain field inferred from the strain measurements gathered from the different systems embedded into the structure. Several types of nonlinearities and defects can be detected in the blade in real time during the certification testing, avoiding the premature failure of the structure.

Several static tests were conducted, including a test campaign with known artificial damages induced into the structure and the sensitivity of the technique was evaluated. The results showed that every damages could be detected by using different sensing techniques.

7173 | Hydrolytic degradation analysis of PLA, PLA/GNP and PLA/CNT-COOH nanocomposites thin films for anterior cruciate ligament repair

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Biodegradable polymers such as polylactic acid (PLA) have been studied for being used on a temporary approach of the natural ligament replacement, combined with Tissue Engineering techniques, instead of the permanent approach. These approach aims to recover damaged natural ligament remaining from a rupture, by using a biodegradable scaffold that allows the growing of the new tissue, promoting the regeneration. Biodegradable scaffold should degrade during the recovery period of the ligament maintaining essential mechanical properties and loosing molecular weight until scaffold is no longer required.
PLA degrades chemically mainly by hydrolytic degradation into lactic acid which is broken down into water and carbon dioxide via the citric acid cycle, been eliminated from the body in carbon dioxide and water form. Water diffusion from degradation media promotes ester bond chain-scission and crosslinking, leaving chains shorten and the polymer brittleness. This mechanism can be affected by factors like the polymer molecular structure, ester group density, degradation media, temperature and mechanical loads. Hydrolysis can be modeled by the Michaelis–Menten scheme, concerning the formation of carboxyl end groups, ester concentration and water concentration.
Attending to some previous results for ligaments replacement, there is the need to mechanically reinforce some of these biodegradable polymers scaffolds, avoiding plastic deformation which is one of the main causes for device failure. Aiming improvement of PLA mechanical properties, the inclusion of carbon nanofillers into PLA matrix, in particular, functionalized carbon nanotubes (CNT-COOH) and graphene nanoplatelets (GNP) have been developed, due to their strong sp2 carbon-carbon bondings and their geometric arrangement that enhance mechanical properties of the polymer matrix. Hydrolytic degradation was studied for PLA, PLA/CNT-COOH and PLA/GNP nanocomposites, namely molecular weight and tensile strength evolutions through degradation time which are relevant concerning the ligament replacement application described.
PLA (4% D-lactide, L-lactide 96%, Mw ~ 170,000 gmol-1, Natureworks™ LLC, USA) and the nanocomposites were produced by melt blending followed by compression molding in a hot press. Small weight percentages of CNT-COOH (Nanocyl™, Belgium) were added to PLA, namely 0.2, 0.3, 0.5, 0.7 and 1% for PLA/CNT.COOH nanocomposites and 1 and 2% of GNP for PLA/GNP nanocomposites.
The specimens were placed in cell culture flasks (BD Sciences™, USA) with 500mL of PBS (phosphate buffered solution), the saline solution to degrade, into a water tank at a temperature of 37ºC for stages of 4, 8, 12 and 16 weeks. The degradation conditions were defined for mimicking human body primarily physiological conditions.
For each stage quasi-static mechanical tests were performed according to standard D882, GPC analysis (Gel Permeation Chromatography) for molecular weight measurement, measuring pH and measuring the mass of the specimens.
Without the degradation effect nanocomposites PLA/CNT-COOH exhibited a higher mechanical strength of PLA, up to 8 to 20%, unlike PLA/GNP. Through mechanical analysis of the nanocomposites it is found that up to 16 weeks degradation, the tensile strength is reduced by about 21% for PLA, 21

to 37% for PLA/CNT-COOH nanocomposites and 31% for PLA/GNP. Relatively to molecular weight, this reduces to 15% for PLA, and 7 to 15% for PLA/CNT-COOH and 27 to 40% for PLA/GNP. After 16 weeks, the Young's modulus of all nanocomposites is higher than that of PLA. The pH value of the PBS remained constant, registering slight reductions of only 4% only in 16 weeks stage. The tensile strength of the nanocomposites is not considerably affected during degradation, showing the a loss of molecular weight higher for PLA/GNP than that of PLA and of PLA/CNT-COOH, being not significantly reduced, suggesting an analysis stage up to 16 weeks degradation.

7180 | Homogenization of the thermo-mechanical behavior of short-fiber reinforced composites

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Short-fiber reinforced composites (SFRCs) are increasingly used for different kind of applications. A robust dimensioning of light-weight structures made of these materials is still a challenging task. SFRCs show heterogeneities concerning micro-structural properties like fiber volume fraction, fiber length and orientation distributions [1]. Apart from the inhomogeneous microstructure, especially thermoplasic based SFRCs show time- and temperature-dependent mechanical properties.

In this talk, we discuss the homogenization [2] of the elastic and the thermoelastic properties of SFRCs based on experimentally determined microstructure data. For this purpose, the microstructure of injection-molded specimens made of polypropylene reinforced with 30wt% of short glass fibers (PPFG30) is analyzed through micro-computer tomography μCT measurements. Applying a segmentation algorithm, the spatial position, the orientation distribution, and the length of the fibers are determined. This data is discussed in terms of orientation tensors and length distributions. Additionally, the thermomechanical properties of pure polypropylene and PPGF30 in three directions are determined through tensile and three-point bending test applying a dynamic-thermo-mechanical analysis.

Based on the experimentally determined microstructure data and the thermomechanical behaviour of polypropylene, the effective thermomechanical properties of the composite can be calculated using the self-consistence homogenization method in two different ways: In the first case, the segmented microstructure data is used directly [3]. In the second case, the fiber orientation distribution function (FODF) is estimated based on leading orientation tensors, which can also be calculated by injection molding simulations. Then this FODF is used to homogenize elastic and thermoelastic properties based on orientational averages.

Applying these methods on the segmented μCT data, the predictions of both methods are discussed with a special focus on the dependence of the effective material behavior on the microstructural properties. These investigations show, that for a reliable prediction of the effective properties, both the length and the orientation distribution have to be considered simultaniously.

Additionally, the effect of the through-thickness inhomogeneity of injection-molded thin plates made of SFRCs on the elastic behavior is investigated. For this purpose, the segmented μCT data is considered layerwise within FE models of tensile and bending tests. For each layer, the stiffness is calculated using the homogenization methods mentioned above. These simulations are compared to experiments.

[1] S.-Y. Fu, B. Lauke: Effects of fiber length and fiber orientation distributions on the tensile strength of short-fiber-reinforced polymers, Composites Science and Technology, 56, 1179--1190 (1996)

[2] M. Kabel, T. Böhlke, T., M. Schneider: Efficient fixed point and Newton-Krylov solvers for FFT-based homogenization of elasticity at large deformations. Computational Mechanics (2014) DOI: 10.1007/s00466-014-1071-8

[3] V. Müller, B. Brylka, T. Böhlke, F. Dillenberger, R. Glöckner, S. Kolling: Homogenization of Elastic Properties of Short Fiber-reinforced Composites Based on Measured Microstructure Data, submitted 2014

7184 | Effect of anhydride curing agents, imidazole of accelerants, and silver particle size on the electrical resistivity and thermal conductivity of silver adhesives

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This study investigated epoxy resin as 3,4-epoxycyclohexyl-methyl-3,4-epoxycyclohexanecarboxylate mixed with different types and contents of anhydride curing agents and imidazole accelerants as well as different sizes of silver particle on the electrical resistivity and thermal conductivity of silver adhesives. Most of the paper discussed the effect of different silver particle sizes on the electrical resistivity of silver composites. However, we also identified different types and contents of curing agent accelerants that significantly affect the electrical resistivity of silver composites. Most silver adhesives of applied to LED as die-attach materials consisted of silver particles, a polymer matrix, curing agents, and accelerants for completed curing at 150ºC for 30 min. Therefore, the study investigated curing agents and accelerants that included anhydride curing agents such as 4-methylcyclohexane-1,2-dicarboxylic anhydride and hexahydrophthalic anhydride as well as an imidazole of accelerants such as 2-ethyl-4-methyl-1H-imidazole-1-propanenitrile, 2-phenylimidazole, 2-methylimidazole, 2-phenyl-2-imidazoline, and 1,2-dimethylimidazole.
As the curing adhesives have different degrees of crosslink by different types and contents of the curing agents and accelerants, the results were demonstrated using differential scanning calorimetric (DSC), which was in effect be electrical resistance. This investigation is very important for any electrical conductive of adhesives. Thus far, no research has investigated the effect of anhydride curing agents and imidazole of accelerants on the electrical resistivity of silver adhesives. The results obtained showed that 100 wt% of epoxy resin mixed with 85 wt% of hexahydrophthalic anhydride and 1 wt% of 2-ethyl-4-methyl-1H-imidazole-1-propanenitrile was ideal when the adhesive contained 85 wt% of 1.3 um of sphere-shaped silver particles, which have a lower electrical resistivity at 2.763×10–4 ohm•cm.
In addition, the study investigated different silver particles, such as 15.2 um and 25 um of flake-shaped silver particles mixed with different contents of 1.3 □m sphere-shaped silver particles on the electrical resistivity and thermal conductivity of silver adhesives. The results indicated that 50 wt% of 15.2 um of flake-shaped silver particles mixed with 30 wt% of 1.3 um of sphere-shaped silver particles, had the lowest electrical resistivity at 1.56×10–4 ohm•cm and

the highest thermal conductivity at 2.9 W/m•K.These results are better than for commercial silver pastes such as Ablebond/84-1LMI (5×10–4 ohm•cm, 2.4 W/m•K), Sumitomo/T-3007-20 (5×10–4 ohm•cm, 1.2 W/m•K), Ablestik/ 826-1DS (5×10–4 ohm•cm, 2 W/m•K) and Eeedpool/FP-5053MV (1×10-3 ohm•cm, 1.2 W/m•K). Commercial silver pastes were generally applied for low-power LED to satisfy the LED requirement as the electrical resistivity is less than or equal to 5×10–4 ohm•cm and thermal conductivity is more than 1 W/m•K. This study of silver adhesives was achieved. In addition, the silver adhesives showed good adhesion strength—namely, 75.1, 52.1, 51.7, and 75.0 kg/cm2 for sapphire, silicon carbide, aluminum oxide, and aluminum nitride substrate, respectively.

7186 | Mechanical properties of disperse hydroxyapatite nanoparticles and carbon nanotube in hybrid bone cement composites for orthopedic applications

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Abstract:
Although bone cement celebrates four decades of success, it remains susceptible to fatigue fracture. This type of failure can directly lead to implant loosening, revision surgery, and increased healthcare expenditures. ceramic/polymer composites have been considered as third-generation orthopedic biomaterials due to their ability to closely match properties (such as surface, chemistry, biological, and mechanical) of natural bone. It has already been shown that the addition of nanophase compared with conventional (or micron-scale) ceramics to polymers enhances bone cell functions. The mechanical properties of Hydroxyapatite and carbon nanotube the resulting composite demonstrated that well-dispersed nanoparticles (carbon nanotube or HA) in Acrylic bone cement enhanced the tensile modulus, tensile strength at yield, ultimate tensile strength, and compressive modulus compared.
The mechanism of fatigue failure is divided into three stages: 1) fatigue crack initiation, 2) fatigue crack propagation, and 3) fast, brittle fracture. Adding reinforcing nanopartilces to bone cement is a proposed solution for improving fatigue performance. The mechanical performance of these reinforced bone cements is limited by nanoparticles ductility, nanoparticles–matrix de-bonding, elevated viscosity, and mismatch of particles size and scale of fatigue induced damage. In this small amounts have been added (0% - 3% by weight) of multiwall carbon nanotubes (MWNTs) enhances the strength and fatigue performance of single phase bone cement. MWNTs (diameters of 20 nm; lengths of 10-6 – 10-3 m) and Hydroxyapatite nanoparticles (20 nm) are recently discovered nanomaterial with high surface area to volume ratios (conferring HA and MWNT – bone cement composites with large interfaces for stress transfer) that are capable of directly addressing sub-microscale, fatigue induced damage. MWNTs and HA (2wt%) significantly increased the flexural strength of single phase bone cement by a modest 12%; whereas, similar additions of MWNTs dramatically enhanced fatigue performance and physiologically relevant conditions, respectively. Comparing the fatigue crack propagation behaviors of reinforced and unreinforced single phase bone cements.
In summary, supplemented by previous the present study demonstrated that the combination of Acrylic bone cement with well-dispersed nanoceramics enhanced mechanical properties necessary for load-bearing orthopedic/dental applications.

7187 | Desirability - fuzzy approach in selection of optimal parameters to develop the AMMC

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The present paper focused on development of AMMC with the application of Desirability-Fuzzy approach to optimize the mechanical and machining properties of Aluminium Metal Matrix Composites (AMMC). In the present work, AMMC samples are fabricated using stir casting process as per the Orthogonal Array L27 of Taguchi Experimental design which is prepared using Minitab software by considering various material and drilling parameters and these samples were tested for various mechanical and drilling characteristics. These characteristics are analyzed collectively and the optimal combinations of influential parameters are determined using Desirability-Fuzzy method which is obtained through the combination of desirability function analysis and fuzzy logic. With this optimum parameters combination, new AMMC is fabricated and is tested for conformation to obtain a developed AMMC which possess good characteristics.

7189 | A general Variational model for predicting the matrix cracking formation and induced delamination initiation in angle ply composite laminates

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One of the most crucial discussions in composite laminates is their ability to stand against different damage modes formation. Matrix cracking and induced delamination are the most predictable damage modes in failing of the composite laminates. The effects of these damage modes on the stiffness and stress redistribution of composite laminates can be studied by many different Micromechanics approaches.
The Variational approach, which was established by Hashin for the first time is one of the powerful methods for obtaining the optimal approximation of stiffness degradation in cross-ply composite laminates with symmetric lay-ups. By minimizing the complementary energy, which is obtained from the perturbation stresses, it is possible to generate a dramatic relation for complementary energy release rate. Nairn extended this model further to obtain the strain energy release rate of composite laminates containing the matrix cracking as well as induced delamination. In this approach, a new criterion for commencement of microcracking or delamination formation was proposed. Lower bound of compliance calculations for angle-ply laminates in the presence of matrix cracking were developed by Hashin and Vinogradof in 2009 to demonstrate how the stiffness reduction happens in different directions with those special loadings.
By the best knowledge of authors, there are no attempts to study the initiation and propagation of induced delamination in angle ply composite laminates using the Variational approach. In the present study, the authors will propose a new Micromechanics model based on Variational approach, which is capable to consider the effects of matrix cracking, and delaminations coming from the tips of microcracks in the middle sub-laminates of [θ_m^((2))/θ_n^((1))]s angle-ply laminates. For this purpose, a unit cell in the ply level of composite laminate containing of both matrix cracking and induced delamination will be considered. For calculating the total energy release rate due to each damage modes, a three-dimensional stress analysis will be done. On the other hand, the assured equilibrium equations, boundary as well as traction continuity conditions will be applied to define the appropriate

stress distributions and stiffness degradation in the presence of each damage modes. To prove the capability of proposed approach, it will employed for analysis of different angle ply laminates under general loading conditions to calculate the energy release rate due to matrix cracking and induced delamination. The obtained results will be compared with available numerical results.
Key Words: Matrix craking, Induced delamination, Variational approach, Energy release rate

7190 | INJECTION MOLDING OF CARBON NANOTUBE AND CARBON FIBER REINFORCED HIERARCHICAL POLYMER COMPOSITE FOR LIGHT WEIGHT AUTOMOTIVE PART

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Reducing weight and improving the mechanical properties of automotive parts have been an important role of product development, which is improving the efficient energy, in the automotive industry. Polymer composite is the key factor to achieve light weight and high mechanical properties by mixing polymer with carbon fibers, glass fibers, carbon nanotube and so on. In our research, carbon nanotube/carbon fiber reinforced polymer composite (polypropylene and polyamide) was fabricated by an injection molding machine to get proper mechanical properties and density as well as relatively low cost for mass production of automotive sunroof frame. The optimum mixing ratio of composite was selected by evaluation of mechanical properties, density, and material cost. To evaluate the mechanical properties, tensile test, bending test and impact test were carried out. And the cost was calculated with raw material costs and weight ratio. The developed composite will be widely used for sunroof frame.

7191 | Evaluation of nonlinear behavior of general symmetric composite laminates containing a central hole under uniaxial loading condition using a developed Micromechanics model

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Transverse matrix cracks are one of the crucial damage modes in composite laminates, which run parallel to the fiber directions in each ply. Matrix cracking can be observed due to tensile loading, fatigue loading as well as thermo cycling loading. The immediate effect of matrix cracking is degradation in the thermo-mechanical properties of composite laminates. Another major side effect of matrix cracking is that it causes the initiation and propagation of other harmful damage modes. Stress concentration near the crack tip at the interface may cause either delamination or matrix cracking in the adjacent plies.
This damage mechanism in composite laminates can be studied through many various approaches. While, the experimental methods are both time consuming and costly, the analytical methods are only applicable in simplified models. Advanced finite element analyses based on continuum damage mechanics is an effective approach, which is widely used for the progressive damage analysis in composite laminates. However, this approach needs multifarious standard and nonstandard lay-up tests for defining the damage evolution law.
To overcome the shortcoming of the mentioned approach, an initiative stress transfer model in the framework of micro-damage mechanics approach is developed by Farrokhabadi et al. [1] for a cracked orthotropic lamina. By obtaining the true stress and displacement fields of damaged ply, it is possible to evaluate an appropriate damage parameter as a function of applied remote loading and effective damaged strains. The aim of present study is to develop a refined, worthy model based on previous micro-meso approach by the authors, which is transposable into the commercial finite element code (ANSYS) for progressive damage analysis of composite laminates.
This procedure will be employed in the extended subroutine for developing a proposed flow rule of damage and numerical integration of constitutive relations.
Using the developed procedure, it will be shown that the predicted stress-strain behaviors and matrix cracking density evolution are in significant agreement with previous numerical approaches [2] for a composite laminate containing a central hole.
Keywords: matrix cracking, Micromechanics approach, holed composite laminates, Nonlinear
[1] Farrokhabadi A, Hosseini-Toudeshky H, Mohammadi B. Consideration of concurrent transversecracking and induceddelamination propagation using a generalized micro-meso approachand experimental validation.Fatigue Fract Engng Mater Struct 2012;35:885–901.
[2] LUBINEAU G, LADEVEZE P, Construction of a micromechanics-based intralaminar mesomodel, and illustrations in ABAQUS/Standard. Computational Materials Science 2008, 43: 137-145. 2008.

7192 | Behavior of R.C Beams Strengthened by Bonded CFRP with Lap Splices.

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The strengthening and repair of reinforced concrete structures using bonded sheets and plates of high-strength fibers has been the focus of a number of publications and research projects in recent years, Carbon fiber-reinforced plastic (CFRP) laminates, or plates, offer very high-strength potential; however, handling of long pieces of these flexible plates can present challenges under field conditions. The development of methods for splicing CFRP laminates will enhance the versatility and practicality of using these materials in field applications. In this paper, the laboratory tests are performed on large-scale reinforced concrete beams that are strengthened with externally bonded carbon fiber-reinforced plastic (CFRP) plates. The CFRP plates are spliced using butt joints reinforced by bonded lap splice plates. Results of the tests illustrate that the dominant failure mode for the splices was debonding of the lap splice plate that started at one end of the splice plate and progressed inward toward the butt joint. Application of the results in the design of strengthening systems using butt joints with lap splices is discussed.

7193 | Advanced finite element models for buckling and free vibrations analysis of smart laminates subjected to in-plane loadings

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Advanced composites, able to provide multi-functional capabilities besides the traditional structural functions, has been gaining attention in many

technological fields. This inherent coupling of different physical fields can be exploited in transducer applications, structural health monitoring, vibration control, energy harvesting and other applications. Magneto-electro-elastic (MEE) composite materials are attracting increasing consideration as they couple mechanical, electrical and magnetic fields and this makes them particularly suitable for smart applications. Generally, single-phase materials exhibit either piezoelectric or piezomagnetic behavior and no direct magneto-electric coupling is observed. However, the full magneto-electro-elastic coupling can be obtained by using composites with both piezoelectric and piezomagnetic phases that provide the magneto-electric effect through the elastic field. These MEE composites are obtained in the form of multi-phase materials, i.e. piezoelectric and piezomagnetic particles and/or fibers, or in the form of laminated structures, with piezoelectric and piezomagnetic layers stacked to achieve the desired coupling effects. Multilayered configurations appear to be more effective than bulk composites.
For the analysis and design of MEE structures, reliable and efficient modeling tools are required. Analytical solutions are available for simple configurations and, actually, numerical approaches need to be deployed for complex analyses. Fully-coupled 3D finite element solutions for multilayered plates and shells present very high computational costs; 2D laminated plate theories and the corresponding finite element solutions have been developed with the aim of reducing the analysis effort while preserving a suitable level of accuracy. In the framework of 2D plate theories, finite elements solutions based on equivalent-single-layer or layer-wise modeling have been proposed implementing different order theories. Recently, an equivalent single-layer approach for multilayered MEE plates and its finite element solution have been proposed by the author, who developed an effective purely mechanical plate model as result of the condensation of the electro-magnetic state to the mechanical variables. This model was systematically extended to refined equivalent-single-layer and layer-wise plates theories approaching the problem through a suitable application of the Carrera Unified Formulation (CUF). Finite element solutions for magneto-electro-elastic multilayered plates obtained by theories with different expansion order have been presented.
In the present work, a unified framework based on CUF is presented to develop layer-wise and equivalent-single-layer plate models for the buckling and free vibrations analysis of MEE laminates subjected to in-plane loading. Variable kinematics with von Karman strains is assumed and approximated by standard isoparametric finite elements. Under the assumption of quasi-static behavior of the electromagnetic fields, the electromagnetic state of each single layer is preliminary determined by solving the corresponding governing equations coupled with the proper interface continuity and external boundary conditions. This allow condensing the electromagnetic state into the plate kinematics and the layer governing equations are inferred by the principle of virtual displacements. This approach identifies effective mechanical layers, which are kinematically equivalent to the original smart layers. These effective layers are characterized by stiffness, inertia and load properties, which consider the multifield coupling effects as their definitions, involve the electromagnetic coupling material properties. The layers equations are finally assembled enforcing the mechanical interface conditions. Numerical results are presented to show the effectiveness of the approach.

7195 | Comparison of time-dependent relaxation/creep in monolithic amorphous ZrCu/nanocrystalline Zr and ZrCu/Zr multilayer composite

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In this study, the monolithic amorphous ZrCu and monolithic nanocrystalline Zr thin films, as well as the amorphous-crystalline ZrCu/Zr multilayered composite thin films were deposited on the Si substrate by magnetron sputtering. Nanoindentation time dependent relaxation tests were performed on the samples at room temperature. The time dependent displacement can be contributed by anelastic relaxation and plastic creep. The anelasticity/creep rate of the monolithic amorphous ZrCu film is apparently higher than that of the monolithic nanocrystalline Zr film. With increasing applied load from 10 mN to 100 mN, the anelasticity/creep rate of the amorphous ZrCu film increases only slightly. In comparison, the rate of the nanocrystalline Zr film increases dramatically. The wider activated deformation zone originated by the higher load in the nanocrystalline Zr film would in-turns result in a higher creep rate than those of the amorphous ZrCu film. This is postulated by the presence of a high portion of grain boundaries in the nanocrystalline Zr film. Without any grain boundary in the amorphous metallic glass ZrCu film, the anelasticity/creep rate becomes much lower. For the ZrCu/Zr multilayered composite thin films, the behavior is found to lie in between the individual monolithic amorphous ZrCu and monolithic nanocrystalline Zr thin films. Various fitting methods are made and the best model is established. The dependence of the anelasticity/creep rate of the composite films is explored in terms of various loads, loading rate and temperature.

7197 | ELECTRICAL, THERMAL AND MORPHOLOGICAL PROPERTIES OF LOW DENSITY POLYETHYLENE/ZINC OXIDE NANOCOMPOSITE FILMS

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Polymer nanocomposites have attracted great attention due to their mechanical, thermal, electrical and optical properties. Especially, polymer composites with improved electrical property have wide application in different areas such as aircraft, defense industry, telecommunication and electronic devices. Electrical properties of the polymer composites are gained by conducting fillers such as metal particle, carbon black, carbon nanotube and inorganic particle. Zinc oxide (ZnO) is one of the important inorganic nano-filler that is used to gain electrical properties for insulating polymers due to its availability in bulk, single-crystal form and its larger exciton binding energy of 60 meV. In this study, LDPE/ZnO nanocomposites were prepared at different concentrations of ZnO nano particle, ranged from 0 to 36 wt%, by melt-blending method using twin screw extruder. Then, composite granules were subjected to two-roll mills and hot pressing, respectively. Finally, nano composite films with 170 micron thickness were obtained. Characterization of the films was done by thermal and morphological analyses. Thermal properties of the films were investigated by thermal gravimetric analysis (TGA) at a heating rate of 10 °C/min from 25 to 450 °C . Morphological properties of the composites were analyzed with scanning electron microscope (SEM) on cryo-fractured surfaces of the films. Electrical properties of the thin films were examined by two probe technique to obtain watt loss and tan loss values of the composites under different frequencies were reported. Particle distribution is significantly effective in determining the electrical property of a composite. Therefore, SEM results were also observed to determine the relation between particle distribution and electrical properties. It has been seen that higher particle concentration increased tan loss and watt loss, however, lower frequencies and small amount of particle concentrations were not effective on electrical properties.

7198 | IMPROVING POLYMER/METAL MACRO COMPOSITE STRUCTURE FOR VIBRATION DAMPING

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It has been known that certain performance functions are best handled by usage of different kinds of materials together such as metal and polymer. Metal/polymer combined macro composite structures are representative of a unique combination to achieve improved quality of products in some fields such as electronics, automotive and aerospace. In polymer/metal macro composite structures, plastic material is used for its saving in weight and especially for its vibration and acoustic damping and impact response. Metal component is responsible for high mechanical strength. However, manufacturing a polymer-metal macro composite is quite difficult to the large degree of labour. Metal part and polymer part are generally manufactured separately and then they are joined together. In this study, a non-traditional method for manufacturing metal-polymer combined structure for vibration damping was generated from a traditional method; plastic injection molding, which is now called plastic injection forming (PIF). As it is known vibration control is significantly important for noise control, dynamic stability, fatigue and impact resistance in advanced engineering systems. Plastic injection forming method is suitable for manufacturing vibration damping components. In PIF, deforming of the metal and adhering the metal with polymer was done in one step. Therefore additional steps were not required and dimensional tolerance of metal and polymer was good for matching for outer surface of the plastic part and inner surface of the metal part.

In the experimental study, a special mold within rectangular cavity was used in PIF process. Aluminum plates with dimensions of 75x 115 x 1.5 mm were used as the metal part of the structure. Three different types of material were used for plastic injection process; polypropylene, nano titan dioxide added polypropylene and ethylene propylene diene monomer (EPDM) added polypropylene. The ability of the polymer materials in deforming the metal was determined by setting injection parameters. In order to provide adhesion between metal and polymer, aluminum plates were cleaned precisely before injection process and micron size roughness was also provided. An elastomeric nature primer adhesive was used over the plates to gain a unique polymer-metal macro composite structure. This was for both adhesion and for supporting vibration property. For determining flexural strength of the polymer/metal macro composite structure, three point bending test was applied and maximum load bear was reported for each of the macro composite. For vibration impact (hammer) test was performed in order to define modal characteristics of the composite structures. The damping ratio of each composite structure was figured out by performing frequency analysis. Finally, damping characteristic of these composite structures were discussed by comparing their damping ratios.

7209 | STUDY OF INDUCED DAMAGE DURING DRILLING ON NATURAL FIBRE BASED BIOCOMPOSITES

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Composite material are characterized by the combination of at least two materials, usually polymer matrix reinforced with carbon or glass fibers, with the intention to get properties that cannot be achieved using the constituent materials separately. In the last years, numerous researchers have introduced natural fibers as reinforcements to increase the biodegradability of composites. The works that have studied biocomposites made of natural fibers as jute, hemp, linen or cotton have shown promising results related with their mechanical properties.
The most of the research done on biocomposites are focused on their quasi-static behavior, and there are also several remarkable works that study their impact behavior. However, a deeper knowledge of the behavior of natural fibers composites under dynamic conditions is needed to increase the use of biodegradable composite in industry.
Drilling operations are a usual process to assemble composite parts. Natural fiber composites are subjected to dynamics loads during drilling that can induce a non-visible damage reducing the strength of the final components. There are numerous studies about drilling of carbon-fibers composites but there is a lack of research on drilling of biocomposites.
The aim of this work is the study of the induced damage on natural fiber composites during drilling to analyze the influence of the main drilling parameters on the final strength of the components.
The specimens were manufactured from flax fibers and Polylactic acid (PLA) matrix. During the fabrication process different layers of flax woven and PLA plies were stacked. Then, they were subjected to a pressure of 30 MPa and a temperature of 185ºC. The results is a composite plate made from natural fibers and biodegradable matrix, see Figure 1. Specimens with different thicknesses were manufactured to analyze its effect during drilling.
Different drilling parameters were analyzed during: drill diameter, cutting speed, feed ratio, and drill shape. The analysis of the results can be used to minimize the induced damage during drilling on natural fiber composites.
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7210 | Green synthesis of S-nitroso-iron oxide nanoparticles: A new nitric oxide-releasing composite

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This work describes the biogenic synthesis of a composite comprising by iron nanoparticles and organic coating, which acts as spontaneous nitric oxide (NO) donor. NO is an important molecule that is involved in several physiological processes as the dilation of blood vessels, inhibition of platelet adhesion, cell communication, wound healing, immune responses, and anti-cancer activities. However, the potential therapeutic applications of NO have been limited by its instability. In this context, the design of new composites based on the combination of NO donors and nanoparticles is considered an interesting approach in the development of new NO-releasing vehicles for biomedical applications. Moreover, the interest in the development of nanoparticles for diverse applications, mainly biomedical, has been greatly increasing in recent years. Among the nanostructured materials, iron nanoparticles have been the focus of intensive research. Due to their special properties, such as small sizes, iron nanoparticles find important pharmacological applications, such as drug delivery. Iron nanoparticles can be synthesized by well-established physical, chemical, and, more recent, biogenic techniques. Physical and chemical techniques are considered out of dated, relatively expensive, complicated, toxic and flammable. In contrast, biogenic synthesis of iron nanoparticles has emerged as a new and environment friendly approach to obtain biocompatible nanomaterials. Particularly, synthesis of metal nanoparticles using plant extract has attracted much attention due to their simplicity and cost-effectiveness. In this work, we report the green single-step synthesis of iron nanoparticles using green tea (Camellia sinensis) extract, which is rich in polyphenols. The rapid reaction between polyphenols and ferric nitrate was carried out at room temperature without the addition of surfactant or polymer as capping or reduction agents. Spherical shaped iron nanoparticles obtained were characterized by ultraviolet–visible spectroscopy, scanning electron microscopy, dynamic light scattering, X-ray diffraction and fourier transform infrared spectroscopy. The results revealed that the green synthesis led to the formation of a composite nanomaterial composed by an iron core coated with plant molecules, such as plant polyphenols and thiol-containing molecules. Such organic coating acts as reducing and capping agents of biogenic iron nanoparticles, increasing nanoparticle stability. Moreover, free thiol groups present on the surface of capped-iron nanoparticles was titrated with the thiol-specific reagent 5`5-dithiobis(2-nitrobenzoic acid) (DTNB). The amount of free thiol (-SH) groups on the surface of biogenic iron nanoparticles was found to be 60.4 ± 5 μmol of –SH per gram of nanoparticles. The free thiol groups on the surface of iron nanoparticles

were S-nitrosated by the addition of sodium nitrite in acidified solution leading to the formation of the composite S-nitroso-iron oxide nanoparticles. S-nitroso (S-NO) groups are known to act as spontaneous NO donor due to the homolytic bond cleavage with free NO release. A total of 58 ± 10 μmol of NO per gram of biogenic iron nanoparticle was determined by amperometric NO analysis. To our best knowledge, this is the first report to describe the biogenic synthesis of a composite based on iron nanoparticles coated with S-nitroso-containing plant extract molecules, which act as NO donor. This nanocomposite may find important biomedical applications, due to the release of significant therapeutic amounts of NO.

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7211 | An Engineering Vision about Sandwich Structures

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As noted in the literature, there are several information on sandwich panels. One point still under discussion are the failure modes and the numerical simulation that considers the stiffness and interlaminar stresses efficiently. Failure modes presented in the literature are not always likely to happen in practice and represent them becomes a challenging task. Regarding to numerical simulation, hypotheses and new formulations appear to consider the shear stresses in the core and to minimize processing time on 3D models. However these new formulations need to be evaluated and compared with results of tests to verify that the results are consistent. In this way, experimental studies are needed to validate theories and check the failure modes present in sandwich panels. In this sense, this paper presents an overview of trends in the use of sandwich panels and the first steps to validate the finite element model. Complementing a typical aircraft panel with experimental results is presented. The finite element model as well as the input parameters of data is also discussed. Experimental strain compared with the numerical simulation results correlated very well. The correct use of plate element and solid element with their correct mechanical properties contributed in these results. This work also contributes to the validation of emerging theories due to the lack of studies with aeronautical sandwich panel experimental results.

7215 | Thermal shock resistance of ultra-high temperature ceramics under active cooling including the effects of external constraints

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A model has been established according to the practical applications that the ultra-high temperature ceramics (UHTCs) are used as parts of the thermal protection system (TPS). Taking the ZrB2 as an example, the effects of convective heat transfer coefficient, thermal shock initial temperature and external constraints on the thermal shock resistance (TSR) of UHTCs have been studied through numerical simulation. The results show that as the convective heat transfer coefficient increases, the critical rupture time decreases, and there is a dangerous region where the critical rupture temperature difference is the lowest, i.e., the UHTC plate has the worst TSR in this region. As the thermal shock initial temperature increases, the critical rupture time decreases firstly and then increases gently, and there is a dangerous temperature region where the critical rupture temperature difference is the lowest, which means that measures can be taken to pass this dangerous region safely in practical engineering applications. It indicates that the TSR performance of UHTCs has been improved when external constraints exist, and the stronger the constraints, the better the TSR of UHTC plate will be.

7217 | A comparative study of rivet hole shapes for the mechanical connections of composite panels

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The rivet joint is one of the most important mechanical connections for hot structures made of ceramic matrix composites (CMCs). The development of chemical vapor infiltration (CVI) technology provides a possible application of headless rivets for these structural components. However, connection still remains to be the weakest link for structural integrity due to the severe stress concentration in the rivets. The geometry parameter of the joints is a key influencing factor to the structural strength. In order to improve the connection strength, a comparative study is presented to analyze the influence of hole shape on the structural stress concentration of a composite panel. The hole shapes considered include circle, ellipse and racetrack shape. The detailed finite element (FE) model of a component-level single lap joint (SLJ) with the three shapes of rivet hole were constructed. The static stress responses of the connections under tensile loading were analyzed to compare the stress concentration factor (SCF) of the different hole shapes. An optimal shape was chosen based on the maximum tensile stress criterion. Then, the FE model of a typical panel-rivets structure was built to determine the optimal orientation of the non-circular cross-section rivets at different positions of the panel. Last, the dynamic stress responses of the panel with the rivets of optimal hole shape and orientation were computed to verify the optimization design. The root mean square (RMS) of dynamic stress was used to assess the design. The results provide a reference for the application of non-circular cross-section rivets to improve the structural strength of composite panels.

7220 | Electrochemical Evaluation of Corrosion in Nano-Modified Cement Mortar Specimens/ Engineered Cementitious Composites (ECC)

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Carbon nanotubes (CNTs) are considered to be one of the most promising reinforcing materials for the next generation of high-performance nanocomposites, primary due to their exceptional mechanical properties. The usage of CNTs in cement mortar specimens was recently introduced in order to develop high-performance cementitious composites. These engineered cementitious composites (ECC) are ultra-ductile fiber reinforced ordinary Portland cement (OPC)-based composites that exhibit high compressive strengths. Previous experimental studies have shown a strong dependence of electrical resistivity of ECC on applied mechanical tensile strain, which can be potentially utilized for self-sensing mechanical damage for structural health

monitoring. The corrosion behaviour of the aforementioned composites has not been explored yet. In the present study non-destructive electrochemical techniques are utilized in order to successfully monitor the corrosion response of the cementitious composites when they are exposed to highly corrosive environment under the presence of chloride ions.
The cement mortar specimens were constructed using Cement II 32,5N, Greek quarry sand 250μm-4mm maximum grain dimension and drinkable water. Steel rebars type B500C were used, having 10mm nominal diameter and 100mm length. The w/c ratio was 0.50. The specimens were cylindrical formed in 40mm×100mm. Steel rebars were axial embedded in each one, were cleaned prior their installation into the mortars and weighted to a 0.1mg accuracy. The rebars were embedded 80mm deep into the mortar and consequently 20mm exerted. The specimens remained molded for 24h stored in the curing room (20˚C, 100% humidity) and after removing the cast they were fully immersed in tap water for 24h at 25˚C. They were left to dry for 8 days under laboratory conditions. In order to receive electrochemical measurements, a copper wire was enwrapped to each steel rebar. A mixture of two different epoxy resins was used aiming to protect the upper part of the rebar from atmospheric corrosion.
Three groups of specimens were constructed. In the first group 0.1% w.t of cement of CNTs was added and mixed homogenously with the rest of the mixture, whereas in the second group 0.5% w.t of cement of CNTs was used in order to evaluate the effectiveness of different proportions of CNTs. the last group was consisting of plain cement mortar specimens without the addition of CNTs for comparison reason. The specimens were remained partially immersed in 3.5% w.t NaCl solution for the whole duration of the experimental procedure.
Half-cell potential was periodically measured versus a SCE, according to ASTM C876-879 at specific time intervals. Linear Polarization Technique (LPR) measurements were conducted using a Potentiostat / Galvanostat Model 263A from EG&G Princeton Applied Research and an associated software package to analyze the obtained data. The electrochemical parameter of polarization resistance (Rp), was defined, as described in ASTM G59-97(2009). The experimental set up was consisted of three electrodes where steel rebars represented the working electrode, saturated calomel electrode (SCE) the reference electrode and a carbon bar served as the counter electrode. The potential scan range was±20mV from Open Circuit Potential (OCP) and the scan rate was 0.166 mV/s.
From the results so far it is shown that the group of cement mortar specimens with 0.1% w.t. of cement of CNTs is demonstrating an advanced corrosion resistance compared to reference specimens. Half-cell potential measurements and Polarization Resistance are both improved in this group mainly because the addition of CNTs blocks the pores of the mortar specimens and diffusion on chloride ions is obstructed. The second group with 0.5% w.t. of cement of CNTs is showing a slightly improved behaviour with regards to reference specimens but is less efficient than the other concentration.

7221 | Bilayer Nafion/graphene oxide composite with alcohol and formic acid barrier property

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The objective of this study is to prepare Nafion composite with well aligned graphene oxide (GO) nano-sheets as a top barrier layer to retard alcohol and formic acid permeabilities. The GO characteristics are tested using X-ray diffraction analyzer, FTIR, and Raman spectroscopy. The GO binder layer is applied on the Nafion 212 film using spin-coating and drop-coating methods for the Nafion/GO composite preparation. The morphology of the surface structure on the resulting Nafion/GO composites is studied using field emission scanning electron microscope and transmission electron microscope. The water uptake, conductivity, and ion exchange capacity are in a linear relationship with the GO content. However, the water diffusivity and alcohol permeabilities show little correlation with the GO content, but have strong linear trends with the alignment (aspect ratio) of the GO. The composite membrane coded with SC-0.3 demonstrates the least GO content while the lowest alcohol permeabilities. This sample also renders very high fuel cell performance when fed with methanol, ethanol, and formic acid fuels.

7222 | Nondestructive evaluation technique of hidden delamination in glass fiber reinforced composites using terahertz spectroscopy

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The glass fiber reinforced composites are being widely used as structural components in various industries because they provide higher specific strength and superior impact characteristics to the structure compared to the conventional metallic materials. However, its reliability and mechanical properties can be much weakened by various hidden defects and damages. Therefore, appropriate inspection techniques are required to detect and characterize hidden damages in their inside in order to ensure the safe use of composite structures. Terahertz (THz) wave has recognized as one of the new powerful nondestructive evaluation (NDE) technique for fiber reinforced composite structures because it has many advantages which can overcome the limitations of conventional NDE techniques such as x-rays or ultrasound. The THz radiation (0.1-10THz) can penetrate common nonmetallic materials, and offers a noninvasive, noncontact, nonionizing method evaluating composite damages, also it gives a broad range of information about the material properties. In this study, the pulse type THz spectroscopy imaging system was devised and used for detecting and evaluating of hidden delamination in the glass fiber reinforced composite laminates. The interaction between THz and the glass fiber composite was analyzed respect to the type of delamination, including their thickness, size, depth and numbers of overlaps among multiple-delaminations in through-thickness direction. Both of transmission and reflection configurations were used for evaluation of hidden delamaniations and Thz wave propagations through the delaminations were also discussed. From these results, various hidden delaminations inside of the glass fiber composite were successfully detected using time-domain THz spectroscopy imaging system and also compared to the results of C-scan inpection. It is expected that THz NDE technique can be widely used to evaluate the reliability of composite structures.

7223 | Porous carbon materials for gas storage

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Mesocellular Carbon Foams (MCFs) were synthesized by using relevant silicas as templates. Synthesis was based on hard templating and structure

inversion of a silica matrix, leading to highly ordered MCFs by using a low-cost carbon source as sugar. Materials' structure and properties were studied by means of a variety of characterization techniques as small angle X-ray scattering (SAXS), transmission electron microscopy (TEM), specific surface area and porosity analysis, X-ray photoelectron spectroscopy (XPS), thermo-gravimetric (TG) and differential thermal analysis (DTA), Fourier transform Infrared (FTIR) and Raman spectroscopies, hydrogen excess adsorption and carbon dioxide capture measurements.
Kratky plots of the SAXS patterns display 3-4 well-resolved scattering peaks suggesting the successful synthesis of porous carbon materials with cellular structure and high ordering. TEM observations confirm the SAXS results concerning the size, periodicity and quality of the formed MCFs as uniform cells are observed.
Final materials demonstrate high specific surface areas (SSA) up to ~ 1000 m2/g and a 1.7 cm3/g pore volume, while DFT pore size distributions (PSD) curves reveal the presence of two different types of pores in both the microporous and the mesoporous regions as they exhibit two narrow maxima at 1 and 4.7 nm pore diameters. In contrary, the starting silica template possesses considerably lower SSA of 740 m2/g, and pore volume of 0.9 cm3/g whereas its PSD curve has a maximum at 14.5 nm. The structure preservation together with the presence of smaller cellular pores in MCFs indicate the successful structure inversion. Additionally, narrow PSD prove their high crystallinity and small pore sizes (1 and 4.7 nm) lead to high SSA.
XPS results show that MCFs possess various oxygen functional groups. Hydroxyl, epoxy/ether, carbonyl, and carboxyl groups are present whilst MCF structure partially collapses when oxygen content increases. TG/DTA analyses verify the total removal of the silica matrix. MCFs exhibit two intense exothermic peaks with related weight loss and no residual. FTIR spectroscopy agrees and validates the TG/DTA results as no silica-originated peaks are observed in the final MCFs. In Raman spectroscopy both D- and G-bands are present. High quality MCF displays a ~ 0.8 ratio of the D- to G-band intensities (ID/IG) whereas at the same time MCF with lower crystallinity and higher oxygen content has a ~ 0.9 ID/IG ratio as more defects are present corroborating with SAXS and XPS results.
Concerning their gas storage properties, hydrogen excess adsorption measurements demonstrate a reversible 3 wt% uptake at 10 MPa for the final MCF materials. In addition, carbon dioxide capture shows a carbon dioxide uptake of 25 mmol/g at moderate pressures of 4-5 MPa with the potential of even better results at higher pressures due to looming condensation and multilayer formation.

7224 | Numerical simulation investigation of local loss coefficients for 90°-bend combinations in Z-shape

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Bend combinations are extensively used in works of Hydraulic Engineering, Petroleum Engineering and Chemical Engineering. However, the adjacent effects of bends and their effects on local resistance have not been well studied, and there is no widely accepted calculation formulas describing local loss coefficients of bend combinations. In practice, the common method is simply to summate the local loss coefficients of all individual bends without considering the adjacent effects of those bends. It is estimated that the local losses computed using the summation method are 20%~30% larger than the actual ones, which leads to designed pipe diameter larger and pump head higher than necessary.
This study examined the effects of three factors, ratio of the distance between two adjacent bends to pipe diameter (relatively affected length), ratio of bend curvature radius to pipe diameter (relative bend radius) and Reynolds number, on the local losses of 90°-bend combinations in Z-shape without considering the possible effects of roughness. Numerical simulations using Fluent software were conducted for 322 operation scenarios with the values of Reynolds number within the commonly used range. The model was validated using the experimental data of the British Hydromechanics Research Association.
The Results showed that relatively affected length had larger effects on the local loss coefficients, relative to the other two factors. The changing trend of the local loss coefficients with relatively affected length tended to be similar under the combinations of different relative bend radiuses and conditions of different Reynolds numbers. The local loss coefficients were negatively correlated with both Reynolds number and relative bend radius under a given relatively affected length. When relatively affected length was less than 35, the local loss coefficients of bend combinations were not equal to the sum of the local head loss coefficients of two adjacent bends. With the increase of relatively affected length, the local loss coefficients of bend combinations decreased first and then increased. Consequently, there is a minimum value for the local loss coefficients, and the minimum occurred when relatively affected length was about 5. A piecewise function with three dimensionless parameters of relatively affected length, relative bend radius and Reynolds number was then developed to describe the effects of the three factors on the local loss coefficients. For the two break points in the piecewise function, relatively affected length had the value of 5 and 35 respectively.
The flow field of a typical cross-section of bend combinations showed that pressure was raised on the outside of the bends and flow was separated from the inner wall under the action of centrifugal inertia force and viscous force. Large Dean Vortex occurred at the sections where the flow passed through the bends. Secondary flow carried fluids with large kinetic energy from outer walls to inner walls, which caused energy exchange in the lateral of bends, and as a result, energy of the flow field was consumed and local energy loss increased. Secondary flow uniting with main flow formed spiral flow which decreased gradually and disappeared eventually in a long straight pipe section at the downstream bends. When relatively affected length was not larger than 35, spiral flow went into the next bend without fully developed, which restrained the local head loss. When relatively affected length was about 5, upstream spiral flow went into the second bend at the best angle with the minimum energy loss of the second bend. The findings of this study can provide the scientific basis to set up appropriate distance between two adjacent bends and to reduce systematic loss effectively.

7226 | Modeling fractured composite materials

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A composite material consists of a matrix and many reinforcing particles or fibers embedded in it. The particles and fibers have different elastic moduli than the matrix and can be called inhomogeneities with respect to it. Inhomogeneities often cause stress concentration around their corners, which may lead to their interfacial deboning from the matrix or fracture within it. In order to conduct failure analysis of fractured composite materials, an accurate knowledge of their stress fields is required.

This paper develops a semi-analytic solution for periodically structured fractured composites using Eshelby's equivalent inclusion method (EIM) and the distributed dislocation technique (DDT). Each structural period contains an arbitrary distribution of inhomogeneities and cracks. The inhomogeneities can be of arbitrary shape and have multiple phases, i.e., they can have different materials among themselves and one of them can be imbedded in another. The cracks can be of mixed modes I and II. Using EIM, each inhomogeneity is modeled as a homogeneous inclusion with unknown equivalent eigenstrain to be determined. Using the DDT, each crack is modeled as a distribution of climb and glide dislocation with unknown densities. The unknown equivalent eigenstrains and dislocation densities are determined iteratively by the conjugate gradient method in conjunction with a fast Fourier transform algorithm for computational efficiency. The solution fully takes into account the interactions among all the inhomogeneities and cracks and thus can give an accurate

description of the stress fields of the inhomogeneities and cracks. The stress intensity factors (SIFs) of cracks are obtained from the dislocation densities modeling the crack tips. The effective moduli of the composite are calculated from average stresses and elastic strains.

The solution can be used to predict the mechanical properties of composite materials with cracks at both the local and global scales. It is also applicable for predicting the remaining life time of fractured composite materials.

7228 | Multiwalled carbon nanotubes impregnated ethylene propylene diene monomer rubber composites: ablation, thermal and mechanical investigation

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Four diverse concentrations of aluminum silicate fibers were incorporated into ethylene propylene diene monomer rubber to fabricate ablative composites for high temperature applications. Ceramic fibers (CFs) were impregnated in the rubber matrix using two roller mixing mill. Ablation testing of the composite specimens was carried out according to ASTM E285-08, in which oxy – acetylene torch was used as a high temperature source. Backface temperature evolution, insulation index, linear/mass ablation rates and % char yield of the ablative composites were evaluated in the ablation study. Anti-ablation performance of the polymer composites was augmented with increasing fibers concentration in the polymer matrix. Thermal degradation of the fabricated composites was diminished with the progressive incorporation of CFs in the host matrix. Ultimate tensile strength, elongation at break, and modulus of elasticity of the composite specimens were reduced due to weak fill to matrix interaction while Shore A rubber hardness was augmented with increasing fiber to matrix ratio. Voids formation & polymer pyrolysis of the ablated specimens, char reinforcement interaction, CFs dispersion in the polymer matrix, elemental analysis & diameter measurement of the CF, and the compositional analysis of ablative composite were analyzed using scanning electron microscopy coupled with energy dispersive spectroscopy.

7229 | On Rotating Laminated Disks of Cylindrically Anisotropic Materials

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This work investigates the coupled stretching and bending deformations of rotating laminated circular disks of cylindrically anisotropic materials. A hollow disk with four sets of boundary conditions (fixed-fixed, fixed-free, free-fixed and free-free) and a free-standing solid disk are discussed in detail. Due to the unsymmetric lamination of the disks, the membrane stress resultants and bending moments at the center of a solid disk can exhibit unexpected and very complicated singular behaviors which are absent if the disk is single-ply or symmetrically laminated. The general solutions for both the non-degenerate and degenerate cases are discussed in detail. To make the analysis complete, the general solution incorporating a uniform temperature change is derived. Our analysis reveals that a uniform temperature change will cause a logarithmic singularity at the center of a rotating solid laminated disk.

7230 | Study on static properties of a cracked aluminum alloy pipe repaired with carbon fiber composite patches

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Abstract: In this paper, the static properties of cracked aluminum alloy pipes repaired with carbon fiber composite patches were experimentally studied. The load carrying capacity of bare and wrapped pipes were tested and discussed first. Then, the paper analyzed the failure mechanism of bare pipes by measuring specimen micro-strain, and the repair function was verified. The specimen stiffness influenced by patches was investigated. The elongation and axial ratio of bare and wrapped pipes were calculated. Finally, the fracture patterns were macroscopically analyzed by comparing photographs of the fracture specimens. The results showed that the load carrying capacity of a cracked aluminum-alloy pipe with carbon fiber patches is increased by 40.39%, and the stiffness of the repaired pipe is improved, but the elongation and axial ratio of the repaired pipe is decreased. These results can be used to guide to reinforce and repair the structure with cracked aluminum alloy pipes.

Keyword: cracked aluminum alloy pipe; carbon fiber composite patch; static property

7231 | Investigation of fatigue properties of a cracked aluminum alloy pipe repaired with carbon fiber composite patches

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The fatigue properties of 5mm thick 7005 aluminum alloy crack pipes repaired with the carbon fiber composite patch were investigated in this paper. The fatigue life of repaired pipes and bare tubes was tested. The effect of surface treatments in an aluminum alloy pipe with threaded processing method and mechanical polishing method are compared especially. The fatigue properties of the specimen with different patch lengths and patch layers were analyzed. The stress intensity factor of the specimen was calculated using the finite element method. Finally, the stiffness and fatigue characteristics of repaired pipes and bare tubes are discussed. The results showed that the fatigue life of specimen repaired with carbon fiber composite patches by threaded processing method is 21.4 times of the bare tube, and higher 23.13% than the polishing method. It means that the repair techniques with carbon fiber composite patches can greatly improve fatigue resistance and life of aluminum crack pipes.

Keywords: Cracked aluminum alloy pipe; carbon fiber composite patch; repair; fatigue property; surface treatment

7232 | The comparison of inspection of CFRP material defect with Electronic Speckle Pattern Interferometry, Shearograohy, and Thermography

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This study utilizes electronic speckle pattern interferometry (ESPI), electronic speckle pattern shearing interferometry (ESPSI), and thermography techniques on carbon-fiber-reinforced-polymer (CFRP) material to explore their defect-detecting capacities.

For ESPI and ESPSI, we have two methods to make the specimen deformed, one is to load the sample at its back center with full boundaries fixed, and the other is to heat the specimen on its back by a 500W Halogen lamp. The simulated and experimental results both depict that the defect shape is easier to be detected by back heating than by back loading. Therefore, the back-heating of 500W Halogen lamp on carbon-fiber-reinforced-polymer (CFRP) is utilized for the ESPI and ESPSI holographic interferometry flaw detection. Under flaw free case, the surface thermal deformations are continuous and the interference fringes would pass the flaw boundary smoothly. On the contrary, the interference fringes would be distorted at the flaw and flaw-free boundaries due to the differences of their heat transfer coefficient and coefficient of thermal expansion.

With IR inspection technique, a material defect would be acted as a thermal resistance and that would cause a temperature gradient on the material surface. Provided this gradient is distinct enough, though IR imaging the material defects can be detected.

Experimental data show that near-surface defects can be detected by all the three techniques, but compared to the ESPI and ESPSI method, the thermography method needs more heating energy to generate sufficient temperature gradient for successful infrared imaging of material flaws. Under the same defect condition, ESPI can detect the defect with lower energy. This means that ESPI and ESPSI are more sensitive than IR.

Additionally, for time efficiency, we use real-time in ESPI and ESPSI, each specimen take about 10min for detect, the thermography technique needs to tune the pseudo color for different temperature scale to make the defect area more visible for detecting and the process is time-consuming, it takes about 30min even more. Therefore ESPI and ESPSI is more Efficient than IR

Unfortunately, none of the three methods can detect deeper-surface defect under the heating and constrain conditions of our testing samples effectively. It needs an auxiliary of other nondestructive detect technology as detecting deeper-surface defect.

7233 | Characterization of a PVDF based sensor for health monitoring of composite structures

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Electroactive polymers (EAPs) are smart materials that respond to electrical stimulation with significant changes in shape or size, and vice versa. Poly(vinylidene fluoride) (PVDF)-based ferroelectric polymers are one of the most promising field-activated EAPs thanks to the relatively large and fast electromechanical response, high mechanical and chemical stability, and so on. Meanwhile, various structural health monitoring (SHM) systems using fiber Bragg grating sensors, acoustic emission, microwave sensors for fibrous composite materials have been actively used in many fields. However, there are few versatile SHM systems embedded within the composite laminate and placed on the surface of the structure simultaneously. This work aims to estimate the possible use of the integrated PVDF based fiber-type sensor for real-time health monitoring by carrying out several electrical, chemical, and mechanical tests as follows; (I) Electrical aspect: We tested PVDF based fiber-type sensor by attaching it on a cantilever beam that was periodically deflected or pressured for piezoelectric property measurement. And the voltage signal generated by the sensor was collected. In addition, PVDF based fibers were exposed to high voltage (up to 5kV) for few minutes to increase effectively the formation of β-phase contributing to the piezoelectric effect. (II) Mechanical aspect: Uniaxial tensile test was performed to investigate the basic mechanical properties such as Young's modulus of PVDF based fibers. Furthermore, the relationship between stress and strain of PVDF based fiber obtained from the tensile test provided the core information on the condition of poling. (III) Chemical aspect: X-ray diffractometer was employed to inspect the material's fundamental characteristics and confirm the poling effect. And thermo gravimetric analysis (TGA) result could provide material's thermal information such as property degradation rate in case of high fabricating temperature of composite materials. Based on the aforementioned test results indicated that PVDF based fiber-type sensor could be potentially used in health monitoring system of composite structures.

7234 | Smart structural actuator using silicone-organically modified montmorillonite reinforced electroactive polymer composites

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Human tissues are exposed to various mechanical stimuli, and the types and magnitudes of the mechanical stimuli on cells and tissues are important factors to control the development pathway of cells or tissues. Thus, the relationship between mechanical stimulation and tissue differentiation has been extensively researched. Electroactive polymers (EAPs) are smart materials that respond to electrical stimulation with significant changes in shape or size, and vice versa. And dielectric elastomers, a kind of EAPs, are promising materials for the design of compliant actuators because of their large deformation capability, high energy density, and so on. The aim of this study is to construct a new type cell culture system which simulates cell-friendly environment using the dielectric elastomer such as silicone rubber. Furthermore, to enhance the performance of a cell culture device and simulate in vivo environment effectively several factors were taken into consideration as follows; (I) Property improvement: To enhance both mechanical and electrical properties of a silicone rubber, organically modified montmorillonite (OMMT) was added (wt. 5%) to the silicone rubber using solvent-assisted mixing method. (II) Uneven structure: To induce the diverse mechanical behaviors of EAP by the electrical stimulation uneven structures were uniformly patterned on the EAP film using the pressing method. (III) Elastic and flexible electrode: To minimize the sacrifice of actuation strain because of the relatively hard and brittle characteristics of ordinary electrodes the elastic and flexible electrode was fabricated by adding an alcohol sugar (Xylitol) to PEDOT:PSS. In this study, the measurements of electromechanical responses of the silicone-OMMT composite films like the actuation strain also were carried out with a circular-shaped actuator. By adding OMMT to the silicone rubber, both the dielectric constant and permittivity increased therefore, the silicone-OMMT composite films showed better electromechanical performance compared to the pristine silicone film under the same condition. And the uneven structure successfully

induced various mechanical behaviors including out-of-plane motion. Finally, the electrode, PEDOT:PSS+Xylitol, enabled EAP cell culture device to perform more effectively since it was more elastic and flexible relative to simple PEDOT:PSS.

7235 | Direct active soldering of Al-graphite composite/Al joints in air using Sn3.5Ag0.5Cu4Ti filler

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Aluminum-graphite composites (Al-Gr) was synthesized on 6061 Al Alloy using a melt conditioned high-pressure die casting (MC-HPDC) process. The microstructure, shear strength and fracture of Al/Al, Al-Gr/Al-Gr, and Al/Al-Grl joints were determined after direct active soldering in air with the Sn3.5Ag4Ti active filler at 250 °C for 30 s. The bond between filler and the Al-Gr sample was perfect. During active soldering, Al dissolves into SAT solder to form a coarse Al-Ag-Sn solid solution around the solder. Also, Ag3Sn nanoparticles are adsorbed at the solder/Al-Gr interfaces. The shear-tested bonding strengths were 14.3 ± 1.57 MPa for Al/Al, 8.45 ± 1.37 MPa for Al-Grl/Al, and 8.15 ± 1.43 MPa for Al-Gr/Al-Gr joints. In the Al/Al specimen, the fracture occurred in Al-Ag-Sn compounds of the active matrix after shear testing. In the Al-Grl/Al and Al-Gr/Al-Gr specimens, the fracture occurred in the Al-Gr/active filler interface.

7242 | Nonlinear free vibration analysis of laminated composite skew plates by the element-free Galerkin method

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The element-free Galerkin (EFG) method is employed here to study the large amplitude free vibration analysis of laminated composite skew plates over arbitrarily located point supports. The geometrical non-linearity is considered based on the von Karman's assumptions, and the effects of shear deformation, in-plane and rotary inertia are included in the formulation. The point support boundary conditions are satisfied through the use of Lagrange multiplier technique. The non-linear governing equations obtained by assuming a periodic solution and using the weighted residual method. The problem is solved by direct iteration technique for different amplitude ratios. Wherever possible, the results are compared with other published numerical methods and also some new examples for laminated composite skew plates with different boundary conditions are presented. The effects of boundary conditions, skew angle and aspect ratio on the non-linear frequency of laminated skew plates are reported.

7243 | Low-Velocity Impact Damage on Laminated Composites: Simulations and Correlations with Tests

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Through-the-thickness direction behaviour of composites have always remained a major weakness despite the advancements in composite technologies, mainly caused by weak transverse properties and unique damage characteristics of composites. Internal delamination followed by matrix cracking is the distinctive damage mode for low-velocity impacts. Past studies focused on developing improved damage resistance properties, dynamic response and damage prediction methods. Ultimately, well-correspondence has been achieved for post-impact damage footprints of advanced simulations and tests. This paper focuses on impact event. Stress fields and damage state of simulations throughout the impact period are compared with Digital Image Correlation (DIC) results of high speed cameras.

7248 | Iron oxide nanoparticle as carriers of the photoactive molecule methylene blue: Preparation, structural, morphological and spectroscopic characterizations

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In recent years, an increasing number of researchers have been considering the possibility of using nanoparticles in photodynamic therapy (PDT). Within this sense, this work describes the preparation and characterization of a composite based on iron oxide (Fe3O4) magnetic nanoparticles/silica as carriers of the photoactive molecule, methylene blue (MB), for biomedical applications. This nanocomposite may find important applications in PDT, in particular cancer treatment, on the basis of the concept that the photosensitizer molecule (MB) generates singlet oxygen upon irradiation, which acts as the primary cytotoxic agent responsible for irreversible damage of the treated tissues. In the first step of the composite synthesis, iron oxide (Fe3O4) magnetic nanoparticles were obtained by co-precipitation technique, by mixing acidic solutions of FeCl2 and FeCl3 in ethanol, followed by the addition of a weak base (NH4OH). A black precipitate of Fe3O4 nanoparticle was obtained. In a second step, tetraetylammonium, tetraethylorthosilicate (TEOS) and MB were added to the aqueous suspension of Fe3O4 magnetic nanoparticles. The final mixture was stirred overnight leading to the formation of the nanocomposite formed by Fe3O4-Si-MB, which was isolated by centrifugation and washed with ethanol. The final nanocomposite was found to be magnetic at room temperature due to the presence of Fe3O4 core and carries the photoactive molecule MB on the surface, allowing its use in PDT. The obtained composite was characterized by different techniques. Structural characterization of the nanoparticles was performed by X-ray diffraction (XRD), which confirmed the presences of crystalline Fe3O4 and the amorphous silica phase. Fourier transformed infrared (FTIR) spectroscopy was used to identify the stretching vibration of Si-O-Fe. The presence of methylene blue (MB) on the surface of the nanocomposite was confirmed by ultraviolet–visible spectroscopy. Scanning electron microcopy (SEM) and energy dispersive X-ray spectroscopy (EDS) revealed the spherical shape of nanosized particles composed by iron, oxygen, silicon, nitrogen and sulfur atoms, confirming the formation of Fe3O4-Si-MB composite. Vibrating sample magnetometer (VSM), at room temperature, indicated a superparamagnetic behavior of the nanoparticles. Taken together, the results confirmed the successfully synthesis and characterization of iron oxide magnetic nanoparticles as potential MB-delivering platform. This new nanocomposite might find important biomedical applications in PDT. Ongoing measurements of oxygen singlet release from the nanomaterial upon irradiation with visible light are being carried out.

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7250 | Effects of Minor Sc and Zr on the Microstructure and Mechanical Properties of Al-4.6Cu-0.3Mg-0.6Ag Alloys

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The effects of Sc or combined addition of Sc and Zr on the microstructure and mechanical properties of Al-4.6Cu-0.3Mg-0.6Ag alloys were investigated by microstructural examination, differential scanning calorimetric analysis, electrical conductivity measurement (%IACS), hardness testing, and tensile testing. The result indicated that the Sc-containing alloy formed primary Al3Sc and W (Al8.5-4Cu6.6-4Sc) and the Sc and Zr-containing alloy formed Al3(Sc, Zr) and W (Al8.5-4Cu6.6-4Sc). Solution heat treatment could not dissolve Al3Sc, Al3(Sc, Zr) and W (Al8.5-4Cu6.6-4Sc) phases into the Al matrix, lowering the solid solution strengthening effect. After T7 tempering, both the Sc-containing alloy and the Sc and Zr-containing alloy have relatively lower tensile strength and higher elongation compared to the Sc and Zr-free alloy. The addition of Sc or combined addition of Sc and Zr to Al-4.6Cu-0.3Mg-0.6Ag alloys could produce grain refinement effects and had the similar mechanical properties. Zirconium can partially replace expensive Sc to reduce the cost of the Al-Cu-Mg-Ag alloys.
Keywords: Al-Cu-Mg-Ag alloy; Sc; Zr; W phase.

7256 | Instant sintering of silver nano-ink on CFRP laminate for structural health monitoring

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Electrical resistance change method (ERCM) has been an area of interest as a sensing system for CFRP (Carbon Fiber Reinforced Plastic) structures. It utilizes an electrical network of conductive carbon fibers, which can serve as a distributed sensor by properly locating electrodes on surface of a structure. At laboratory level the electrodes can be simply installed by painting commercially available silver pastes on polished surface with exposed carbon fibers. Those made by electroplating are qualitatively more uniform and also feasible for mass production. However, these methods are not efficient in terms of time and labor, which prevent ERCM from being applied to large scale structures such as aircrafts and space structures. Simpler and faster way of making a number of electrodes are demanded to maximize the advantage of ERCM.
In recent years, printing electronics has made remarkable progress as an alternative to the standard production of electronic devices. Particularly, metal nano-ink has been widely available on electronic components since it can be simply printed by ink-jet printing onto a substrate, and then sintered by thermal heating. Our recent work has shown that silver nano-ink works as electrodes on a CFRP substrate when it is gradually sintered in electric furnace. Compared to conventional silver paint electrodes, silver nano-ink electrodes showed compatible conductivity with superior bonding with CFRP substrate. In addition, remarkable sintering method has been proposed for instant sintering of metal nano-ink on polymer substrates. Metal nano-inks can be sintered in a few milliseconds at room temperature under ambient conditions using white flash light irradiation from a xenon lamp. If this instant sintering method is also applicable to CFRP laminate, ERCM will become a practical system for structural health monitoring.
In this paper, the flash light sintering of silver nano-ink is applied to make electrodes on CFRP laminate for ERCM. Quality of the electrodes is investigated by sheet resistance measurement and peel test to measure interfacial strength between the electrode and CFRP substrate. Feasibility of the electrode on structural health monitoring of CFRP structure is also examined by measuring contact resistance on CFRP substrate and monitoring electrical resistance change during a tensile test. It was found that electrodes sintered by flush light is comparable to those by thermal sintering when parameters are properly determined.

7257 | Full-field measurement of carbon fiber composite under tensile test using digital image correlation

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This paper presents a method of digital image correlation (DIC) applicable to measure the deformation of carbon fiber composite under tensile test. The proposed technique employs an in-house DIC core for image processing, which makes it possible to obtain displacement and deformation of solids by tracking features on the surface of measured objects, thereby realizing non-contact, full-field measurement. This approach simplifies measurement devices to only a camera (static problems) or a video camera (dynamic problems) for the recording of images. The proposed DIC technique was used to various applications at different scales, including tracking the trajectory of robot arms and the measurement of large displacement for structures (civil engineering) subjected to seismic waves. Our results were compared with those of expensive, high-precision measurement devices, and gave consistent value in different metrology.

In this study, we measured the quasi-static displacement and strain in a cantilever beam and conducted tensile tests on a carbon-fiber composite material using the proposed DIC technique to measure deformation before failure. The results were compared with those obtained using strain gauges. The deformation characteristics of brittle material prior to tensile failure were used to demonstrate the accuracy and reliability of the DIC technique in strain measurement.

Unlike ductile materials, which display distinct necking before breaking, carbon fiber composite materials are brittle and break without significant necking when they reach their tensile strength. They show almost no plastic deformation prior to failure, and their tensile strength is limited by defects, such as fiber breakage and interfacial delamination.

To increase the tensile strength of carbon fiber composite materials, the number and size of defects must be reduced. In the DIC technique, images of the specimen during the tensile test were captured using a digital camera at a sampling frequency of 86 fps. We then conducted measurements and analysis using the strain gauge. Our DIC technique could reach a resolution of 0.01 pixels, and provide 12.84 μm/pixel in this case. The fixed end of the specimen was gripped with a constant grip force of 125 bar, whereas the other end was pulled at a speed of 2 mm/minute. Fracture failure occurred when the tensile

load reached 35 kN. The DIC results show that when the material failed, the tensile strain was approximately 16155 $\mu\varepsilon$ (or 1.62 %).

The DIC technique developed in this paper makes it possible to obtain non-contact, full-field measurement with high spatial and temporal resolution. It is applicable to numerous problems in various domains and at various scales.

7263 | Experimental and theoretical study on axial compressive behavior of CFRP-confined damaged high strength concrete column

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In recent years, it has become increasingly common to strengthen concrete structures by bonding externally carbon fiber reinforced polymer (CFRP) laminates. CFRP is of interest to rehabilitation engineers because of the high-strength/weight ratio, ease of handling and application, the elimination of the need for heavy equipment, a faster construction rate and the fact that they do not corrode.
Extensive studies on the mechanical behaviors of CFRP-reinforced concrete column have been conducted. However, most of these studies mainly focused on the use of CFRP sheet for the repair of virgin columns. In fact, for the most part of concrete structures, the in-service components usually work with damage cracks. Therefore, the study on the mechanical properties of pre-damaged concrete column with CRFP closed to the actual state of the in-service components has more reference value. In addition, few studies have been directed to investigate the mechanical behaviors of CFRP-confined high strength concrete (HSC) column, which limits the application of CFRP strengthening technology in HSC structure.
In this paper, an experimental and theoretical study was conducted to investigate the compressive behavior of CFRP-confined damaged columns, including normal strength concrete and high strength concrete. 60 cylinders with the size of 150mm×300mm (diameter×heigh) were tested subjected to axial compression loads. The test parameters include two concrete strength, two pre-damage levels of cylinder and three CFRP thicknesses. The effects of these parameters were analyzed on the failure modes、compressive strength、stress-strain relationship of the CFRP-confined column. Based on the test result, a strength model of CFRP-confined damaged concrete was proposed, which not only considers the effects of the pre-damage, but also is fit for the CFRP-confined HSC column. The results show that the theoretical model is in good agreement with the experimental data.

7265 | Experimental and Numerical Investigation on Failure Behavior of Pin Loaded Glass Fiber Reinforced Polymer Straps

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Experimental and Numerical Investigation on Failure Behavior of Pin Loaded Glass Fiber Reinforced Polymer Straps

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Composite structures are very advantageous since they can easily be tailored with respect to the loading path. Although this is one of the reasons why composites are preferable for thick primary structures, machining operations like drilling may cause local failures including delaminations and fiber cuts in such structures. Therefore, strap type designs have emerged as a viable alternative against such problems.

On the other hand, straps have a unique failure behavior caused by the nature of their geometry. For example, wrapping plies around a bushing results in serious local stress variations which may eventually alter the failure behavior. Similarly, dimensional variations such as in thickness and width would have significant effects on stresses. In order to utilize strap designs effectively, their properties and limitations should be clearly identified.

This paper presents an experimental and computational study on the failure behavior of pin loaded glass fiber reinforced polymer (GFRP) straps. One of the objectives is to develop a guideline for modeling and designing of composite straps. In the experimental part of the study, effects of geometrical variations on failure behavior are monitored. Experimental results are compared with the finite element model constructed in a commercial software package in terms of the strain values and failure modes of the structure. The computational model is optimized in terms of failure criteria including Tsai-Wu, Hashin, the maximum stress and by applying a progressive failure algorithm.

Once all specimens are manufactured and their configurations are validated, they are instrumented with strain gauges for the tensile tests. The location of the strain gauges is demonstrated in Figure 2 a. Static tension tests are conducted with DARTEC Hydraulic Universal Tensile Testing Machine with a 600-kN capacity.

The experimental and numerical results will be given and discussed in the final manuscript.

7267 | Mechanical property and fracture analysis of hybrid composite of recycled paperboard and recycled carbon fiber

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Abstract:
Paper recycling is an effective way in reducing deforestation and energy consumption. Recycled paper materials are widely used, such as in packing

industry, media platform and house and life products. However the relatively low mechanical properties limits its applications. As more and more products made of FRP, the rubbish of FRP is also increasing which has become an important problem to the environment. Recycling and reusing is a noticeable method to reduce trash discharge and to save resource. Although it is a more challenging work for FRP, many researchers have report their scores in this area. In this study, recycled paperboard and recycled carbon fiber was employed to fabricate composite with unsaturated polyester resin by hand lay-up method. Different content of recycled carbon fiber and different hybrid structure was applied during hand lay-up process. Mechanical properties included tension, bending and impact were investigated comprehensively on these composite. Scanning electron microscope was used to observe the fracture behavior after mechanical test. Combined with anisotropic property of recycled paperboard, the relation between mechanical property and fracture behavior was discussed. It was found that the mechanical properties gained remarkable improvement after combining with resin and recycled carbon fiber.

7269 | A COMPARATIVE STUDY OF TREATMENT METHODS FOR SURFACE MODIFICATION OF OIL PALM MESOCARP FIBER FOR BIOCOMPOSITE PRODUCTION

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Poor compatibility between natural fiber and polymer matrix as well as relatively higher moisture absorption of natural fiber have led the researchers to modify the surface of natural fiber to improve its characteristics. In this study, oil palm mesocarp fiber (OPMF) was treated with three different methods: superheated steam (SHS), sodium hydroxide (NaOH) and potassium hydroxide (KOH) to investigate the influence of each treatment method on the fiber composition and the mechanical properties of polypropylene/OPMF, PP/OPMF biocomposites. It was found that the treatments conducted affected mainly the hemicellulose and lignin composition, resulted in improved characteristics of the fiber compared to the untreated one. Thermal stability at T5%deg of treated OPMF was almost similar between 260 to 280 □C for all samples, suggested that similar components were removed from OPMF for all treatment methods. Overall, thermal stability of treated fiber was improved by 7% compared to the untreated OPMF. Based on SEM analysis, OPMF treated with SHS and alkali had rough surface due to the removal of some silica bodies. This rough surface is beneficial for fiber-polymer adhesion, which may help to increase the mechanical properties of the biocomposite. This is evident by the tensile strength data, which showed that PP/SHS-OPMF biocomposite had the highest tensile strength value at 20.5 MPa. NaOH and KOH treatments gave almost similar results at 18.9 and 19.6 MPa, respectively. On the other hand, PP/untreated-OPMF biocomposite had the lowest tensile strength at 16.3 MPa, which can be explained by incompatibility between PP and untreated OPMF. Unlike alkaline treatment, SHS treatment selectively removed hemicellulose, leaving a high percentage of lignin in OPMF. Hydrophobicity of lignin contributed to the adhesion between OPMF and PP. From the results obtained, it is suggested that SHS treatment can be a good treatment method for modification of OPMF which subsequently improved the characteristics of the biocomposite produced.

7270 | Analysis of mechanical property on correlation between paperboard and paper tube

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Abstract:
Recycled paper is helpful to reduce trash discharge, save resource and cost. Tube is one of the most common structures for recycled paper in application. It is an excellent choice for packing. It's also can be used in the construction of temporary structures for both exhibition spaces or for rapid-recovery shelters in emergency operations. As paper tubes are laminated by paperboards which are inherent anisotropy materials, the researches on mechanical property and fracture behavior became complicated. In the current study, paperboards used for paper tubes were tested on universal testing machine to investigate their basis mechanical properties, such as tension, compression and peeling properties. Then, paper tubes fabricated with different kinds of paperboard and different numbers of ply were used to investigate lateral compression properties by Instron universal testing machine. And, a camera was employed to record the fracture process of paper tube during compression test. The fracture mechanism of paper tubes were discussed and analyzed during compressed process based on the load-displacement curves and detailed observation. Combined with the previous test of paperboard, the lateral compress results were discussed to investigate the correlation between paperboard and paper tube. The simulation of lateral compression was also introduced to investigate the stress state inside the paper tube. Finally, the fracture process and fracture characteristic were evaluated in this research.

7272 | FIRST PLY FAILURE STUDY OF LAMINATED COMPOSITE SPHERICAL SHELLS

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FIRST PLY FAILURE STUDY OF LAMINATED COMPOSITE SPHERICAL SHELLS
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Keywords: Finite element method, First ply failure loads, laminated composite spherical shell.
ABSTRACT
A study of laminated shells reveals that these are widely used in different civil engineering applications. For efficient use of these materials their performances under service conditions need to be assessed properly. The failure of laminated composites may be through different modes of

overstressing and overstraining of the fibres or the matrices. Internal lamina failures may lead to collapse of the structure and hence the first ply failure, progressive failure aspects drew attention of many researchers. Such reports are available on plates but the study of literature on shell unveils that similar reports on different types shells are very limited. The present endeavour is to work on first ply failure of industrially as well as aesthetically important spherical shells under uniform loading for different practical boundary conditions. In this paper only theories that predict a first failure of a ply are reported. The first ply failure does not mean that the whole structure fails instead the load is redistributed to other existing layers. A finite element code with mathematical formulation related to the shell geometry, generalized force components is developed. Its accuracy is validated using some bench-mark problems. The magnitude of the load values are increased in steps and the lamina strain and stresses are put into the failure criteria to evaluate the first ply failure load along with the failed ply, the point of initiation of failure, Failure modes (fiber breakage, transverse matrix cracking in the plane of the lamina or inter-fiber shear failure of the matrix, fiber buckling) and failure tendencies (as in interactive failures) using different types of recommended theories are reported. The results are interpreted from engineering standpoint to extract conclusions of engineering significance.

7274 | Recycled Copper Filled Epoxy/PMMA composites: The Effect Of PMMA Blend Ratio

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The effect of PMMA content of 30% mixed particle size of recycled copper filled epoxy composites on mechanical, electrical, thermal and physical properties was investigated. PMMA was diluted before mixed with epxy and recycled copper was added to the blend. The effect of volume percentage of PMMA of the epoxy composites were studied based on the flexural, thermal, electrical and physical properties. incorporation of PMMA has increased the CTE of the composites. The flexural, electrical and physical properties of the composites decreased with increasing the volume percentage of PMMA.

7276 | The Powder Metallurgical Route To Tungsten-Fiber Reinforced Tungsten

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Tungsten is a promising material for fusion applications. Due to its high melting point, high thermal conductivity, low erosion and its low tritium retention it is suitable to withstand the harsh conditions at the first wall in a fusion reactor. A major disadvantage of tungsten is its brittleness after recrystallization and at low temperatures, making it prone to catastrophic failure of full components. Therefore, for the application of tungsten in a fusion reactor, a toughening strategy has to be developed. An established possibility to improve the properties of a material is to use it as part of a composite. E.g., silicon carbide-fiber reinforced silicon carbide (SiCf/SiC) is known for its increased toughness compared to bulk SiC [1].
For the Wf/W it was shown that indeed the tungsten composite performed better under mechanical loads than pure tungsten. Stable crack propagation through energy dissipation by several mechanisms, e.g. fiber pull-out or by crack deflection at the tailored fiber-matrix interface was experimentally observed [2].
Extensive studies have been performed relating to the choice and viability of the W-fiber coating, the interface to the tungsten matrix[3]. In these initial studies the composite was produced from fibers with a diameter of 150 μm which were coated by magnetron sputtering (below 1 μm) with the selected interface materials. The tungsten matrix was produced by chemical vapor deposition (CVD). The parameters of various interface coatings were determined in single-fiber composite experiments and indicated the composites satisfy the criterion of crack deflection regarding classic ceramic matrix compost toughening mechanism[4].
The infiltration of tungsten into larger fiber structures might prove difficult for large-scale prototypes and industrial scale production. Therefore, in addition to further development of the chemical vapor infiltration (CVI) technology, powder metallurgy (PM) is investigated aiming at the production of Wf/W composites on a larger scale in a shorter time with the same properties. PM routes are well established in industrial refractory metal processes. The main differences between CVI and PM are the forces and temperatures involved. This will be of particular importance for the interface between the W matrix and the fibers. During CVI there are no forces acting on the interface-fiber complex, whereas during the preparation of PM samples high pressure and temperatures can alter the material properties.
This contribution aims at presenting the early stages of PM Wf/W. Initial results of composite materials produced by hot isostatic pressing (HIP) allow insight into interface de-bonding and structural changes. The fiber-interface-matrix behavior differs strongly as the powder directly impacts the interface structure as the W powder is pressed into it. . The fiber partly recrystallizes during HIPing, the interface thickness is reduced and the smoothness destroyed. Consequently, for the PM Wf/W production route an optimization of the interface is required. Nevertheless, the crack energy dissipation mechanisms are still active. The presentation will demonstrate mechanical test results of the PM composite and an analysis of the fracture surfaces. Fiber Push-Out test results are presented. Moreover, a general discussion of the requirements for fusion applications and the consequences on material choices for Wf/W composite materials is presented.

References
[1]Hinoki, T., et al., Materials Transactions, Vol. 54, Issue 4, 2013, pg. 472-476
[2]Riesch, J. et al., Physica Scripta, PFMC-14, 2014
[3]Du, J., Ph.D. Thesis, Technische Universitt München, 2011
[4]Du et al, Composites Science and Technology 70 (2010) 1482–1489

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7277 | Effect of Anchors on the RC Slabs strengthened in Flexure with FRP Strips.

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The use of FRP composites as a repair and strengthening material for RC slabs increase over the past thirty years. The tendency for FRP to debond at loads below ultimate capacity prompt researchers to investigate various approaches to increase the efficiency of FRP strengthening systems. Studies that assess the effectiveness of anchors in anchoring FRP strengthening in flexural members is, however, limited. This research study aim to investigate the effectiveness of using anchors to secure FRP sheets installed to strengthen and repair RC slabs in flexure. Eight RC one-way slabs are strengthening in flexure with anchors. The test variables include the type of FRP, type of anchor and the strengthening configuration. The load–deflection responses of all slab tests are plotted, in addition to selected strain results. The behaviours of the specimens including the failure modes are also discussed. The paper also discusses the strategic placement of anchors for optimal strength and deflection enhancement in FRP-strengthened RC slabs.

7278 | INVESTIGATION OF BOND-SLIP BEHAVIOUR OF MASONARY SURFACE AND CFRP INCLUDING CFRP FAN TYPE ANCHORAGE EFFECT

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Carbon Fiber Reinforced Polymers (CFRP) have been widely used in the retrofitting of masonry buildings since 15 years. Application area of CFRP is continuously widening due to its high tensile strength, ease of application, light weight, durability and resistance to corrosion. Application of CFRP in the retrofitting of masonry structures also increased. CFRP is generally bonded to the structural member to retrofit by a two-compound resin. Generally, failure mechanism of structural members retrofitted with CFRP forms up as the slip of CFRP from the bond surface, such failure mechanism is frequently verified with extensive experimental studies. Consequently, accurately determining the parameters such as stress distribution between the CFRP and the bond surface, load- slip displacement relation and the strength became more important to calculate the retrofitting details. In addition to that, to prevent the slip of CFRP from the bond surface and having a more effective retrofitting detail, several types of anchorages are proposed and used by researchers. The most common type of such anchorages between the others is the fan anchorage which is manufactured using CFRP material. Load- slip displacement relation of such an anchorage is an effective parameter on the performance of a retrofitting detail and an important research topic. Consequently, in this study, variation of stress distribution between CFRP strips and masonry is investigated. The main variables in the study are CFRP strip width, bond length of CFRP strip and the effect of the presence of anchorage. In the experimental study, CFRP strips are used with 50 mm and 100 mm width and the bond length is chosen as 200 mm and 280 mm. CFRP strips are bonded to the surfaces of hollow bricks. Furthermore, all test specimens are manufactured two times with and without anchorage. From the experimental study, load-slip displacement, stress distributions along the CFRP and strength parameters are obtained and their effects are investigated. Moreover, the experimental load carrying capacities of test specimens are compared with those obtained using two current analytical equations.

7280 | Preparation of Porous Composite Microspheres From W/O/W Emulsions

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In recent years, porous polymer microspheres has attracted much attention in wide variety of applications ranging from drug delivery to catalytic processes. In this context, scientist have been reported a variety of microspheres with miscellaneous properties based on template-assisted processes. In the last decade, depending on the advantages of low density and high specific surface area further interest was focused on the preparation of hollow spheres consisting porous shells.
Emulsion templating is a simple and effective route for the preparation of macroporous and open-cellular polymers through high internal phase emulsions (HIPEs). HIPEs are usually defined as concentrated emulsions consisting of a high ratio of internal or dispersed phase. The volume fraction (ø) of the internal phase of a HIPE is usually greater than 0.74. If one or both phases of a HIPE contains monomers, it will be possible to produce highly porous, low-density and crosslinked polymers, namely poly(high internal phase emulsion) - polyHIPE -with a well-defined morphology [1-3].
In this study we report the preparation of novel composite microspheres through water-in-oil-in water (w/o/w) double emulsions. In order to tailor the properties of the resulting microspheres and obtain a composite structure pullulan, a non toxic and water-soluble polysaccharide, was incorporated to the HIPEs. The composite microspheres were synthesized by polymerizing the pre-obtained GMA/BDDMA/pullulan HIPE in a secondary suspension medium. GMA/BDDMA/pullulan HIPEs were obtained by dispersing the internal phase in the continuous phase consisting of GMA and BDDMA. The internal phase was prepared by dissolving pullulan in deionized water. In order to stabilize the HIPE droplets in the aqueous suspension phase either hydroxyethyl cellulose (HEC) or pullulan was used as stabilizer. The morphological, mechanical and thermal properties of the synthesized composite microspheres were characterized depending on the preparation conditions. Consequently, morphological features were investigated by Scanning Electron Microscopy (SEM) and Polarized Optical Microscopy (POM). The surface area and pore sizes were calculated by applying Braunauer-Emmet-Teller (BET) method to the nitrogen adsorption/desorption isotherms. Additionally, thermal properties were investigated by Thermal Gravimetric analyses (TGA) and Differential Scanning Calorimetry (DSC). Moreover, modification of the resulting composite microspheres was carried out with chelating ligands such as 1,4-ethylene diamine (EDA) and 2-aminothiazole (ATAL). Elemental analysis was used to confirm the modification of the resulting microspheres.

References
1. Cameron NR, Polymer 2005, 46, 1439-1449.
2. Mert EH, Kaya MA, Yıldırım H, Des Monomers Polym 2012, 15, 113-126.
3. Mert EH, Yıldırım H, E-Polymers 2014, 14(1), 65-73.

7281 | Analysis of high velocity impact on hybrid composites

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In addition to fiber properties, fabric structure is also an important parameter in determining ballistic performance of composite targets in body armor textile. Some textile materials used in ballistic protection have either woven, unidirectional, or nonwoven fabric structures .This paper presents an analytical model based on wave propagation and energy balance between the projectile and the target to analyze hybrid fabric panels for ballistic protection. This hybrid panel consists of two types of structure, woven fabrics as the front layers and unidirectional (UD) material as the rear layers. The model takes into account elliptical shape for the cross-section of the cone formed on the surface of the target in the woven part and circle shape in the unidirectional part of the hybrid panel. In addition, possible shear failure is also considered by using shear strength together with maximum tensile strain as the failure criteria. Reflections of deformation waves in intersection points and also the crimp of the yarn is modeled in the woven part of the hybrid panel. The results show that the greater efficiency of woven fibers in front (more shear resistance) and unidirectional yarns in the rear (more tensile resistance), lead to better ballistic performance. Also modeling the yarn crimp results in more trauma in the back face of the panel, producing data closer to the experimental results.
It was found that there is an optimum ratio of woven to UD materials in the hybrid ballistic panel. It is noted that the improvement in ballistic protection of the hybrid fabric panels allows less material to be used, leading to lighter weight body armor.
Keyword: hybrid textile, composite, high velocity, impact, analytical model

7283 | THE MECHANICAL PROPERTIES AND FIRE STABILITY OF NATURAL FIBER COMPOSITES FROM PE-HD FOIL AND WALNUT SHELL

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The aim of the work was to manufacture inexpensive and environmentally friendly Natural Fiber Composiets (NFCs) possessing favourable functional features.

Materials and process
The PE-HD foil was used as a matrix (MFR190˚C, 2,16 0,88 g/10 min), being a substitute of the packaging waste, while milled walnut shell, obtained from food and farm industry, was used as a filler. During the analysis it was found that almost 82% of filler particles ranged between 32 and 420 μm. The density of the walnut shell flour was 1.3775 g/cm3 and the aspect ratio of particles was 1.6.
The components were mixed using a mixer (Farrel Bridge from David Bridge and Co.) and a roller (type LWII from Veb Erste Maschinenfabrik). In the next stage the mixtures were broken and samples for strength test were made using injection moulding machine (BOY 22A from Dr. Boy GmbH & Co.KG.). Three types of materials were prepared with filler mass share of 10, 25 and 40% along with the reference material fabricated from the polyethylene itself (Table 1).

Results and discussion
The introduction of walnut shell flower caused a decrease in impact strength of NFCs comparing to unfilled PE-HD. The results are conformed with the literature [1, 2]. Impact strength of composites dropped with the increase of filler content which is caused by the growth of pore content and the appearance of agglomerates. The reason of reduction in tensile strength values were: poor dispersion of fillers leading to the agglomeration, low value of aspect ratio and rough and not very well developed area of ground walnut shells, hindering wetting of the filler surface by plasticized polyethylene with relatively low MFR.

Table 1. List of compositions and test results
The values in parentheses are standard deviations

Sample name	Impact strength, kJ/m2	sM, MPa	QPCS, MJ/kg
PE-HD	27.02 (1.31a)	21.8(0.30)	50.7 (0.2)
WS10	17.53 (0.70)	20.60 (0.37)	49.3 (0.2)
WS25	12.21 (1.14)	19.36 (0.24)	40.7 (0.2)
WS40	8.19 (0.58)	15.5 (0.45)	

38.1 (0.2)

OI,
% V/V
20.6 (0.2)
20.2 (0.2)
19.6 (0.2)
19.6 (0.2)

The introduction of natural fillers analyzed for PE-HD resulted in a slight decrease in the oxygen index for the tested NFC, thereby increasing the susceptibility of the polymer to the ignition from small flame. However, the increase in the amount of filler in the composites resulted in an increase in the degree of charring materials, and reduction of melting did not allow for the appearance of flaming droplets. This means that despite a slight decline in the OI plant materials had a positive impact on the process of NFC burning. Lowering calorific values of NFCs was caused by the reduction of hydrogen and carbon in the materials and might result in a reduction of fire load density, leading to a slowdown in the intensity of fire.

Conclusions
The introduction of a filler plant had a positive impact on the flammability of polymeric materials, which increases their use. However, due to the relatively low mechanical properties it is impossible to use these composites as construction materials.

Acknowledgement
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References
1. Araujo JR, Mano B, Teixeira G.M et al., Compos. Sci. Technol., 70 (2010) 1637-1644.
2. Ruksakulpiwat Y., Suppakarn N., Sutapun W., et al., Composites: Part A, 38 (2007), 590-601.

7284 | Health monitoring of a repaired runway using compliant polymer concretes under thermomechanical loading condition

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When a repair material is used in runway maintenance, possible material failure due to the differences in material properties such as coefficient of thermal expansion (CTE) and excessive shrinkage of the repair material needs to be investigated. Moreover, the repair part takes various mechanical loadings such as impact and dynamic loads from airplanes therefore, these mechanical loadings also take into account to select the best repair material and estimate the robustness of the repair part. In this study, a real-time monitoring system composed of a few Fiber Bragg Grating optic (FBG) sensors was used to monitor strain variation in a repaired runway during service. The strain of the maintenance parts induced by environmental conditions and material shrinkage were measured by this real-time monitoring system. Three FBG sensors were embedded at regular intervals from the center of the repair parts to the interface near by the repair parts. In order to check strain variation of repair parts made of various polymer concretes under environmental condition four repair structure with different materials were prepared in Gimpo airport Korea during summer season. Strains due to cure shrinkage of polymer concretes and temperature variation for two days were measured and compared with. From the basic monitoring test results, it was found that resin contents highly affected not only material properties but also the level of strains in the material. As a result, the generated stress should be quantitatively investigated to check possible material failure in the repair part. Moreover, the mechanical loading induced by airplane such as impact during landing is other source of stress inducing condition, which also needs to be considered during the estimation of the generated stress in the materials. Finite element analysis using a commercial code ABAQUS 6.10-1 was introduced to evaluate the type of the generated stresses and their magnitude and finally estimate the possibility of the material failure. By using the measured strain data and analyzed stress results the most appropriate polymer concrete was determined; that is, the appropriate mixing ratio between aggregate and resin, and the type of ingredient for the material compliance were suggested.

7286 | STRENGTH PREDICTION OF ADHESIVELY BONDED CFRP/STEEL JOINTS USING DAMAGE MECHANICS

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Strengthening and repair of structures using bonded carbon fiber reinforced polymer (CFRP) materials has attracted a great deal of attention in the past three decades. The method is well established and widely implemented when it comes to upgrading concrete structures. Despite research efforts, there are still some obstacles preventing the widespread use of this technique to upgrade steel structures. One of them is the lack of design methods to predict the strength of joints. The shortage of reliable design models is another obstacle to the development of design methods for such adhesive joints. Recently, damage mechanics-based approaches has been applied successfully to characterize the failure initiation and propagation in adhesive joints with thin adhesive layers. However, their application to thick adhesives that are commonly used in bridge applications is yet questionable. This paper is mainly concerned with evaluation of these approaches to predict the strength of thick adhesive joints used to bond FRP laminates to steel beams.
Adhesively bonded CFRP/steel double-lap shear (DLS) specimens are numerically modeled using cohesive zone modeling (CZM). The simulation results correspond well to the experiments, both in terms of displacement and ultimate load. The input cohesive material data for thick adhesive joints are obtained by testing Double Cantilever Beam (DCB), End Notch Flexure (ENF), and Mixed-mode Cantilever Beam (MCB) specimens.
This study shows that by using the implemented procedure to obtain fracture data, the CZM approach can be used to predict load bearing capacity and failure mode of thick adhesive joints with acceptable accuracy. Therefore, the adopted modelling approach in this paper, could be used in practice to determine the strength of adhesive joints in FRP bonded steel beams.

7290 | Interface analysis between fibrous system strengthening and masonry elements

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The use of FRP sheets for strengthening masonry structures is a promising technique, in conjunction or in place of traditional technologies. The problems related to the reinforcing techniques, have been widely discussed in the last decades for concrete structures but only in the last few years, the use of composite materials (FRP) for masonry structures, that represent a monumental and historical heritage in many European countries, has been addressed. As well known, the analysis of the interface performance of the FRP (Fiber Reinforced Polymer) reinforcement and masonry substrate is a critical problem as it influences the effectiveness of the technique. In fact, the adhesion between the two materials involves the reinforcing material, the adhesive layer and the substrate.
The bond depends on many parameters as mechanical proprieties substrate, interface and reinforcement, bond length, type of test, environmental conditions etc. The research work of the authors was devoted to this topic from many years and several of the above parameters were analysed, however further investigations are needed in this area in order to extend and validate the existing design guidelines.
In this study, the bond between different types of composite reinforcements and masonry elements was investigated by means single face shear test. In particular, several fibrous systems as strengthening materials were analyzed: natural, synthetic and steel fibers immersed in both polymeric resin and cement-based mortar. Furthermore, different type of masonry substrate considering, block and masonry realized in both natural stone and bricks and hydraulic mortar joints were tested
The obtained experimental data were analysed and discussed in terms of bond strength, kind of failures, strain behaviour along the bond length and bond strength versus slip curves.

7291 | FRP composite materials - an alternative solution for retrofitting of shear walls affected by cut-out openings

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Precast reinforced concrete shear wall buildings were used as structural systems in seismic areas, because of their good behavior under previous earthquakes. Research was developed in the form of theoretical, numerical and experimental investigations, comprising mostly as-built walls with or without openings. But, due to comfort or functional requirements, engineers encountered also the aspect of cut-outs performed in walls. In order to investigate the effect of weakening on the as-built walls, an experimental program was developed by the authors. The involved specimens were as-built solid walls, as-built walls with window/door openings, and were tested under quasi-static reversed cyclic lateral loads - displacement controlled. The main investigation interests were focused on the seismic performance, weakening effects, numerical assessment and structural rehabilitation using FRPs. In order to study the effect of different opening types on the as-built specimen, a large number of elements would be necessary. Good reliable data can be provided also by numerical analysis. The present paper shows the experimental results and a numerical investigation on shear walls affected by cut out openings. It is proposed to find a relationship between the specific performance and the opening ratios, taking into account the fact that the strength performance ratio is the complement of the peripheral ratio. The effect of the FRP strengthening systems on the seismic response of the cut-out weakened members was also evaluated and presented. Considering the theoretical and numerical assessments performed, a large variety of available strengthening systems using FRPs can be further analyzed for a good seismic behaviour. It is concluded that the composite materials could be an alternative solution used for retrofitting of shear walls affected by cut-out openings, for buildings placed in seismic areas.

Keywords: FRP composite, numerical investigation, weakening, cut-out, shear wall, seismic behaviour

7300 | Prediction of surface roughness and process parameters optimization in WEDM machining of Al6061/SiCp composite

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In recent days, the silicon carbide particulate reinforced aluminium metal matrix composites are most promising material in various engineering applications due to their strength to weight ratio over the non-reinforced alloys. However, these materials are very difficult to cut by conventional machining methods due to the presence of silicon carbide particles. To overcome this limitation, the wire electrical discharge machining (WEDM) is employed to machine these composites.
The aim of this study is to predict the surface roughness by using the fuzzy logic modeling technique and to optimize the process parameters in wire electrical discharge machining (WEDM) of Al6061/SiCp composite using Taguchi method. Analysis of Variance (ANOVA) is employed to determine the effect of influential process parameters on surface roughness. Al 6061/2% SiCp/3μm particulate metal matrix composite is fabricated by using stir casting method and the uniformity of particle distribution was analyzed by SEM. Taguchi L9 orthogonal array is designed by considering various process parameters viz. Sensitivity (S), pulse-on time (T ON), pulse-off time (T OFF) and wire feed rate (WF) for conducting experiments. The obtained experimental results were analyzed and the results revealed that Sensitivity (S) is the prevailing factor on the surface roughness followed by pulse-on time (T ON), wire feed rate (WF) and pulse-off time (T OFF). In addition, the fuzzy predicted values and experimental values of surface roughness are quite close to each other. Therefore, the developed fuzzy logic modeling technique can be used effectively to predict the surface roughness in WEDM of Al6061/SiCp composite. The obtained optimal process parameters are confirmed by the experimental test.

7304 | Parameter-free Shape Optimization of Orthotropic Shell Structure

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Shell structures have high load-carrying capacity in spite of their thinness and lightness and can span large areas. They are widely used in architectural and civil structures, among other artifacts such as automobiles, aircraft and pressure vessels. The material used is metals, plastics and composite

materials, and especially the demand of composites is more increasing, since they are light, strong and functional. In the view of material design, it is important to control some material characteristics to the required ones. In contrast, in the view of shape design it is important to find the optimal shape, since the shape of shell strongly influences the structural characteristics such as stiffness, natural frequency, and buckling. Numerical shape optimization techniques offer a unique way to find the optimal shape efficiently.
When executing the shape optimization design of a shell structure, the shape variation directions that determine the shape can be classified as in-plane variation in the tangential direction to the surface and out-of-plane variation in the normal direction to the surface. In-plane shape variation can be utilized in determining the optimal boundary shape while maintaining the surface curvature distribution of the initial shape and can be used effectively at the final design stage. On the other hand, out-of-plane shape variation can be used in determining the optimal curvature distribution of the surface. This approach displays its effectiveness in the initial stage of shape design with large degrees of design freedom. Shape variation in the out-of-plane direction in particular can drastically improve the structural characteristics.
In our previous studies, we developed a parameter-free shape optimization method for the out-of-plane shape variation, called the free-form optimization method for shells or called the H1 gradient method for shells [1]. However, the material used in the method is restricted to an isotropic one.
In this paper we present a parameter-free shape optimization method of orthotropic shells. The orthotropic material is often used as the composite material for various structures. The design problem dealt with here concerns a stiffness design problem. The compliance is minimized under a volume constraint. It is assumed that a shell is varied in the out-of -plane direction to the surface to create the optimal free-form, the angle of the orthotropic material defined in each element coordinate is not changed with respect to the shape variation and the thickness is not also changed. This shape optimization problem is formulated as a distributed-parameter shape optimization problem based on the variational method.
The shape sensitivity function, or the shape gradient function for this problem is theoretically derived by using the Lagrange multiplier method and the adjoint variable method, and by applying the material derivative formula. The derived shape gradient function is applied to the H1 gradient method for shells. In this method, the negative shape gradient function derived is applied to the shell surface as a distributed force under the Robin condition in order to vary the shape. The shape gradient function is not used directly to vary the shape but is replaced by a distributed force instead. This approach makes it possible both to reduce the objective functional and to maintain the surface smoothness or the mesh regularity, which is one of the features of the proposed method. The optimal shape variation is determined as the displacement field of a fictitious linear elastic shell structure. This method is a gradient method in the Hilbert space, where the positive definiteness of the stiffness tensor of the fictitious linear elastic shell structure is used.
Several calculated examples with this are demonstrated to show the effectiveness and practical utility. The difference of optimal shapes between the orthotropic and isotropic shell and the influences of the orthotropic angle to the optimum shape are investigated.

Reference
[1] Masatoshi Shimoda and Yang Liu, A non-parametric free-form optimization method for shell, Structural and Multidisciplinary Optimization, Structural and Multidisciplinary Optimization, Vol. 50, Issue 3 (2014), pp. 409-423.

7306 | Fiber-reinforcement of anisotropic plates by topology optimization

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Fiber-reinforcement is a popular technique when addressing strengthening and retrofitting of reinforced concrete structural elements. Ad hoc algorithms are available from the literature to design optimal layers of fiber-reinforcement for in-plane structural elements, such as beams and shear walls [1]. They are able to search for the best distribution of a given amount of unidirectional reinforcement along with its optimal orientation.
Dealing with an existing concrete slab, two different reinforcing layers can be at most applied to the element depending on the opportunity of accessing and strengthening its upper and lower sides. Technical codes suggest performing the automatic research of load paths for the design of reinforced concrete elements adopting an energy-based procedure, see the case of strut-and-tie methods [2]. Adopting anisotropic plate finite elements to mesh the slab, one can account for the effect of cracks and arrangements of steel bars, thus providing a quite accurate modeling of the existing structure to be reinforced. The contribution of each anisotropic layer of fiber-reinforcement material to the local stiffness matrix is shown to depend on a density field and an orientation field. Combining algorithms derived from topology optimization [3] along with methods for the so-called free material design [4], a mathematical problem can be formulated that searches for the best distribution and orientation of a given amount of fiber-reinforcement strips such as the global elastic energy is minimized. An ad hoc weight function is introduced to penalize the energy contributions due to any fiber-reinforcement in compression and an efficient formulation is derived to solve the minimization problem through methods of mathematical programming [5].
Some numerical examples are presented to investigate features of the computed optimal layouts, along with their possible application as preliminary design for the retrofitting of reinforced concrete slabs, or more in general, of anisotropic plates. Comparisons are finally provided with respect to conventional solutions based on plastic limit analysis.

[1] M. Bruggi, A. Taliercio, Topology optimization of the fiber-reinforcement retrofitting existing structures. International Journal of Solids and Structures, 50, 121-136, 2013.
[2] M. Bruggi, Generating strut-and-tie patterns for reinforced concrete structures using topology optimization. Computers & Structures, 87, 1483-1495, 2009.
[3] M. Bendsøe, N. Kikuchi, Generating optimal topologies in structural design using a homogenization method. Computer Methods in Applied Mechanics and Engineering, 71, 197-224, 1988.
[4] N. Pedersen, On optimal orientation of orthotropic materials. Structural Optimization, 1, 101-106, 1989.
[5] K. Svanberg, Method of moving asymptotes – a new method for structural optimization. International Journal for Numerical Methods in Engineering, 24, 359-373, 1987.

7308 | White light shearing interferometer and its application to examine residual stress of deposited thin films

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This paper is to introduce a technique which evaluates residual stresses of thin-films deposited on substrates using a white light shearing interferometer. The interferometer contains a white light source and Savart plate placed on a rotation stage. Where the Savart plate divides the wavefront reflected from the substrate into two laterally displaced ones, the interference pattern generated by the mutual interference of the divided wavefronts is modulated by an envelope function, and the curvature of the substrate is determined by examining the shifting of the darkest fringe of the pattern as the Savart plate is angularly scanned by the rotation stage. Once the curvatures of the substrate before and after thin-film deposition are sequentially determined, the Stoney

equation is utilized to calculate the film stress on the substrate. A setup for realizing the interferometer was constructed. And the concept of this technique was verified by conducting this setup to examine the residual stresses of silicon substrates having CrN thin-films deposited on them.

7311 | Diagonal shear behaviour of FRC-strengthened masonry walls built with calcareous blocks and hydraulic mortar

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Unreinforced masonry (URM) present in historical constructions of southern Italy is often made by stone blocks and poor mortars, showing a low strength against the in-plane seismic forces. The shear behaviour of masonry walls subjected to in-plane lateral forces is strongly dependent on the quality of the mortar used in the joints and on the strength of the blocks. In heritage buildings, where masonry was made by using weak materials, it is not unusual to find collapse due to sliding forces acting along the loaded diagonals of the walls, following the joints directions.
This typical vulnerability of URM walls in historical buildings can be mitigated by using strengthening techniques that result simply and quick to be applied, if compared with traditional techniques or FRP (Fiber Reinforced Polymers) epoxy-bonded sheets. Different innovative strengthening techniques are proposed and compared in the paper. They consists of different types of fibrous grids that are grouted to the wall surfaces by using cementitious or non-cementitious mortars. URM walls were built by using calcareous stone blocks and hydraulic mortar having low mechanical properties in order to simulate in-field conditions. Experimental tests were conducted on half scale masonry walls by using a shear-diagonal test set-up.
Strengthened walls were prepared by using three different fibrous systems as strengthening materials: a dry 0°/90° glass grid; a dry 0°/90° grid made with PBO (Poly p-phenylene benzobisoxazole) fibers; a preformed Glass-FRP (GFRP) grid made with AR glass fibers and vinylester matrix. A first group of walls was tested without any reinforcement and diagonal shear failure occurred at very low load levels through a sliding shear failure along the mortar joints. A second group of specimens was strengthened on both sides of the walls with a glass fiber grid immersed in a cement-based with organic additives fiber reinforced mortar having a compressive strength of fmc=25 MPa. A third group of specimens was strengthened on both sides of the walls by using a polymeric grid made with PBO fibers grouted with a fiber reinforced inorganic mortar having fmc=20 MPa. The last group of specimens was strengthened with a GFRP (Glass FRP) grid which was grouted on both sides of the walls. In this last case different mortars were used, having three different compression strengths. The first two mortars were hydraulic lime-based ones, having a compressive strength, respectively, of 8 MPa and 13 MPa. The remaining mortar was a cement-based and had a compressive strength equal to 25 MPa.
Results of the diagonal shear tests revealed the effectiveness of the strengthening systems, that contributed to increase the ultimate load and at the same have helped to establish a dissipative behaviour. This pseudo-ductility was due to diffuse cracking of the mortar that developed after the peak load. High load levels were maintained during the progress of the crack that extended well beyond the compressed strut. Once the unloading of the samples occurred, a subsequent step of load was applied, which showed a high residual strength of reinforced masonry, even up to 100% of the peak load. Conclusions will illustrate how the mechanical properties of the URM walls subjected to diagonal shear can be upgraded through the use of the tested strengthening systems.

7312 | Effects of rate-dependent interface properties to intersonic delamination propagation

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Sensitivity of curved and thick composite laminates to delamination failure becomes a challenging design concern for the aerospace industry since Interlaminar Normal Stresses are induced together with the Interlaminar Shear Stresses where the laminate is not reinforced. Delamination in these parts are unstable and it occurs catastrophically. Previous studies showed that the delamination in curved and thick laminates occurs so dynamically that the speed of delamination propagation may exceed shear wave speed of the laminate, reaching to intersonic speeds after initiation, which yields to formations of shear Mach waves in the laminate. In this study, intersonic delamination is modeled using a derived bilinear rate-dependent cohesive zone model which is aimed to provide better predictions compared to rate-independent cohesive zone models. The delamination speeds obtained with different rate-dependent fracture toughness and interfacial strengths are compared with the experiments using high-speed camera. The energy balance and dynamic phenomena such as frequencies of flexural vibrations are discussed in detail.

7316 | Modelling of damage process in two-phase ceramic composite materials under mechanical loading

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Modelling of damage process in two-phase ceramic composite materials under mechanical loading

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Two-phase ceramic composite materials (e.g. Al2O3/ZrO2) have a non-linear and complex overall response to applied loads due to: different phases, existence of an initial porosity and internal microdefects. All microdefects act as stress concentrators and locally change the state of stress, leading to the development of mesocracks and finally macrocracks. Experimental results show that defects develop mainly intergranularly and cause inhomogeneity and induced anisotropy of the solid. Modelling of such material response is possible by multiscale approach describing different phenomena occuring at different scales:
- the microscopic level is associated with the degradation phenomena developing at the single grain. Micropores inside of grain or at the grain boundaries act as a crack initiators. Microcracks spread along grain boundaries,
- the mesoscopic level corresponds to a set of grains, which create Representative Surface Element (RSE). The basic elements of the defect structure are: meso-cracks, which diameters correspond to the single straight facet of the grain boundaries structure, kinked and wing (zig-zag) cracks,
- the macroscopic level corresponds to the dimensions of the tested sample of the material. The composite is treated as a continuum with properties of the

polycrystal calculated as averaged values over of RSE.
The constitutive equations for the considered CMC are the following:

where is the compliance tensor, is the strain tensor, is the stress tensor, p is the porosity parameter and are set of parameters defining the presence of different kinds of defects “i” developing inside the material.
The model was verified by experiments under quasi-static loading. The obtained results confirm the correctness of the theoretical approach.

Keywords: 2-phase ceramic composites, damage process, theoretical modelling

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7317 | Analysis of FRP cable stayed bridge under seismic loading – Dual shaking tables test on full bridge model

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Cable-stayed types of structure are becoming more and more popular in the construction of long span bridges due to their many advantages, i.e. light in weight, efficient in load resistance, and of smaller cross sections. The cable-stayed bridge can be constructed for even longer spans, if the deck and cable stiffness and strength to weight ratios can be further improved. However, at this moment, it has almost reached its limit and is impossible to achieve longer span lengths with current technology and using conventional construction materials, steel and concrete. Composite materials have superior structural characteristics, such as high strength and stiffness to weight ratios, high resistance to corrosion and favorable fatigue characteristics. Therefore, to build longer cable-stayed bridges, the composite materials can play an important role in this type of structure. In this research, a cable stayed bridge using FRP tubes girder is redesigned based on the original Kap Shui Mun Bridge. A 1:120 scaled full bridge model is modified and tested in the dual shaking table. The dynamic performances of such as nature frequency and a bridge response under seismic excitations are investigated via white noise testing and seismic loading. From the test results, the proposed FRP girder bridge is having a higher resistance towards seismic loading, characterized by the overall lower critical acceleration response.

7319 | Study the Effect of process parameters of WEDM machining on Aluminum metal Matrix Composites

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The present paper describes the experimental investigation of the machining parameters and the effect of wire electrical discharge machine (WEDM) process parameters during machining of Al/ SiC and Al/Al4C3 particulate reinforced metal matrix composites (with 15% Reinforcement). Experiments are carried out to investigate the effects of input parameters such as Pulse on time, Pulse Off Time, Wire feed and sensitivity on performance measures like Material Removal rate and Surface roughness. Taguchi method based design of experiment and L18 mixed orthogonal array have been used for experimental investigation.
The level of significance of the machining parameter for their effect on material removal rate and surface roughness was determined by using analysis of variance (ANOVA).
Achieving higher material removal rate is the main objective of rough cutting operation. Therefore, using Taguchi grey relational analysis, parameters have been predicted for maximizing the material removal rate and minimizing the surface roughness. Through Grey relational analysis, grey relational grade has been computed as a performance index for predicting the optimal parameters setting for multiple machining characteristics. Using Analysis of Variance (ANOVA) on grey relational grade, significant parameters affecting the multiple machining characteristics has been determined. Confirmatory results prove the potential of present approach.

7320 | Influence of orientation sequence and mesh size on delamination by using cohesive elements

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The motivation of this study stems from the importance of the delamination between the layers of the composite structures in aerospace, automotive and the other industries. In our study finite element procedure is used for different stacked orientation plates with a circular hole by ABAQUS. Composite laminates are simulated to investigate their behavior subjected to quasi-static loading. Interface cohesive elements are inserted between the layers to predict the delamination and the Hashin damage model is implemented to predict the behavior of fiber reinforced-epoxy layers. The constitutive law is governed by exponential softening response after degradation. The influence of the mesh size on the delamination of laminates, especially close to the regions of the hole is determined. Also the effect of the orientation sequence on delamination phenomena, particularly between the mismatch layers is investigated and compared.

Keywords: Cohesive element; Finite element modeling; Composite laminates with holes; Delamination; Failure

7323 | Shearing effects of woven fabrics on the permeability and filling time in liquid composite moulding

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Permeability of preform is an important factor in liquid composite moulding (LCM) process simulation. This factor is dependent on fabric type, fiber volume fraction, stacking sequence of laminate and etc. In manufacturing of complex composite parts, the reinforcement undergoes deformation due to draping the preforms on the complex surface of the mold. The draping of the preforms on the complex surface leads to a shearing of the reinforcement fabric which changes the permeability. This variation of permeability significantly affects the resin flow and the filling time. In this study the local shear of fabrics with different stacking sequence is simulated in order to take the local permeability into account in filling simulation and also the effect of the fabric orientations on the local shear angle of layers is investigated. For this modeling, PAM-RTM software which is based on the Darcy‘s law and resin mass conservation is employed.

Keywords: Liquid composite moulding, Shear angle, Local permeability, Filling time

7324 | Evaluation of Nano-Modified Cementious Sensors for Corrosion Monitoring in Reinforced Concrete

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The aim of this study is the corrosion monitoring of reinforced structures by cementious sensors modified with carbon nanotubes, embedded in the concrete structures. Specifically, an attempt is made to monitor and record the electrical resistance of the sensors specimens and correlate it with the corrosion of the reinforcement.
For the experimental procedure the nanotechnology-modified cement-based sensor that was used contained 0.5% w.t. carbon nanotubes (CNTs). It was a rectangular section mortar specimen with dimensions of 20mmx60mm. Four titanium meshes were placed at 10, 20, 40 and 50mm for the left edge.
In order to be successfully used as a corrosion monitoring method into concrete structures, the sensor’s long term resistance had to be evaluated in different environmental conditions. Consequently the sensor’s resistivity was examined:
1. In water
2. In 3.5% w.t. NaCl solution
3. Embedded in cement mortar specimens and exposed to water
4. Embedded in cement mortar specimens and exposed to 3.5% w.t. NaCl solution
5. Embedded in reinforced cement mortar specimens exposed to 3.5% w.t. NaCl solution
In the last group of specimens (No. 5) stable anodic potential was applied aiming to accelerate the corrosion process.
Sensor specimens from groups 1 and 2 were immersed in water and 3.5% w.t. NaCl solution almost fully, leaving the surface in the atmospheric air. The measurements were taken in standards conditions of temperature and RH. In specific time intervals the sensor was removed from its environment, was wiped dry and its resistance was measured using an Earth Ground Tester from NORMA. The resistance measurements were performed with an alternating current of 100 Hz, to avoid electrochemical reactions in the sensor.
From the results it was shown that all measurements consist with the general theory were the resistance is decreased versus time. Additionally, the rule of resistors in series, applies.
Sensor specimens from groups 3 and 4 were embedded in cement mortars (W/C=0.5) horizontally, 50mm from lower horizontal surface of the mortar. The cement mortar specimen containing the sensor was then immersed in water or 3.5% w.t. NaCl solution for 45mm.
The resistance of the sensors was measured in specific time intervals and from the results it can be shown that the expected theoretical curve is not followed. The initial increase of the resistance is caused by the continual hydration of the specimens which were placed in the humid environment just after seven days from casting. Moreover, the rule of resistors in series is not applicable, which is due to the expansion of the electric field and the mortar.
Sensors specimens from group 5 were cast into cement mortars with B500C rebars as reinforcement and stainless steel rebars as auxiliary electrodes. Two experiments took place, applying 450mV and 800mV stable anodic potential.
The resistance of the sensors was monitored versus time. From the results it is shown that measurement’s dispersion is increased, mainly due to the creation of electric fields derived from the anodic potential. It also possible that several cracks appeared inside the mortar specimen, due to the intense corrosion, which caused a disturbance while measuring the resistance.
From all the above it can be concluded that the nano-modified sensor can be used for corrosion monitoring of the reinforcement. However, more experiments need to be conducted in order to evaluate:
• The disposition of the reinforcement (horizontal or vertical)
• The content of the nanotubes
• The usage of mortars which are maintained for 28 days

7325 | Magnetic Carbonyl Iron/Natural Rubber Composite Elastomer and Its Magnetorheology

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Magnetorheological (MR) elastomer composites, composed of magneto-responsive magnetizable particles such as carbonyl iron dispersed in an elastomer matrix, are one of the most interesting smart composite materials along with MR fluids which have drawn a lot of attentions due to their special characters of reversibly changeable rheological and physical properties depending on a magnetic field strength applied [1].
On the other hand, natural rubber (NR) has appropriate mechanical characteristics than other rubbers as an MR elastomer matrix material. Among various magnetic materials of magnetite, iron oxide and carbonyl iron (CI) particle, the CI was selected due to its high magnetic permeability and low hysteresis in this study [2]. MR elastomer composites consisting of NR and CI were cured in two different forms of isotropic and anisotropic states. In the case of the anisotropic MR elastomer sample, it was cured while an external magnetic field was being applied. Therefore the CI particles were pre-aligned in the direction of the applied magnetic field. To confirm the arrangement of the CI particles in the elastomer composite, a mapping method through scanning electron microscope was used. MR effect of these MR elastomer samples was measured using a rotational rheometer under external magnetic fields [3].

Results showed that as the magnetic field strength increases, storage moduli depending on the angular frequency are observed to be increased at a constant shear strain of 1.0%. Experimental data were further correlated based on viscoelastic models.

References
[1] B. J. Park, F. F. Fang and H. J. Choi, Soft Matter 6, 5246 (2010)
[2] F. F. Fang, H. J. Choi and Y. Seo, ACS Appl. Mater. Interf. 2, 54 (2010)
[3] I. Bica, Y. D. Liu and H. J. Choi, Colloid Polym. Sci. 290, 1115 (2012)

7326 I COMPOSITE ELASTOMERS WITH TITANIUM (IV) OXIDE

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Introduction
Ureaurethanes (PUUR) belong to this group of polymers [1] and characterized by very good usability and technological properties such as low wear, high mechanical strength, good damping properties and high resistance to aggressive water environment [2]. PUUR advantageous features are due to the application of DYDI as extender giving each merz of rigid segment a substituent in the form of strongly polar imidonitrile groups [3].
It was decided to use the properties of the materials in the application on wheel tires in the suspended mining transportation. Such wheels work in temperatures ranging between -40ºC and +50ºC, in conditions of high loads, significant dust and high humidity. Elastomer components of driving units are subjected to coplex stress fields. Staff operating the mining tractor work in conditions of high humidity and apply high loads on the device at start-up. These conditions cause rapid wear of elastomeric wheel tires or rollers. In order to ensure security of mining crews it is necessary to develop and implement an effective technological solution that guarantees the production of wheels with improved operating performance. Materials developed so far do not meet the requirements of the presented applications. It is necessary to develop a new class of materials for polyurethane matrix with high performance characteristics.
In connection with such assumptions it was found that these requirements are met by ureaurethane matrix composites with the addition of titanium (IV) oxide, from 0.05 wt.% to 0.5 wt.% . The powder have particle size about 21 nm.
The structure description of PUUR was carried out using differential scanning calorimetry (DSC). Thermal analysis was performed using thermogravimetry (TGA). Hardness (H) was determined using durometre Shore A according to ASTM D2240-75 and resilience (η) was tested by Schobe method according to PN-71/C-04255.

Results and discussion
The results of physical and mechanical properties are given in Table 1. The hardnesses (H) of the materials ranged between 82-87°Sha. After the initial addition of titanium (IV) oxide, the hardness decreased, but it then increased with the addition of more filler. The resilience (η) of the composites increased after the initial introduction of titanium (IV) oxide, but it began to decrease when a large amount of filler was added. DSC analysis was conducted for information about glass transition temperature of analysed materials. Test showed the presence the glass transition temperatures of soft segments (Tg). Temperature Tg is lowest for PUUR with 0.25% of titanium oxide and that increased.

Table 1. Physico-mechanical and thermal properties of tested PUUR

Sample	H, ºShA	η, %	T5%, ºC	Tg, ºC
PUUR	86.5	28.3	296	-31.3
P0.05%T	82.2	33.3	290	-29.5
P0.1%T	82.9	35.8	291	-30.8
P0.25%T	85.8	31.1	290	-32.4
P0.5%T	83.6	28.7	283	-29.3

Thermal stability of the produced materials was assessed based on the temperature value of 5% volume loss (T5%), shown in Table 1. PUURs with titanium (IV) oxide have lower T5% than pure PUUR.

Conclusions
The introduction of titanium (IV) oxide to ureaurethanes causes changes in chemical structure and consequently in the properties of the materials produced. This is probably because the addition of fillers changes the reaction between the reactive groups of individual substrates.

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1. I.Gruin, H.Piotrowska, J.Ryszkowska et al. Pat. Pol. nr 148671 (1986).(Method of manufacturing new polynitrileurethano-ureas and polynitrile-ureas)
2. R. Xie, H. Lakrout, G. Mueller. J. Appl. Polym. Sci., 2012, 125 (1), 584-594.
3. J. Ryszkowska, B. Waśniewski. Materials Science Forum, 2008, Vols. 587-588, 582-586.

7331 I Novel manufacturing the micro- and nano- hierarchical structures like Gecko''s feet for the adhesion system

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There are many attempts to mimic the structures of Gecko’s feet since Gecko’s feet have a good adhesion feature. Generally, Gecko’s feet consist of cilia and seta hierarchically. So many researchers made novel adhesion systems by a micro-molding method or using nanomaterials such as CNTs (carbon nanotubes) and CNFs (carbon nanofibers). However, it was very hard to manufacture the hierarchical structures like Gecko’s feet according to previous research results.
In this work, we suggested a new method to mimic the hierarchical structures of Gecko’s feet. According to the suggested method, the microstructure is fabricated with the mixture of PDMS (Polydimethylsiloxane) and CNTs, and then projections of the microstructure are etched by plasma. During plasma etching process, PDMS are removed and CNTs are exposed on the projections, and finally we can get the hierarchical structures like Gecko’s feet.

We manufactured the hierarchical structures by the suggested method with respect to the weight fractions of CNTs, dimensions of the microstructures, and the plasma etching conditions. We observed the morphologies of manufactured hierarchical structures using optical microscope and FE-SEM in order to check the dispersion and embedded shape of CNTs. Also and evaluated the adhesion characteristics and durability by the adhesion tests.
From the experimental results, we could concluded that the suggested method was very effective and efficient to fabricate the hierarchical structures like Gecko's feet and make a good adhesive system.

7338 | EXPERIMENTAL STUDY ON THE DIAPHRAGM BEHAVIOR OF TRAPEZOIDAL-PROFILED FRC COMPOSITE METAL DECKS

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This study investigates the effect of discrete fibers on the diaphragm behavior of composite metal decks constructed with trapezoidal-profile metal sheets. Eight large-scale composite deck slabs were constructed, instrumented and tested in a cantilever diaphragm configuration in the strong and weak orientation. The slabs were reinforced with three different types of secondary reinforcements: Conventional steel mesh (A142 and A98); synthetic macro fibers (dosages of 3 kg/m3 [5 lb/yd3] and 5.3 kg/m3 [9 lb/yd3]); and hooked-end steel fibers with a dosage of 15 kg/m3 [25 lb/yd3]. Load-deflection response, strain in the composite slab, interfacial bond strength degradation, and cracking pattern were measured in the test. Results revealed that the use fibers has notably improved the diaphragm strength of the slabs and enhanced their ductility. The results show that fibers increased the ultimate in-plane shear capacity for composite slabs by up to 42% relative to the unreinforced slab (control). Fibers and steel mesh were found efficient in distributing the applied load to the whole matrix, inducing multiple cracking, thereby enhancing the strength and ductility of composite slabs in diaphragm applications. Moreover, the results show that the degradation of the interfacial bond between the metal sheet and the concrete topping was not influenced by the type of the secondary reinforcement.

7340 | EVALUATION OF CARBON NANOTUBE AND CARBON FIBER REINFORCED POLYMER COMPOSITE FOR LIGHT WEIGHT AUTOMOTIVE PART

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Reducing weight and improving the mechanical properties of automotive parts have been very important because they can improve the fuel efficiency in automotive industry. Polymer composite is one of the key options to achieve light weight and high mechanical properties by mixing polymer with carbon fibers, glass fibers, carbon nanotube and so on. In our research, carbon nanotube/carbon fiber reinforced polymer composite (polypropylene and polyamide) was fabricated by an injection molding to get proper mechanical properties and low density as well as relatively low cost for mass production of automotive sunroof frame. The optimum mixing ratio of carbon nanotube was selected by evaluation of mechanical properties, and density. To evaluate the mechanical properties, tensile test and bending test were carried out. And the density was calculated with the measured weight and its geometry. The developed composite could show the feasibility of industrial usage with reduced weight and sufficient mechanical properties.

7341 | EFFECT OF FIBRE WRINKLING TO STRENGTH OF L-SHAPED COMPOSITE MATERIALS

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EFFECT OF FIBRE WRINKLING TO STRENGTH OF L-SHAPED COMPOSITE MATERIALS
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It is difficult to manufacture parts with complex shapes due to undesired defects occuring during manufacturing. For example, wrinkles, buckling of plies during lay-up of prepreg-based multilayer composites, etc. are observed in the corner section of the L-shaped parts [1]. Although these wrinkles have negative effect on the strength of the composite parts [2] they decrease the amount of the deformation after curing [3]. As it is known fact that a fibre reinforced composite part generally take a shape different from the one that is originally designed after removing from the mould at the end of the curing process although prepregs take the form of the mould during the lay-up stage.In order to quantify the influence of fibre waviness on stiffness and strength reduction of unidirectional composite materials some analytical studies have been introduced [2]. These studies included in-plane loading of composite laminates. Although previous studies identified and modelled fibre wrinkling phenomenon, effect of which on the strength of corner sections has not been attracted much attention yet.

In this study, L-Shaped parts are produced by introducing excessive fibre waviness artificially to corner sections, and the strength values of these parts are compared to parts manufactured by conventional lay-up method. In order to determine the effect of fibre wrinkling on the strength of a composite laminate two lay-up methods were used. Firstly, by using the conventional lay-up method parts with four plies thickness were produced. As it is known in the conventional lay-up method, the prepregs were laid sequentially layer by layer on the mould surface. In the second alternative method, four layers of

prepreg were first laid on a flat plate and then the whole stack is bent to conform to the surface of the L-shaped mould. This method will result in more fibre wrinkling in the inner surface of the parts as compared to conventional method. Five unidirectional samples [0]4 were produced by the conventional method and five unidirectional samples [0]4 were produced by the alternative method on both 15 mm and 25 mm radii corners of the tool. The arm and the length of the samples were 100 mm and 150 mm, respectively.In order to investigate the effect of fibre wrinkling on the strength four point bending tests were done.These laminates were then tested using four point bending apparatus mounted on tensile testing machine, in where out-of plane loading was applied. The tensile test results were compared and how much the strength was affected by wrinkling was discussed. Failure strengths of the L-shaped laminates were found by the help of acoustic emission method during tests.

REFERENCES
[1]P. Hubert and A. Poursartip, “Aspects of the Compaction of Composite Angle Laminates: An Experimental Investigation”, J Compos Mater, 35(01), 02-26 (2001).
[2]H.M. Hsiao and I.M.Daniel, “Effect of fibre waviness on stiffness and strength reduction of unidirectional composites under compressive loading”, Composite Science and Technology 56, 581-593 (1996).
[3]K. Çınar and N. Ersoy, "Effect of fiber wrinkling to the spring-in behaviour of L-shaped composite materials",submitted to Composite Part A.

7342 | Design and analysis of composite repairs in helicopter horizontal stabilizers

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Horizontal stabilizers (HS) in today’s helicopters are made of carbon based sandwich composite material. The leading edge of HS is prone to external damages such as lightning strike and hail strike impact. Hence, HS are frequently repaired due to the external damages, which considerably increase the long-time cost. This study is aimed to seek better repair concepts and has two parts. In the first part, simulation of hail strike has been carried out to estimate the damage zone on the leading edge of the HS. The hail is modeled using SPH method while the inplane damages are modeled using Hashin and delamination is modeled using bilinear cohesive zone model in ABAQUS/Explicit. Afterwards, several repair concepts are theoretically applied to repair the damaged part. The repair concepts are based on bonded solutions where alternative repair solutions are studied by modeling the repaired HS by ABAQUS/Implicit. The part is loaded by torsional and bending loads to compare and contrast the influences of repair concepts to the global stiffness and stress/traction distribution in the bonding interfaces.

7347 | Development of the biodegradable joining tool for grafting plant

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There has been increased interest in renewable resources from both the academics and industries due to worldwide concern on the shortage of non-renewable resources such as petroleum. Use of regular plastics in every sector of our life and the enormous increase of production cause huge plastic wastes that pollute the environment. Biodegradable plastics and bio-based polymer products based on annually renewable agricultural and biomass feedstock can form the basis on sustainable society. These greener products may compete and capture the markets dominated by products based on petroleum feedstock. Moreover, greener products have great concern with the applications, not only as a resolution to overcoming environmental issues but also as a neat solution to the uncertainty of petroleum supply.

The plant grafting techniques are an effective technology to overcome soil-borne diseases and pests and to add extra vigor to the plants under various environmental stress conditions and then to increase amount of harvested crop for agricultural industry. The stable and efficient plant seedling can be obtained by grafting for uniting stock and scion from one plant and attaching it to another plant. Some of the most widely practiced grafting methods are hole insertion, tongue approach, cleft grafting and tube grafting. Growing grafted vegetables was first launched in Japan and Korea in the late 1920s by grafting watermelons to gourd rootstock (Ashita, 1927; Yamakawa, 1983). Moreover, tomato grafting has been utilized worldwide in Asia and Europe for greenhouse and high tunnel production and is gaining popularity in the United States. The most common commercial technique for grafting tomato is tube grafting. Tube grafting method is also called ‘Japanese Grafting Method’. Tube grafting takes place when the scion and rootstock are severed as seedlings and reattached with a small, tube or clip. Generally, the grafting tubes for seedling are made from plastic based on petrochemicals and also it is disposable after grafted seedling. It is one of the reasons that the world consumption of plastics in agriculture amounts yearly to 6.5 million tons (Mugnozza, 2011). Furthermore, the grafting tubes are not biodegradable products, and cause the environmental pollution by the disposal.

The purpose of our research in this report is to develop the grafting tubes made from biodegradable materials. To reduce the volume of plastics waste on grafting tools after grafted seedling, we propose to replace biodegradable materials from non-degradable materials. In order to produce the biodegradable grafting tubes as alternative materials to standard non-eco-friendly tubes, tapes and clips, the polymer blend films; poly(isoprene)(PI)/ poly(ε-caprolactone)(PCL) and PI/poly(L-lactide)(PLLA), were prepared using twin screw extruder.

7348 | Optimized Honeycomb Geometry to Prevent Dimpling Failure in Composite Sandwich Structures

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Intracellular buckling, so called dimpling, is a failure mode in sandwich structures with composite face sheets and honeycomb core. Dimpling is one of the critical sizing criteria for sandwich parts under compression loading where the accuracy of the failure prediction determines the weights of the parts since the thicknesses of the skins are increased due to dimpling failure. In this study, dimpling failure is predicted by finite element modeling where the influences of composite honeycomb geometry, facesheet layups and interaction between those are studied. Firstly, experiments are conducted on several

specimens to verify in-plane and through the thickness material properties for the given honeycomb geometries. Then, detailed 3D finite element models of each of the sandwich structures are carried out. The results obtained from finite element analysis are compared with the results of empirical formulas from the literature. As a result, the proposed 3D finite element model approaches of composite sandwich structures are used to determine the optimal honeycomb geometry and face sheet layups to reduce the skin thickness where adequate strength is provided against dimpling failure and the lightest weight is achieved.

7355 | Properties of SiO2/ Al2O3 Nanoparticles Reinforced Polycarbonate

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Polycarbonate, it is polymer that is considered as a noteworthy in many industries including construction, car producing, aerospace industry, according to its unique features. Very good mechanical properties with excellent light passing have created highly desirable engineering properties of polymer. But beside these cases, it has a huge defect in front of scratching.
In this study, the effect of scratching in polycarbonate nanocomposites for transparency's maintaining were investigated. Mechanical properties, transparency and scratching of polycarbonate in the presence of SiO2 and Al2O3 nanoparticles have been examined in different percentages. Silanes have been used as a coupling agent. A twin screw extruder for mixing and ultrasonic method for modifying surfaces of nanoparticles has been used. Results showed the nanoparticles improved mechanical properties but reduces transparency.

7358 | Determination of through-the-thickness stiffness properties of non-crimp fiber composites by using Representative Volumetric Elements

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Non-crimp fiber composites (NFC) is made of layered stitched fibers in the formation of very thin layers in order to have better draping ability and through-the-thickness strength. As today's composite structures take the shape of thick and curved laminates, through-the-thickness tensile and shear modulus are important parameters in finite element modeling. In this paper, various configurations of NFC are modeled using Representative Volumetric Elements to have the through-the-thickness stiffness properties and stress concentration regions in the stitching architecture. Finally, the stiffness values are used to compared with the experiment of delamination in curved-thick composite laminates made of NFC.

7372 | Enhanced 2D lamina formulation for composite materials, simulation with a peridynamics approach

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Dynamic load conditions in aerospace applications justify the use of dynamic analysis of fracture in composites. However the dynamic failure behavior of this materials is extremely complicated: dynamic loading leads to very different fracture behavior compared to quasi-static conditions [1].
Peridynamics is a recently proposed continuum theory based on a non local approach and formulated with integral equations. The theory is suitable for dealing with crack propagation in solid materials and it has been applied mainly to dynamic analyses [2,3].
Two main peridynamic approaches have been used to study composite materials: one based on homogenized models and one based on the explicit model of fiber and matrix materials. A first example of peridynamic model used to study damage of composite materials is presented in [4,5] to analyze the damage patterns in laminated composites subjected to bi-axial loading. The original peridynamic formulation has been improved to solve the case in which the discretization grid has an arbitrary orientation relative to the fiber direction of the unidirectional lamina [6,7]. The homogenized peridynamic model has been also extended to take into account the transverse elastic module of the lamina in a 3D approach [8].
The explicit model of fiber and matrix is presented in [9] in which the author underlines that the homogenized approach is not always able to capture the splitting fracture mode. Explicit modeling of fibers has the advantage of obtaining a most detailed solution, but demands high computational cost [10].
In all 2D cases the lamina behavior is "in plane" so no bending rotation is allowed. In this paper a new peridynamic model for fiber reinforced composite lamina, using the homogenized approach, will be proposed and applied on the dynamic analysis of the progressive damage. The new model will take into account the bending stiffness in the 2D formulation extending the approach described in [11] to orthotropic material. The aim of this work is to study the evolution of the damage and the growth of a pre-existing crack in a composite lamina with different inclination of the fibers with respect to the applied external load.
Results will be evaluated taking into account different grid sizes, horizon dimension, crack initial lengths and crack orientations.

[1] S. Kazemahvazi, D. Zenkert, M. Burman, Notch and strain rate sensitivity of non-crimp fabric composites, Comp. Sci. Tech. 69, 793–800 (2009)
[2] S.A. Silling, Reformulation of elasticity theory for discontinuities and long-range forces, J. Mech. Phys. Solids, 48, 175-209 (2000)
[3] S.A. Silling et al. Peridynamic states and costitutive modeling, J. Elasticity, 88, 151-184 (2007)
[4] J. Xu, E. Askari, O. Weckner, S. A. Silling, Peridynamic analysis of impact damage in composite laminates, J. Aer. Eng. 21, 187–194 (2008)
[5] W. Hu, Y. D. Ha, F. Bobaru, Modeling dynamic fracture and damage in fiber-reinforced composites with peridynamics, Int. J. Mul. Comput. Eng. 9, 707–726 (2011)
[6] W. Hu, Y. Doh Ha, F. Bobaru, Peridynamic model for dynamic fracture in unidirectional fiber-reinforced composites, Comp. Meth. App. Mech. and Eng., vols. 217–220, 247–261 (2012)
[7] M. Ghajari, L. Iannucci, P. Curtis, A peridynamic material model for the analysis of dynamic crack propagation in orthotropic media, Comput. Meth. Appl. Mech. Eng. 276, 431–452 (2014)
[8] H. Yi-le, Y. Yin, W. Hai, Peridynamic analytical method for progressive damage in notched composite laminates, Comp. Struct. 108, 801–810 (2014)
[9] B. Kilic, A. Agwai, E. Madenci, Peridynamic theory for progressive damage prediction in center-cracked composite laminates, Compos. Struct. 90, 141–151 (2009)
[10] D. Dipasquale, M. Zaccariotto, U. Galvanetto, Crack propagation with adaptive grid refinement in 2D Peridynamics, to appear in Int Jour. of Fracture (2014).

[11] M.Taylor, D. J Steigmann, A two-dimensional peridynamic model for thin plates, Math. and Mech. Solids, Vol XX(X) 1–13 (2014)

7373 | Modeling of Mode I Delamination Growth in Composites by using Peridynamics Implemented in Abaqus

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Numerical prediction of mode I delamination growth in composites have been investigated in several studies. This paper investigates how delamination initiation and propagation in laminated composites can be simulated by implementing bond based peridynamics into a commercial finite element code ABAQUS for the first time. Peridynamics is a nonlocal theory which removes the restrictions of fracture modeling in classical continuum mechanics. To find out mode I fracture behavior of laminated materials double cantilever beam test (DCB) is utilized. Peridynamic model of DCB experiment is generated using mass and truss elements. Initial and final failure loads are compared with experimental results from the literature. The effect of stacking sequence on delamination behavior is also observed.

7374 | A CONTINUUM MODEL OF INTERFACE TO INVESTIGATE STRESS TRANSFER ON FIBER-MATRIX COMPOSITE

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Interface of fiber/matrix composite has important role for overall composite performance as load bearing structure because it has to effectively transfer stress from matrix to fiber and vice versa. Failure initiation in composite is also mainly caused by cracks at the interface. Single fiber fragmentation test (SFFT) is popular method in assessing the bonding quality because it represents actual stress transfer in real composite. Several models to describe the stress transfer on SFFT have been proposed. The resemblance of those SFFT models are in assuming perfect bonding condition which describes the interface as rigid surface. However, recent studies show that the interface is a thin layer having different mechanical properties from fiber or matrix. The layer is formed on manufacturing process of composite which strongly depends on characteristics of fiber surface. Several micro cracks at the interface might also appear due to poor manufacturing process of composite. Those studies indicate that imperfect bonding should occur regardless of how strong the bonding condition is, and there should be always a relative displacement at the interface. Therefore, the stress transfer may not be estimated accurately because the imperfect bonding can reduce bonding quality and create an ineffective stress transfer.
This study aims to investigate the effectiveness of stress transfer on SFFT. Theoretical analyses of stress transfer were developed by considering the interface having imperfect bonding. A continuum damage model of the interface was proposed by following bilinear traction-separation law. The equation of stress transfer at the interface was derived theoretically. Numerical analyses using finite element method were also conducted by developing axis-symmetric model representing SFFT. Comparison between theoretical and numerical analyses was clearly demonstrated and showed good agreement. The results were also compared with conventional model that the interface is traditionally assumed as rigid surface. It was found that the presumption of SFFT cannot be used when accurate evaluation is required because imperfect bonding causes significant effect to evaluation results. An experimental verification was also conducted in order to clarify the influence of imperfect bonding at the interface using single carbon fiber-epoxy specimen since we have proposed the evaluation of bonding quality based on stress contour in matrix. The method can possibly estimate interfacial properties defined by continuum damage model which was difficult problem in recent years.

7377 | Singular integrals in boundary element analysis for unsymmetric laminated composites

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In practical applications, to take advantage of the designable characteristics of composite laminates, it always has the possibility to design a plate with unsymmetric laminated composites. In that case, the stretching-bending coupling may occur no matter what kind of loading is applied on the laminated plates. Due to the coupling of stretching and bending deformations, the stress analysis of the unsymmetric laminated plates become much more complicate than that of the metallic plates or the symmetric laminated plates since the latter can be treated by considering only in-plane or plate bending analysis. To effectively treat the coupled stretching-bending deformation, a boundary element was developed by using the boundary integral equation derived from the reciprocal theorem of Betti and Raleigh and the fundamental solution derived from the Stroh-like complex variable formalism. Like the conventional boundary elements for two-dimensional or three-dimensional analysis, the boundary integral equation contains singular integrals whose integrands may become infinity when the field point approaches to the source point. Since the fundamental solutions embedded in the boundary element analysis for unsymmetric laminated composites are written in complex variable matrix functions, at the first glance it is not easy to see how to deal with the singular integrals. For example, the logarithmic function with real variable is only valid for the positive argument, whereas the same function with complex variable is valid for any complex number (including negative real number) and to have a unique value a suitable branch cut should be selected for the principal value of the logarithmic function. Due to the selection of the branch cut for a unique function value, discontinuity may occur at the cut region. And hence, to satisfy the continuity requirement for a continuum a special attention should be made on the numerical programming with complex function. This problem will not occur in the real form fundamental solution, but now for the coupled stretching-bending analysis it happens since its available fundamental solutions are expressed in complex form.

To deal with the complex function singular integrals, the fundamental solutions obtained for the coupled stretching-bending analysis were re-derived to make the singular integrals expressed in real function. Consider a boundary element with deflection interpolated by a third order polynomial and all the other quantities such as boundary geometry and in-plane displacements, normal slopes, and the tractions, are interpolated by a linear function. With the newly derived fundamental solutions and the selected interpolation functions, the analytical solutions for the singular integrals involved in the influence matrices and free term coefficients of the boundary element analysis for unsymmetric laminated composites are obtained in this paper. The key step for this derivation is that the combination of the re-derived complex form fundamental solutions and the proper coordinate transformation can finally lead to a real form integrand.

7380 | PROCESSING OF CELLULOSE BASED POLYMER COMPOSITES BY ADDITIVE MANUFACTURING

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In the last two decades the number of reviews and scientific papers published on cellulose research increased exponentially. This is because cellulose has been recognized as an emerging renewable material due to their fascinating physico-mechanical properties derived from its structure. In addition, irrespective of its source, cellulose is an inexhaustible source of biodegradable, low toxicity and natural raw material, which can answer to the unwearying and increasing demand of environmentally friendly, sustainable and biocompatible products from consumers, industries and governments [1-3].
The research works available provide a depth analysis and comprehensive knowledge about issues as cellulose extraction, preparation, chemical composition, treatment, morphology, properties and characterization. Furthermore, its suitability for use in very different application areas such as additives in food, reinforcing agents for use in bio-based composite material, biodegradable films and barriers for food and pharmaceutical packaging, texturing agents in cosmetics, transparent films and porous dense aerogels for electronics and medicine, for medical implants and devices and for automotive components, among others is also investigated in detail and properly reported in literature [1-6]. It is well recognized that cellulose has a great potential as a reinforcement in polymer composite materials due to the improvement of mechanical properties obtained. For this, proper interface compatibilization between polymer matrix and cellulose natural fillers is of paramount importance. Nevertheless, cellulose fibers present compatibility problems with hydrophobic matrices. In fact, due to their hydrophilicity, cellulose nanofibers are suitable for combination with hydrophilic polymers but generally incompatible with hydrophobic ones, regardless whether they are biopolymers such as poly-lactic acid (PLA), polyvinyl alcohol (PVOH), PCL, polyhydroxybutyrate (PHB) or synthetic polymers, e.g. polyethylene (PE) or polypropylene (PP) [6]. The improvement of compatibility with apolar materials requires chemical modification of nanocelluloses. Until now there is as yet no industrially practical way to produce cellulose nanocomposites based on hydrophobic polymers. However, from the point of view of industrial applications, chemical modification of fibers is usually neither convenient nor cheap. Consequently, more research targeting using environmentally-friendly and industrial practicable methods of cellulose modification is required. Another topic which requires more attention from research community is the processability of cellulose composites, in particular, in what concerns thermoplastic matrices. Thermoplastics can be processed by usual technologies such as extrusion, injection molding, sheet extrusion, blow molding, thermoforming and film forming, but if the purpose is to produce complex free form geometries, such as the ones required for medical applications using biocomposites, additive manufacturing techniques are the solution. In fact, nanocellulose composite scaffolds are promising tools for biomedical applications since they are shown to be suitable for cell adhesion/attachment, which means that they can be used for wound-dressing or tissue engineering scaffolds. Although for these specific applications fully biodegradable composites are normally used, in this work composites of carrot cellulose dispersed in PEO and PCL matrices were prepared without addition of any coupling agent. From this composite scaffolds were manufactured, using a BioExtruder. Processed and non-processed cellulose polymer composites were analyzed by DSC, TGA, FTIR and DMA in order to evaluate the influence of cellulose reinforcement in the matrices of synthetic and biodegradable polymers.
[1] M. Poletto, V. Pistor A. J. Zattera: Structural characteristics and thermal properties of native cellulose, Licensee InTech, Chapter 2, (2013), pp. 45-68.

7392 | Investigation of the vibro-acoustic behaviors of luffa bio composites and assessment of their use for practical applications

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Considering the adverse effects of petroleum-based composite materials on nature, finding and developing new materials as alternatives to these chemical materials become a necessity in practice. On the other hand, these new materials need characterization to be considered and effectively used in practical applications. The state-of-the-art of luffa bio composites is exhibited, the vibro-acoustic properties of these composites are explored and their uses in practical applications are evaluated in this study. The epoxy resin is used as a matrix to manufacture the bio luffa composite samples. Here, the elastic and damping properties (loss factors) of luffa composites are determined by comparing the experimental and theoretical modal parameters of some luffa composite plates. The acoustic absorption properties and transmission loss levels of luffa composites are explored using the impedance tube method. The interface properties of the luffa fibers and matrix are also examined using Scanning Electron Microscope. All the results are evaluated and the potential of the use of luffa composites in practical applications is evaluated.

7401 | Numerical and experimental behavior of PEEK composite materials under low impact energy

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Traumatic brain injury is responsible of death and disability. However, when the skull break due to impact without brain damage, the skull can be repaired using cranial implant. Actually, more and more part of human body can be changed due to new technologies and new materials biocompatible. Generally and during several years, the material used was titanium alloy. However, new material actually can be used as polymer with biocompatibility. One of the more used for implant design is the PEEK polymer (polyether ether ketone) However this polymer has not been strongly studied under extreme condition in term of impact velocities. Comparing Titanium and PEEK the main advantages are the volumetric density and the ductility which is more than at room temperature and increase with temperature. For this reason, it is interesting to analyze the behavior of PEEK polymer at high impact velocity in order to see if a brittle transition is observed since for high velocity the initial temperature is increasing strongly. In this work PEEK composite materials are studied to analyze his energy absorption power under high impact velocity and low energy. The dynamic properties are compared with titanium alloy frequently used for medical applications. Indeed, the polymer PEEK is with a great interest since it is biocompatible and can be sued to design implant. The energy used in this work is comparable with the energy observed for bicycle accident when the person drops on the ground. This quantity is depending on the impact velocity but also the impact location around the skull.

7405 | Carbon-fiber and glass-fiber test pieces heating during tensile fatigue tests using resonant test machine.

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It is important to know the wide mechanical properties spectrum of polymer composite mate-rials while designing structural elements of gas turbine engines. It is well known that polymer com-posites can increase the life cycle and survivability of aircraft engine at the same time decreasing its weight. However, half century of practice revealed the essential composite materials durability de-pendence on operation conditions of the structure such as temperature for example [1].

There were standard coposite polymer pieces recommended by ASTM D 3479 used for fa-tigue tests [2].
The specific of composite polymer materials fatigue tests using resonant test machines con-sists in proof samples heating because of the high loading cycle frequencies. The frequency of the loading cycle can be equal to 33...55 Hz depends of proof sample stiffness and resonant test machine characteristics.

The designed air cooling system allows to decrease proof sample temperature during fatigue tests for 15…20 ˚C and depends of high temperature zone location.

The probability of high proof sample warming up to 100…110 ˚C was observed for carbon fiber polymers owing to test piece and plate surfaces friction in adhesive layer at high loading cycle parameters Fa=22,5 kN , R=0,05.
It was found that there is no such high local warming possibility for the glass-fiber laminates brought by adhesive layer friction such as it was obtained for carbon-fiber pieces. The reason is low loading cycle parameters Fa=3,1 kN, R=0,1 used for fatigue tests considering low value of durability limit for glass-fiber material relative to the carbon-fiber. Applied air cooling system gave an option of reaching the fiber-glass test pieces temperature of 22…25 ˚C.

In accordance with test results there were geometrical configuration, polymer composite proof samples type and cooling system parameters recommendations developed for unacceptable test pieces heating prevention during tension-tension fatigue tests using resonant test machines.

References:
1. Tarek H Almusallam, Yousef A Al-Salloum, Saleh H Alsayed, Sherif El-Gamal and Mo-hammed Aqel, Tensile properties degradation of glass fiber-reinforced polymer bars em-bedded in concrete under severe laboratory and field environmental conditions, Journal of Composite Materials 2013 47: 393 , 2012.
http://jcm.sagepub.com/content/47/4/393
2. Standart Test Method for Tension-Tension Fatigue of Polymer Matrix Composite Materials D 3479, ASTM International, PA 1942802950, United States, 2007.

7408 | Evaluation and validation of modal strain energy and complex eigenvalue methods for modelling damped composite structures

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Evaluation and validation of modal strain energy and complex eigenvalue methods for modelling damped composite structures

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Structures subjected to resonant vibrations are frequently treated with damping materials in practice for vibration and/or noise reduction purposes. However, the theoretical models developed for structures with damping treatment are usually not accurate enough, mainly due to the difficulties in the formulation and characterization of dynamic properties of damping materials. In this paper, two different finite element approaches for modelling damped structures are evaluated and validated. Firstly, the damping materials are characterized using the Oberst beam method. Here, the most appropriate signal processing parameters including the frequency resolution and modal analysis method, such as half-power, circle-fit and line-fit are determined for the extraction of modal parameters using the measured frequency response functions. Then, a few undamped and damped composite structures including simple beams and more complex L-plates are modelled. Here, the conventional finite element approach based on modal strain energy method and a finite element formulation with damping capability based on complex eigenvalue method are used for the estimation of modal properties of the composite structures. The effect of element type is also investigated. Experimental modal analyses are also carried out for the same undamped and damped structures in order to validate the theoretical models.
Keywords: Composite structures; damping materials; finite element; modal strain energy method; complex eigenvalue method.

7409 | Comparison of numerical results of a 3-D model accounting for mode I and II delamination with experiments

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Fibre reinforced composites are an integral part of many lightweight constructions such as planes, cars, sporting goods and aerospace applications. One of the most crucial failure mechanisms is delamination, the separation of the individual layers of the composite material. Due to the complex stress states in real structures the occurring delamination is mixed mode in nature. Therefore, a proper description and validation of the mode-dependent, non-linear interface behaviour is necessary.
In this work, a full 3-D continuum-based material model is used to model the finite thickness interface between the layers of the composite. Various onset and failure criteria as well as softening curves are implemented into a commercial finite element code. These models account for mixed mode I and II delamination. Experiments with fibre reinforced composite materials are carried out for various mode ratios according to ASTM D 6671. A digital image correlation system (Aramis) is used to obtain the local strain field and crack propagation. Thus, the local strain fields as well as the global load-deflection curves can be compared.

7418 | An enhanced multi-scale technique for the study of reinforced composites with damage

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The interest for the design of innovative composite materials, characterized by outstanding constitutive properties, calls for developing advanced numerical tools to describe their structural behavior.
Among others, particulate-reinforced materials are extensively adopted for different engineering applications. The resulting material properties of such composites are tailored by varying the material, the shape and the volume fraction of particles dispersed into ceramic, polymer or metal matrices.
These materials exhibit a constitutive response strongly influenced by the onset and the evolution of irreversible phenomena that can take place both into the matrix (damage and plasticity) and the particles and at the interfaces between them (damage) [1]. Moreover, the overall response is apparently dependent on the characteristic size of the particles.
On the basis of these considerations, the aim of this work is to propose an enhanced FE² multi-scale approach to study the 2D nonlinear constitutive response of particulate-reinforced composite materials of different types. The heterogeneous material is modeled at two scales and different continuum models are considered: a Cosserat continuum at the macro-scale and a standard Cauchy continuum at the micro-scale [2,3].
The Cosserat continuum is endowed with an intrinsic length scale that naturally accounts for the size of the particles modeled at the lower level and exhibits regularization properties in case of strain softening behavior.
At the microscopic level, the nonlinear behavior is modeled adopting a nonlocal constitutive model characterized by damage and plasticity.
The description of the damage and plasticity evolution results from the fully coupling between the two scales exchanging information in real time. The features of the parallel computing are exploited to hold the computational costs down.
Different numerical tests are presented considering axial and bending tests on composites containing various size particles and material parameters. The micromechanical response is compared to the homogenized multi-scale response. By comparing the results with the response obtained using a standard first order homogenization (adopting a Cauchy continuum at both levels) the superiority of the Cosserat continuum in capturing size effects clearly emerges.

References
[1] Tohgo, K., Itoh, Y., Shimamura, Y., A constitutive model of particulate-reinforced composites taking account of particle size effects and damage evolution, Composites: Part A, 41, 313-321 (2010).
[2] De Bellis, M.L., Addessi, D., A Cosserat based multiscale model for masonry structure", Int. J. Multiscale Comput. Engn., 9 (5), 543-563 (2011).
[3] Addessi, D., De Bellis, M.L., Sacco, E., Micromechanical analysis of heterogeneous materials subjected to overall Cosserat strains, Mech. Res. Commun., 54, 27-34 (2013).

7429 | Novel hybrid nanocomposites as protective and strengthening agents of lithic substrates

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The last decades, natural and anthropogenic factors are responsible for the increased weathering of architectural structures.The intensive weathering od monumental architecture in urban cities, implies the utilization of effective consolidants and protective agents in the conservation field. In an attempt to improve the characteristics of nanomaterials used as weathering resistance agents for building materials, two innovative nanocomposites were synthesized. More specifically, this work deals with the development of a mesoporous consolidant (SilHAp) and a water repellent with self-cleaning properties material (STPS).
SilHAp nanocomposite based on the modification of tetraethoxysilane (TEOS) through the incorporation of hydroxyapatite particles (HAp) into the silica matrix. HAp in association with calcium oxalate and silica layers encountered on monuments as patina. Recently, HAp has been studied as a consolidant, improving the weathering resistance of the lithic substrates. The combination of the advantages of the HAp particles along with the low viscosity of ethyl silicates led to the design of the SilHAp nanocomposites. A colloidal solution of nano-HAp incorporated with TEOS via the sol–gel process. Firstly, the aqueous solutions of calcium hydroxide and phosphoric acid were reacted, producing HAp particles. These precursors have the ability to promote the hydrolysis/condensation process of TEOS, while no by-products are formed during their reaction process. TEOS and stabilized HAP particles in iso-propanol were mixed in the presence of a small quantity of distilled water which undergoes the hydrolysis process. Furthermore, amylamine was added to the mixture ensuring the formation of a uniform matrix and reducing the surface tension during the drying process.
The water repellent and self-cleaning STP was synthesized with the modification of the silicate matrix by the incorporation both of synthesized nano TiO2 particles and an organosilane hydroxyl-terminated polythimethylsiloxane (PDMS) in the presence of oxalic acid. The design of the synthesis based on the development of an innovative and low energetic demanded synthesis for producing photoactive SiO2-crystalline-TiO2 nanocomposite at ambient temperature. Hydrophobic properties of the STP were achieved due to the addition of PDMS siloxane into the SiO2 matrix. The choice of oxalic acid was based on its multiple functions articulated in the: (a) catalysis of TTIP and TEOS hydrolyses, (b) enhancement of the photocatalytic activity due to its ability to function as a hole-scavenger, (c) contribution on the formation of anatase TiO2 crystals at ambient temperature through a peptization process and (e) promotion the simultaneous transition of the TEOS and TTIP.
The synthesized HAP nanoparticles and the SilHAp/STP nanocomposites were characterized by using various analytical techniques such as: XRD, FTIR, BET, SEM and TEM. The physical-microstructural characterization of the SilHAp nanocomposite revealed a mesoporous material with low viscosity, which penetrates deeply into pores of the stone. It exhibits enhanced resistance to cracking during drying while its chemical compatibility with carbonate

substrates provides corrosion resistance. The observed properties indicate similar characteristics with patinas, a layer which has been detected on the surfaces of several well-preserved Mediterranean monuments. The nanostructure of the synthesized STP revealed the formation of independent anatase TiO2 crystals inside the silica matrix, thus proving its photocatalitic ability. The designed nanocomposite meets the requirements as self-cleaning and water protective agent of building materials. The designed consolidant and the water repellent nanocomposite can be simultaneously applied to lithic substrates without modifying the physico-chemical characteristics of the latter, improving their mechanical properties and preventing them from further decay.

7430 | Development of polymeric nanocomposites graphene derivative to packing

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In recent years, needing to replace degradation resistant plastics has stimulated research to develop materials that can serve as conventional polymers during storage and use and then be transformed into non-toxic and non-polluting products, when exposed to the environment [1]. With the increased awareness of environmental problems, the production of "green materials" derived from natural resources has received increasing attention from academic and industrial viewpoints [2]. In the present study, biodegradable polymeric (BP) nanocomposites containing a graphene derivative (BP/GD) were obtained by solvent casting method, by varying the amount of GD added to the polymer matrix, as shown in Figure 1, and the morphology, dispersion, crystalline structure, thermal stability, optical and mechanical properties were investigated. All the thin films were characterized by UV-visible spectroscopy (UV-vis), X-ray diffraction (XRD), thermogravimetry analysis (TGA), field emission scanning electron microscopy (FEGSEM) and hydrophobicity of the films was determined by sessile drop deposited on the sample surfaces, contact angle measurement. The results showed that the incorporation of GD into BP improved optical properties. The transparency of BP/GD thin films slightly increased as function of GD amount. As the optical transmittance of all BP-GD thin films in visible region (550 nm) is still in the range of 53 – 61% compared to 30-40 % for the neat BP thin film. The XRD patterns of BP/GD thin films, no diffraction peaks of GD were observed except the crystalline diffraction peaks of BP matrix, indicating that the incorporation of GD does not significantly affect the crystal structure of polymeric matrix. Also, the absence of the diffraction peaks of GD at $2\theta = 11.1^{o}$, could be attributed to full exfoliation of GD within the BP matrix. The addition of GD into the BP thin films did not change the thermal stability of the polymeric matrix, however, it did decrease the hydrophilic character of thin films, caused by presence of GD distributed the BP matrix and the thin films surface. Figure 2 shows the FEGSEM images of top surfaces of pure BP and BP/GD thin films. The rough regions are attributed to the GD sheets. The homogeneous dispersion of GD was observed on top the surface polymeric matrix. It was observed that for low amounts of GD the presence of non-interconnected pores. Furthermore, it is clear that the BP/GD thin films have a rough top surface, due to the embedding of GD in the BP matrix. Typical stress-strain behaviors for the BP/GD thin films with varying GD loadings were investigated. The tensile strength and Young's modulus of BP are enhanced over 60% and 70%, respectively, with the incorporation of GD 1.0 wt%. Further increasing the GD loading, the tensile strength and Young's modulus increased gradually, however, the tensile elongation is decreased continuously, probably because GD can act as physical cross-linking points in the matrix and restrict the movement or mobility of BP chains thus resulting in the brittleness of the films. The improvement in mechanical properties of films could be attributed to the intrinsic properties of GD, strong interaction and adhesion between GD and the BP matrix as well as uniform dispersion. These thin films can be considered interesting materials in different applications such as food packing and drugs delivery.

Figure 1. Photographs of polymeric films: (A) BP, (B-D with an increase of BP-GD ratio.

Figure 2. FEGSEM images of (A) BP, (B-D) with an increase of BP-GD ratio thin films top surfaces.

[1] A. Soroudi, I. Jakubowicz. Recycling of bioplastics, their blends and biocomposites: A review. European Polymer Journal 2013, 49, 2839–2858.
[2] A. Sorrentino, G. Gorrasi, V. Vittoria. Potentilal perspectives of bionanocomposites for food packaging applications. Trends in Food Science & Technology 2007, 18, 84–95.
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7434 | Preparation of Epoxy Nanocomposite Incorporated with Silane Treated Nanosilica for End Plate of PEMFC

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Polymer electrolyte membrane fuel cell (PEMFC) has been expected as most promising power sources for residential and mobile application due to its attractive features such as high power density, relatively low operating temperature, convenient fuel supply, long life time, etc. Therefore many researchers and companies have investigated to develop new materials or to improve the existing materials for the parts of electrolyte membrane, gas diffusion layer (GDL), catalyst, bipolar plate, electrodes, etc. at lower price with higher performance.
In this study, epoxy/nanosilica nanocomposite was prepared by incorporating silane treated nanosilica into an epoxy resin in order to use for end plate in a PEMFC. Firstly the surface of a nanosilica was treated by an amine-type silane coupling agent and thermal and mechanical properties such as glass transition temperature (Tg), dynamic mechanical analysis (DMA), tensile and flexural strength were studied. Surface treatment was as follows: Silane coupling agent (3 g) was solved in toluene (180 g) using a homogenizer, and very few amount of deionized water (DIW) (0.3 g) was poured into the solution and vigorously mixed using the homogenizer until water droplet was transparently disappeared in the toluene solution. The DIW was previously controlled to pH = 4.5 using acetic acid. The silane coupling agent was hydrolysed forming three silanol groups and the silanol group reacted with each other making polysiloxane chains. And then nano-sized silica was mixed in the solution and the silane coupling reaction took place at 85oC for 24 hr. The surface-treated nano silica was washed and dried and it was stored at a desiccator.
To study mechanical and thermal properties, epoxy/microsilica (60 wt%)/nanosilica (2 wt%) were cured at 150 oC for 3 hr. The mechanical and thermal results were estimated by comparing scale and shape parameters in Weibull statistical analysis. It was found that the properties of conventional epoxy/microsilica composite were improved by addition of nanosilica and it was due to the increment of the compaction via the even dispersion of the nanosilica among the microsilica particles.

7444 | Effect of Organifier Elimination on Mechanical Properties of an Epoxy/Organoclay Nanocomposite Prepared by

Using an Electromagnetic Field Dispersion Method

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Multilayered silicates have been used as nanofiller in an epoxy nanocomposite and the most well-known one is montmorillonite. The driving force to separate the multilayered silicates each other is given by epoxy resin and curing agent through the interlayers of the silicate monolayers. This result leads to the intercalated or exfoliated nonocomposites. However, it is very difficult for the polymer chains to penetrate into the hydrophilic interlayers. Therefore, it should render the interlayers organophilic by means of cation exchange with alkyl ammonium ions. However there is another problem. That is, ion part of the organifier has bad effect on the electrical properties, because the ion part in the well dispersed organifier would be acted as a passage for electrons so that electrical properties of the nanocomposite decreased. Therefore the organifier should be eliminated from polymer matrix after exfoliation step.
In this study, organifer-elimination method was reported after the exfoliation step in an epoxy/organoclay nanocomposite using electromagnetic field dispersion method. Epoxy base resin (diglycidyl ether of bisphenol A, DGEBA, 100 g) and Cloisite 10A (organoclay, 1.5 g) were well-mixed with high-speed agitator for 30 min and then they were put into an electromagnetic apparatus. In the initial state, the organfiers were positioned in the intergallery among silicate monolayers and after the exfoliation step, the organifers were exposed from the intergallery to the surface of the silicate monolayers. To remove the revealed organifiers, ethyl alcohol (150 mL) was poured into the DGEBA/ogranoclay nanocomposite and ultrasonic wave was treated in order to disconnect the weak ionic bonding between aluminium anion and ammonium cation. And then it was leaved until ethyl alcohol phase and epoxy/organoclay nanocomposite phase were separated, and the latter phase was positioned in a vacuum oven to remove ethyl alcohol. The former ethyl alcohol phase was used in order to analyse the organifier.

7451 | Investigating the transitional state between circular plates and shallow spherical shells

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The stiffness of circular plates can be increased by inducing a rise at the center of these plates; this rise converts the circular plates from two-dimensional stiffness elements into three-dimensional stiffness elements. This slight change in the geometry shifts the state of stresses from mainly bending stresses to tensile-compressive stresses. The rise at the center of a circular plate is increased gradually to the point where a shell element is formed. This paper focuses on this particular transition between the plate elements to the shell element which is called the transitional rise. Several finite element models were used to identify the transitional rise given fixed parameters. Stresses and deflections are also studied for each case. An optimized approach was used to minimize the cost and improve the serviceability of the structural elements. Parametric study is also conducted using several loading cases.

7458 | Development and characterization of biocompatible magnetic nanoparticles based on magnetite (Fe3O4) and ferrite (Fe2O4) and its application in the treatment by hyperthermia.

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Composites of magnetic nanoparticles in a polymeric matrix are of great interest for both fundamental research and emerging applications, due to their capacity to respond to external magnetic or electromagnetic field. In the biomedical field, magnetite (Fe3O4) and ferrite (Fe2O4) have shown promise as tumors therapeutic agent using hyperthermia treatments. However, preparing suitable solubilized magnetic nanoparticles is challenging, primarily due to aggregation and poor biocompatibility. Thus for use with biological purposes, methods for coating Fe3O4 nanoparticles with biocompatible stabilizers are required. Algal polysaccharides such as agar are used extensively as gel-forming agents, thickeners, and stabilizers due to their low cost and high degree of biocompatibility and biodegradability. Therefore, in this study, Gelidium robustum agar has been chosen as a natural biocompatible polymer to build the matrix of cobalt ferrite (CoFe2O4) and magnetite (Fe3O4) nanoparticles, which were synthesized by the co-precipitation method in agar gel. After that, agar gels were then dried and ground into powder, yielding agar-conjugated Fe3O4 and CoFe2O4 nanoparticles. The samples were characterized by X-ray diffraction, and scanning electron microscopy (SEM). The nanoparticles were identified as cobalt ferrite (CoFe2O4) and magnetite (Fe3O4) and had a well-defined crystalline structure with sizes in the range of 5-7 nm. The potential of these nanoparticles as hyperthermia agents in different phantoms is also explored.

7459 | Free vibration of rotating composite beams

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Abstract
In this study, free vibration of laminated composite beams are studied using Ritz method. Simple polynomials are used as displacement field components. Clamped-free boundary conditions are considered. Different shear deformation theories and classical beam theories are used in the formulation. Parametric results are obtained for different rotation speed, hub radius, orthotropy ratio, length to thickness ratio. Cross-ply lamination confugurations are considered for the numerical results. Effect of continuity of the transverse shear stresses among the layers are also considered. It is obtained that dimensionless frequency parameter of rotating composite beam increases with increasing the rotation speed, the orthotropy ratio, length to thickness ratio and hub radius to length ratio. However the results obtained for continuous shear deformation theory are sligthly lower then discontinous theory.

7460 | The Physical Behavior and Repetitive Freeze-Thaw Resistance of Polymer Modified Mortars

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The uses of polymers for various structural applications are gaining popularity throughout the World. Physical and mechanical properties of concrete are very important for life of structure. As well as, it is known that the mechanical properties of concrete fall when concrete is exposed to repetitive freeze-thaw effects. The freeze-thaw resistance of the concrete and the physical properties of the concrete may be significantly improved by incorporation of different types of polymers.
In this study, it is aimed to increase physical and mechanical properties of cement mortars by means of polymer addition. In addition to, freeze-thaw resistance of cement mortars is observed depend on polymer addition ratios. In this study, Stiren Butadien Rubber (SBR), Stiren Butadien ve modifiye polikarboksilat emülsiyonu (PSBR), Modified Acrylic Dispersion (MAD) polymers are chosen as polymers. Firstly, three different types of polymers are added to cement mortars in five different ratios (0.0%, 5%, 10%, 15%, 20%) and cured watering twice a day for 28 days. Then, physical properties of mortars are observed. Secondly, the samples which cured watering twice a day for 28 days, exposed three different freeze-thaw cycles (0, 100, 200). It is observed the flexural strength, compressive strength and deflection under this condition.
It is concluded that each polymer contributes physical properties of mortars. All polymer additions contribute to physical properties. Especially, permeability of mortars dramatically decreases about 90% thanks to polymer addition. The mortars modified with SBR polymer show the best performance for the highest freeze-thaw cycle (200).

7461 | Combined use of digital image correlation and multi-scale stochastic model for the characterization of tensile behavior of textile reinforced concrete

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The multiple-crack initiation and propagation in textile reinforced concrete (TRC) components under uniaxial tension leads to strain hardening behavior. The quality of the bond interface between the matrix and textile fabrics is one of the key factors that influence the global response of the component. In this paper, the method for characterization of the tensile response of TRC capturing the interaction between the matrix cracking and local bond interface behavior is presented. In the proposed method, numerical modeling approach is combined with advanced experimental technique, such that the tensile response of TRC specimens can be reproduced in terms of elementary damage mechanisms occurring in the heterogeneous material structure.

More specifically, the behavior of a tested specimen is recorded using CCD camera and then processed by digital image correlation technique (ARAMIS). The obtained results are used for automated detection of crack initiations in the tested zone of the specimen during the loading. The data describing the history of cracking including the quantitative characteristics (positions and crack widths) serves as an input for the numerical simulation of the fragmentation process using a multi-scale stochastic cracking model. The micro-scale effects occurring during the debonding process in the vicinity of a crack are described using the representative crack bridge model. As a result, the crack bridge properties can be calibrated in the configuration relevant for behavior of structural components. Validation of the model has been performed by comparing the model prediction with test results obtained for specimens with modified reinforcement ratio.

Keywords
Textile Reinforced Concrete; Strain Hardening; Digital Image Correlation Techniques; Multi-scale Modelling, Stochastic Cracking Model, Single-Fiber-Fragmentation-Test

7462 | TORSINAL WAVE PROPAGATION IN MULTIWALLED CARBON NANOTUBES USING NONLOCAL ELASTICITY

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Summary. In this study, torsional wave propagation in multi-walled carbon nanotubes has been studied. Nonlocal elasticity theory is used in the formulation. The effect of van der Waals interaction coefficient is considered between nanotubes. Dispersion relations are obtained and discussed in detail. van der Waals interaction between adjacent tubes has not been considered in the previous studies.

7463 | FORCED VIBRATION OF NANORODS USING NONLOCAL ELASTICITY

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Summary. The longitudinal forced vibration of nanorods studied using nonlocal elasticity theory. The nonlocal constitutive equations of Eringen are employed in the formulation of the problem. Uniform and linearly varying axial loads are considered. Dynamic displacements are obtained for nanorods with different geometrical properties, boundary condirions and nonlocal parameters. The nonlocal effects increase dynamical displacement and frequency when compared with local elasticity theory.The present results can be used in the continuum modeling of axial nanomotors and nanoelectromechanical systems.

7470 | The Physical and Mechanical Behavior of Polymer Modified Mortars under High Temperature

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Concrete are subjected to acid, sulfate attack, high temperature, cold conditions etc. during its service life. Thus, durability is very important phenomena for concrete and it has still studied by a lot of researchers. One of the application of enhancing durability of concrete is polymer modified concrete/mortar applications.
In this study, it is aimed to improve physical properties and increase high temperature resistance of cement mortars by means of modification of various polymer materials. Firstly, three different types of polymers are added to cement mortars in five different ratios (0.0%, 5%, 10%, 15%, 20%) and it is determined physical properties of mortars. After it is aimed to developed mechanical properties of modified mortars under high temperature. In this study, Stiren Butadien Rubber (SBR), Polycarboxylate-Stiren Butadien Rubber (PSBR) and Solution of Polyurethane (PU) polymers are chosen as polymers. The samples which cured watering twice a day for 28 days, and determined water absorption, depth of penetration of water under pressure and specific mass. Besides, they exposed four different temperatures (21 °C (control), 100 °C, 200 °C, 250 °C) and it is observed the flexural strength, compressive strength and deflection under this condition.
It is concluded that each polymer contributes the mechanical and physical properties of mortars for each temperature. PSBR modified mortars shows the best performance in physical properties. When PSBR is used, depth of penetration of water under pressure and water absorption of mortars, decrease (90%) and (66%), respectively according to control sample. The mortars modified with SBR polymer show the best performance for the highest temperature (250 °C). For the highest temperature, the flexural strengths of the samples increase (42%), deflections increase (15%) and compressive strength increase (21%) according to control sample.

7474 | Porosity and temperature dependence of Young's moduli of mullite-alumina composite ceramics prepared by starch consolidation casting

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Mullite-alumina composite ceramics, in the context of refractories called "high-alumina ceramics", are important materials for high-temperature structural applications such as furnace linings. Due to their high alumina content in the form of free corundum and low glass-phase content the refractoriness of these materials is high and their high-temperature properties and performance are usually much better than for fireclay refractories. While dense materials are required for corrosive environments, e.g. inner layers of composite furnace linings, porous materials have a lower thermal conductivity and are therefore more suitable from the viewpoint of thermal insulation, e.g. in the outer layers of composite furnace linings. In both cases, of course, the use of these materials in the construction of high-temperature aggregates requires adequate mechanical properties. This work deals with the preparation of mullite-alumina composite fine ceramics that may be considered as realistic model materials for coarse-grained high-alumina refractories. Porosity is intentionally introduced into these ceramics using potato and corn starch as pore formers. The size of raw materials is characterized via laser diffraction (Fritsch Analysette 22 NanoTec) and different sample series are prepared with (alumina:mullite) mass ratios of 90:10, 80:20 and 70:30 and starch contents of 15, 30 and 45 vol.% (related to solids) by casting of 75–80 wt.% aqueous suspensions into nonporous brass molds (bars of dimensions 7 x 15 x 80 mm). After firing at 1570 °C (heating rate 2 °C/min, dwell time at maximum temperature 2 h) mullite-alumina composite ceramics are obtained with total porosities in the range 29–55 %, depending on the type and amount of starch used. The starch is eliminated without residues during firing. Young's moduli at room temperature were measured by impulse excitation (IMCE RDFA) using flexural vibrations (measured Young's moduli in the range 29–144 GPa). For the three types of ceramics prepared, Young's moduli of the solid phases are calculated using the micromechanical bounds and their porosity dependence predicted using the Voigt bounds, Hashin-Shtrikman upper bounds, power-law relation and exponential relation. It is found that the lowest of these curves, the exponential relation, provides the most realistic prediction for the materials prepared in this work. Finally, for selected samples, the temperature dependence of Young's moduli has been measured by high-temperature impulse excitation (IMCE RFDA HT 1600) in the temperature range from room temperature up to 1400 °C. Based on the knowledge of composition and porosity and using previously determined master curves for the temperature dependence of these two end members the measured values are again compared with theoretical predictions (applying micromechanical bounds for the composition dependence and the exponential prediction for the porosity dependence). With respect to the many sources of error sources the agreement of predicted and measured temperature dependence is satisfactory. An interesting and unexpected finding is the slight increase and peaking of Young's moduli in the temperature range 900–1150 °C, which has been confirmed several times and is discussed in some detail for samples with (alumina:mullite) ratios of 70:30.

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7475 | Elastic properties of porous kaolin-based mullite-reinforced ceramic composite materials

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Kaolin is a fundamental raw material for preparing silicate ceramics and refractories, while mullite is often the most important crystalline phase in these materials. During heat treatment, the kaolinite dehydroxylates, forms metakaolinite and transforms via an amorphous phase and a defective spinel-like phase into mullite and amorphous silica, which usually remains in the microstructure as a high-silica glass. When extra mullite is added, it is usually expected that the mechanical properties are significantly changed, because mullite needles are supposed to act in silicate ceramics and refractories as a fiber reinforcement. In this work we show that at least for the elastic properties this expectation is not fulfilled. We report the elastic properties of kaolin-based mullite-containing ceramic composite materials prepared by uniaxial pressing with (kaolin/mullite) mass ratios of 80:20, 70:30 and 60:40. Both disks and bars have been prepared, using microcrystalline cellulose as a pressing agent and pore former (for the disks in the range 0–50 wt.%, for the bars fixed at 10 wt.%). Disks have been fired at 1550 °C using a standard firing schedule (heating rate 2 °C/min, dwell time 2 h), while bars have been fired at

three different temperatures (1250, 1400, 1550 °C). The resulting multiphase ceramic materials are composites with a glassy binder phase and two crystalline phases, mullite and alumina, the latter being a residual impurity from the raw mullite (unreacted part of the mullite synthesis). Surprisingly, however, the (mullite/alumina) ratio in the final microstructure is not changed significantly when the (kaolin/mullite) ratio is changed in the raw materials mixture (it remains constant at approx. 90 % mullite and 10 % alumina). Of course, an integral part of the microstructure of these materials is porosity. Based on the measured bulk densities and the calculated true density (3.16 g/cm3), the total porosities of these materials can be estimated. They are in the range 29–66 %. With respect to the relatively constant composition of the solid phase, and estimating the glass phase content to approx. 10 ± 5 % with Young's modulus of 75 ± 10 GPa, the Young's modulus value of the dense multiphase solid can by estimated using the Voigt and Reuss bounds. The arithmetic mean of these two (Voigt-Reuss-Hill average) is 204 GPa, which is only slightly lower than the value predicted for polycrystalline mullite (225 GPa). When Young's moduli, measured via impulse excitation, are plotted against estimated total porosity values, it is found that all Young's moduli exhibit a decrease with increasing porosity, as expected. However, unexpectedly, the correlation between Young's moduli and porosities is extremely similar for all compositions. From all these findings it must be concluded that the extra addition of mullite into kaolin-based raw material mixtures inhibits the crystallization of mullite originating from the kaolinite, so that the glass phase remains relatively alumina-rich. Comparing the measured Young's moduli with theoretical predictions (Voigt bound, upper Hashin-Shtrikman bound, power-law relation and exponential relation) it is found that the measured values are best described by the exponential relation. Moreover, for disk-shaped samples it has been possible to determine the Poisson ratio. It is found that the latter is around 0.195 ± 0.017 (again without any significant differences between samples of different composition) and remains essentially unchanged by porosity. Based on this finding, also the bulk and shear moduli can be calculated and compared to the aforementioned theoretical predictions. Also in this case it could be confirmed that the exponential relation provides the most realistic prediction.
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7477 | EFFECT OF CELLULOSE NANOCRYSTALS ON MORPHOLOGY AND DIAMETER OF CHITOSAN ELECTROSPUN NANOFIBERS

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Electrospinning is a technique used to produce polymeric nanofibers which have attracted great interest in the biomedical field because their features (high surface area and high porosity) are interesting, for example, for the construction of scaffold for tissue engineering. Chitosan nanofibers have been widely used in this area because they are biocompatible, biodegradable and non-toxic. However, despite of the great potential of chitosan nanofibers for this application, they exhibit unsatisfactory mechanical properties. The aim of this work was to study the process of electrospinning of chitosan/cellulose nanocrystals (CNCs) to produce nanofiber reinforced. Methods: Production of CNCs: acid hydrolysis of microcrystalline cellulose (sulfuric acid 64% (w/v), 45ºC, 1h 30 min). Electrospinning conditions: Electric field: 4kV/cm, Feeding rate: 0,2 mL/h. Results: The CNCs were obtained with a good dispersion and reduced dimensions ~ 5 ± 3 nm diameter and ~ 330 ± 140 nm length. In order to enhance the fibers properties it was used PEO in the chitosan solutions. The addition of PEO in chitosan solutions (without CNCs) favored the fibers formation due to the lower viscosity that allow the electrospinning of more concentrated solutions. However the fibers were formed with drops as demonstrated by SEM measurments. Only the PEO solutions containing PEO and CNCs resulted in uniform fibers. The chitosan/PEO solutions with CNCs presented a higher conductivity in relation to the solutions without CNCs. A higher conductivity favors the fiber formation because produces a larger stretch of the jet. However, the difference between the conductivity of the solutions without CNCs and with 5% CNCs was little. Therefore, the fiber formation may have been also favored by other mechanism. One of parameters that avoid the break of the jet during the electrospinning is the entanglements of polymer chains. Therefore, the interaction between CNCs and polymeric chains could avoid the break of the jet favoring the fiber formation. The solution containing 10% CNCs produced a higher percentage of thin fibers compared to the solution with 5% CNCs, what can be related with the larger solution conductivity that cause larger stretch of the jet. Conclusions: Chitosan nanofibers reinforced with cellulose nanocrystals were successfully produced by the electrospinning technique with the addition of PEO (20%). The CNCs had an effect on the uniformity and average diameter of the nanofibers.

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7479 | SYNTHESIS AND CHARACTERIZATION OF POLY (3-HYDROXYBUTYRATE-CO-3-HYDROXYVALERATE)/TANNIN COMPOSITES

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The aim of this study was the development of biodegradable composites of natural polymer, with potential to substitute some of the conventional plastics by natural macromolecules, contributing thus the binomial production versus environmental preservation. The tannin is a biomacromolecule that are available in great amount in the tropical countries like Brazil. The other component of the blends, the copolymer of poly (3-hydroxybutyrate-co-3-hydroxyvalerate) or PHBV, is a natural biomolecule, thermoplastic, biodegradable and biocompatible. It was selected a 50:50% (w/w) mixture, since previously this ratio was also studied previously in our research group, for the blend of lignin of sugar cane bagasse with PHBV, in the Haake apparatus [1]. The mechanical properties measured showed good resistance characteristics. The blends were processed in the double screw extruders and injected for obtaining the samples for the test assays. The biodegradation of these blends by the soil fungi and bacteria was also studied. The characterizations of (50:50%) (w/w), tannin/PHBV blend were carried out by: Fourier Transform Infrared (FT-IR), Differential Scanning Calorimetry (DSC), Dynamic Mechanical Analysis (DMA), Scanning Microscopy Electronic (SEM), Elementary Analysis (CHN), Spectroscopy of Fluorescence, Fluorescence of ray-X and Proton Nuclear Magnetic Resonance (NMR -1H). SEM micrographs of the isolated materials and of the blend, showing significant differences. The mechanical properties were also studied. The maximum force (kgf), maximum tensile stress (MPa), elongation at break (%), Young´s modulus (MPa) and tensile stress break (MPa) were for tannin 40.2, 9.2, 0.12, 7716, and 9.1, respectively. On contrary, PHVB alone exhibited values such as 122, 0.8, 5045 and 26.4, respectively. Although PHVB exhibited better mechanical behavior than the PHVB/tannin composite in all the parameters, tannin composites appears feasible since in the substitution of 50% of the PHVB the parameters were still appears near to those of PHVB and showing a good chance for

technical uses. The biodegradation of the PHVB/tannin composite was around of 10% (through CO2 measurements) when PHVB alone was 30%. These results are indicative that the proportion of tannin in the composite could be studied at lower tannin loading.
References.

1) F.A. Camargo, L.H. Innocentini-Mei A.P. Lemes, S.G. Moraes, N. Durán. Processing and Characterization of Poly(3-hydroxybutyrate-co-hydroxyvalerate) and Sugar Cane Bagasse Lignin Blends.. J. Compos. Mat. 46, 417–425 (2012).

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7487 | An alternative strategy for offshore flexible pipes Finite Element Analysis

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Flexible pipes are herein referred as complex structures composed by several polymeric tubes and metallic helical layers, mounted in a concentric arrangement. As a well known and proven concept in the offshore oil and gas industry, flexible pipes have been used as flow lines and risers to conveying fluid from the wellhead, at the sea floor, to the floating production unities. Created circa forty years ago, to operate in relatively shallow waters, such a concept has evolved substantially, aiming at matching increasing mechanical requirements to deal with more and more severe dynamic loads, which came into play with production in deep, very deep and ultra deep waters, as those encountered in the Brazilian pre-salt area or in the Gulf of Mexico. Likewise, the accompanying technological challenges and the always increasing computing power stimulated structural modeling to evolve from consistent analytical-numerical approaches to full nonlinear finite element analysis ones, where material properties and geometric nonlinearities must be taken into account properly.

Certainly, one of the most challenging aspects is to find an efficient way to model interfacial contacts, particularly those related to the helical armor wires and the surrounding layers. The present paper brings a strategy to cope with this task, by using the concept of an equivalent pipe to represent tensile wire layers. Such an equivalent pipe is taken as composed by two distinct materials, disposed in helical arrangements, representing wires and voids. The strategy reduces the number of contact interaction calculations, and speeds numerical convergence up, thus increasing computational efficiency. Limitations will be addressed as well. Examples and case studies, regarding axial-torsional-bending loads, will be presented.

7490 | In situ polymerization of polyolefin (nano)composites using sepiolite as support of metallocene co-catalyst

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A study concerning the use of sepiolite (fibrillar clay) as support of the co-catalyst (methylaluminoxane, MAO) for a process of in situ polymerization was performed. The formation of an ether bond on the clay surface was necessary to achieve the heterogenization of MAO over sepiolite's surface. In this sense, the experimental variables used during the process of grafting of MAO onto sepiolite's surface were studied. Therefore, it was demonstrated that the structure of modified clay and the structure of grafted MAO were kept because they were able to form the active species for polymerization in presence of catalyst and monomer.
In order to assess the effectiveness of this anchor process, a small group of polymerization test was performed. Four different (nano)composites based on polyethylene were synthesized with modified sepiolite. The presence of clay in the polymerization medium, in either case, increases the nanocomposite fusion temperature and the chain's length and is able to narrow molecular weight distributions leading to significant improvements of mechanical properties such as elongation at break (%εb) and Young's modulus.
It is important to highlight that the improvements on properties of synthesized polymers with this supported catalyst are dependent on the type of treatment applied. If small amounts of anchored MAO are used, low reaction productivities are obtained. This fact is due to the few active sites available for polymerization. As a consequence, the molecular weight increasing and monodispersity are exacerbated, thus, the chains lose the ability to crystallize and finally major losses in mechanical performance are obtained.
These preliminary data have demonstrated the importance of the study of the variables that influence the process of chemical anchoring of MAO onto sepiolite surface for nanocomposite polymerization processes. Furthermore, this procedure may be easily transferred to conventional polymerization processes for obtaining polymers in which the chains are synthesized onto the surface of the filler, maximizing the interaction of matrix–nanofiller and leading to (nano)composites with better performance than the ones obtained by melt intercalation.
A more advanced study is presented by our research group in the WO2013-167764A1 patent.

7503 | Properties of Roller Compacted Concrete with Bituminous Recycled Aggregates

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For economic and environmental reasons, concrete road recycling aggregates coming from bituminous road pavements is increasingly investigated. In some countries like Algeria, a huge quantity of this type of waste is produced every year but rarely recycled. This paper examines the possibility of using bituminous recycled aggregates(BRA) as coarse and fine in a Roller Compacted Concrete (RCC). The natural and recycled aggregates are characterized and compared. The mechanical properties and durability performances of RCC with BRA are analysed.The experimental results showed that it is possible to manufacture roller compacted concrete with a maximum of 50% of bituminous recycled aggregates.

7505 | Rheology of self-compacting concrete reinforced with steel fiber: Effect of fiber volume fraction

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Self-compacting concrete (SCC) is a highly-workable concrete that fills the form work under its own weight (without any vibration or impact), it also passes easily through small spaces between reinforcement bars. The inclusion of fiber in such concrete limits the concrete shrinkage cracks at early age and enhances some of its properties; however fibers may affect the flowability characteristics of SCC. In this paper, three fiber lengths (35, 40 and 50mm ±2mm) with six different steel fiber volume fractions (0.3%, 0.5%, 0.8%,1%,1.2% and 1.4%) were considered to evaluate the effect of steel fibers on rheological properties, compressive strength, flexure strength and elasticity modulus of SCC specimens.
Rheological properties were determined through slump flow time and diameter, L-box, and V-funnel flow time tests. Mechanical characteristics were obtained through compressive strength with cubic specimens (100x100x100 mm), flexure strength tests with prismatic specimens (70x70x280 mm) and elasticity modulus tests were performed by using cylindrical specimens (160x300 mm).
The results revealed that the workability of SCC is reduced by increasing the steel fiber volume fraction. The use of high fiber lengths led to decrease other rheological characteristics specified by EFNARC.

7506 | Influence of coarse bituminous recycled aggregates on the properties of ordinary concrete

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Following the repair of roads, millions of tons of waste asphalt concrete will appear in the environment and therefore it is necessary to think to valorize this type of waste. In this context, this work is part of a large environmental project in Algeria and aims to contribute to the valorization of this type of waste (coarse aggregate) in concrete. Five mixtures were made with different percentages of substitutions (0, 25, 50, 75, 100%). The fresh (workability, density and entrained air) and hardened (compressive strength, tensile strength, modulus of elasticity) properties of different concretes produced are tested and compared. The results show that the recycled concrete containing only coarse recycled bituminous aggregates, has a acceptable behaviour over time.

7522 | Preliminary theoretical study on shear lag effect of the PC box girder bridge with a constant depth and corrugated steel webs

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The prestressed concrete (PC) box girder bridge with corrugated steel webs is a promising steel-concrete composite structure. It has been constructed worldwide. Since 1970s there has been much research about the mechanical behaviors of this kind of bridges. However, the study on shear lag effect of the PC box girder bridge with corrugated steel webs is seldom found, and there also has been no relating guideline in the design standards or codes for the design purpose by now. In this paper, based on the energy variational principle, the theoretical solution of the PC box girder with corrugated steel webs with a constant depth is derived, with the assumptions that the flange longitudinal displacement expressed as a three-order polynomial function and the strain energy of the corrugated steel webs equals to zero. The shear lag coefficient at a certain cross section is then calculated based on the theoretical solution. Finally, the comparative study on the shear lag effect between the simply supported corrugated steel web bridge and the corresponding concrete web bridge is carried out when the uniformly distributed loads and concentrated loads are respectively applied. The results show that the shear lag effect in the corrugated steel web girder is more obvious than that in the concrete web girder.

7523 | THE RECYCLING AND REINFORCEMENT OF POLYSTYRENE WASTES USING CELLULOSE

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Plastics find application in almost all aspects of modern society but their wastes and environmental management remain a challenge. In particular, the efficient recycling of mixed plastic wastes has been identified as the major challenge for the plastic recycling sector due to the wide variety of type, properties and characteristics of the mentioned products. New and environmentally friendly processes should be designed in order to achieve the recycling of mixed plastic wastes [1, 2].
However, the challenge of recycling mixed plastic wastes could be very advantageous if they are used as a potential source of polymer materials. Thus, polymer blends showing improved properties could be obtained through new processes. In this work, Polystyrene (PS) is the selected plastic because high amount of wastes are produced yearly and they occupy huge volume.
Recently, the interest in using natural fibres as reinforcement in plastics has increased significantly. Moreover, the advantages of such fibres over man-made fibres include low density, low cost, recyclability, and biodegradability [3]. Particularly, cellulose is a natural polymer generally mixed with plastics as part of labels which can be considered as a reinforcement source.
Following the Green chemistry principles, CO2 has been proposed to blend Polystyrene and Cellulose using Limonene as solvent in order to obtain a foamed product with improved properties. Dissolution with terpenic solvents is presented as an efficient and cheap alternative that is developed at room

temperature to carry out the blending process [4]. Supercritical carbon dioxide (scCO2) (critical point Tc= 31ºC, Pc=73.8 bar) is widely used in the context of green chemistry, mainly for polymer synthesis and purification, but also as a porogen agent to produce porous polymeric materials. Thanks to the versatility of the technique, polymers can be foamed not only as plain materials but also in the form of blends or as composites with the addition of inorganic particles [5]. The effect of pressure, temperature, concentration and Polystyrene/cellulose ratio has been studied on the characteristics of the blend in order to improve the characteristics of the Polystyrene.

References
[1] A. Carné Sánchez, S.R. Collinson, The selective recycling of mixed plastic waste of polylactic acid and polyethylene terephthalate by control of process conditions, European Polymer Journal, 47 (2011) 1970-1976.
[2] C. Gutiérrez, M.T. García, I. Gracia, A. De Lucas, J.F. Rodríguez, The selective dissolution technique as initial step for polystyrene recycling, Waste and Biomass Valorization, 4 (2013) 29-36.
[3] Y.F. Shih, J.X. Cai, C.S. Kuan, C.F. Hsieh, Plant fibers and wasted fiber/epoxy green composites, Composites Part B: Engineering, 43 (2012) 2817-2821.
[4] C. Gutiérrez, M. García, I. Gracia, A. Lucas, J. Rodríguez, The Selective Dissolution Technique as Initial Step for Polystyrene Recycling, Waste and Biomass Valorization, (2012) 1-8.
[5] C. Gualandi, L.J. White, L. Chen, R.A. Gross, K.M. Shakesheff, S.M. Howdle, M. Scandola, Scaffold for tissue engineering fabricated by non-isothermal supercritical carbon dioxide foaming of a highly crystalline polyester, Acta Biomaterialia, 6 (2010) 130-136.

7524 | Predictions of the strength of bonded connections in space opto-mechanical domain

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In the spatial and opto-mechanical domains, bonding is already very often preferred to other solutions of connections. Its applications in these domains have really a promising future on account of the numerous advantages of the bonding (large field of products, great adaptability, relative easiness of the realisation, reduced fixation sizes, high strength performances, very limited mass,…) and, last but not least, two majors advantages,
. soft interface created between metallic parts and brittle optical ones,
. rather easy management of induced stresses and deflections

In the case of cryogenic optics, the bonded connections are subjected to quite stringent conditions:
. temperature excursions from roughly +60°C down to –170 °C for the structural fixations and down to # –290° C for bonding of thermal control components,…..for the time being!
. at least some tens of thermal cycles on ground, then several years of storage in ambient humidity and finally launch and several years in cryogenic conditions,
. several tens of vibrations runs at maximal load level, i.e. under some tens of g.

Materials used for the various spatial optics include from metallic ones (not often) to the complete field of ceramics, without forgetting composite materials (CFRP and carbon/carbon); the most usual materials are ceramic ones (SiC, CeSiC, Si3N4 and all the grades of glasses).

The strength of bonded connections is a phenomenon rather complex involving numerous parameters relative to the adhesive, to the adhesion surfaces and to the assembled materials. It remains difficult to predict their performances with accuracy, leading often to rather long and iterative studies and tests.

With composite materials and above all with ceramics, the weak component is often no more the adhesive, but the adherent material itself. Ceramics and mainly Glasses, brittle and sensitive to static fatigue phenomenon, make mandatory a very good knowledge of the behaviour and of the particular rules of design and of sizing of such materials too.

The adhesive keeps nevertheless an essential role with these brittle materials as deeply involved:
. in the very local mechanical and thermal-elastic over-stresses which lead first to the partial degradations then to complete failure,
. in the thermal-elastic deflections induced in the optic during the cool-down, with allowable deformations limited to some nano-or even pico-meters ! A very good knowledge of the behaviour of the adhesive remains thus quite important in the whole temperature range.

Often faced to needs for advanced bonded connections, THALES ALENIA SPACE has developed a methodology to characterise adhesives and adherents and efficient tools to predict with a good accuracy the strength of bondings:
discrepancy ≤ 15 % on 55 different bondings with

. 3 different adhesives and 4 main types of connections
. 7 couples of metallic, ceramics and CFRP / GFRP materials,
. a very large set of bonding lengths (1 to 40) and adherents thicknesses (1 to 32),
. a very large range of rupture loads (1 to # 100)
. at room and at very cold temperatures including complex loading cases

That allows :
. an optimization from the beginning of the design : the optimized definition is achieved directly by analysis and not by successive tests
. and thus significant savings in cost, schedule, performances and reliability.

A survey of the application scope is given through the validation panel and in particular by three examples of bonded assemblies subjected to large temperature excursions.

7525 | A Simple and Reliable method for the Strength prediction of the CFRP UD Pieces

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The reliable prediction of the failure of the CFRP pieces is a domain which still calls for academic and industrial improvements, even for the pieces made with unidirectionnal plies. The usual industrial methods are simple, conservative but very often with scatters between Predictions vs Tests rather important. This limits drastically the confidence in the predictions and leads to numerous elementary or sub-assembly tests. That is why national and international great studies, syntheses or research ones, with numerous teams, appeared in the last years whereas some large studies are still in progress.

Among the numerous proposed methods, the most efficient seem to be the ones based on the progressive damage of the plies. Some very detailed works gave very good results. These methods have nevertheless some drawbacks: they are not easily handled (for analytical brain storming phases or by non acute experts) and they are not always implemented in usual FEM codes. But the main drawback is really that they require the characterisation and the watch of numerous additional material data, values derived from extensive additional material testing. That asks for particular and very brittle samples inducing a poor reliability and increasing significantly the cost of the characterisation and above all of the following-up of the materials scattering along the years.

Taking benefit of a large data base and of a survey of some detailed works, it was attempted to derive a simplified method with the following guidelines:
. for pieces subjected to plane stresses (e.g. sandwiches extensively used in space projects)
. compatible with fast sensitivity comparisons for the optimisation of the stackings as well as for the final detailed strength evaluation
. to demand for meshing refinement compatible with industrial time and cost constraints
. to limit clearly the additional characterisation tests and the supplementary material intrinsic values to evaluate (mean value and scatter) and to follow along the batch deliveries
. to improve significantly the reliability vs. usual industrial methods.

The preliminary conclusions of the presented work are :
. a quite good correlation between the predictions and the test results, close to the best but more intricate, expensive and more difficult to manage methods :

an average correlation Prediction vs Tests equal to 0.97

on 60 different stackings of 5 various materials in Tension, Compression, bi-axial loadings, at room and extreme Temperatures between [- 110° and + 150° C],
. an important mass saving in the most of the cases with a minimum of 15%, whatever the plies stacking and the materials,
. but the strength benefit is particular interesting when predicting the strength in case of stress concentrations, i.e. the most critical case of the most of the pieces : increase of the predicted rupture of at least 60 % vs usual methods,
. the cost of the elementary and sub-assembly tests can be drastically reduced thanks to the achieved reliability.

7554 | EFFECT OF SILICA FUMES AND POLYPROPYLENE FIBERS IN CONCRETE

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The experimental study is aimed to determine the effect of adding silica fumes and polypropylene fibers upon the behavior and strength of concrete. Silica Fume, a byproduct of the smelting process in the silicon and ferrosilicon industry, if utilized in construction will serve as an alternative to disposal and will decrease its hazardous effect on the environment. Polypropylene fibers are thermoplastic polymer which improves the durability of concrete and also gives enhanced strength. They are also used widely for making fire resistant concrete. The experimental study also help in establishing an inter-relationship between silica fumes and polypropylene fibers and also determine the optimum percentage of both silica fumes and polypropylene fibers that would give good compressive and tensile strength. A total of 12 mixes, 228 Samples (108 cubes, 108 prisms, and 12 cylinders) are being casted.The main variables taken into consideration for the mixes were the percentages of silica fume varied along with the percentage of Polypropylene Fibers. Its effect on the behavior of concrete will be determined through compression, flexural and Modulus of Elasticity tests. Testing the samples after 7, 28, and 56 days curing periods it was found that higher percentages of silica fume significantly increases the compressive strength, flexural strength and modulus of elasticity of concrete while polypropylene fibers increased the compressive and flexural strengths till 0.1% addition while any further addition causes reduction in both values. It also has minimal effect in determining the modulus of elasticity. Polypropylene Fibers also reduce the width of cracks and prevent the concrete from failing abruptly and breaking apart.

7562 | GYPSUM COMPOSITES FOR IMPROVING PASSIVE ENERGY STORAGE IN BUILDINGS

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The regulation of the energy performance of building is a key point to achieve the energy and climate aims of most of the European countries, these objectives are defined by the European Directive 2012/27/UE [1], which emphasized the need to increase energy efficiency in the Union to achieve the objective of saving 20% of the Union´s primary energy consumption by 2020 compared to projections. According to the EU directive 2010/31/UE [2], buildings account for 40 % of total energy consumption in the Union. The sector is expanding, which is bound to increase its energy consumption.
The use of the solar energy could reduce the energy demand in the residential sector but this energy is intermittent and its exploitation requires the development of proper technologies to storage it. An alternative can be the use of microencapsulated phase change materials (PCMs) which are able to store the solar energy and further release it. In this work, lightweight gypsum composites were synthesized by adding different kinds of microcapsules containing PCMs in order to develop building materials with a high thermal energy store (TES) capacity useful for being applied in high comfort constructive systems.

In this work, lightweight gypsum composites were synthesized by adding different kinds of microcapsules containing PCMs in order to develop building materials with a high TES capacity useful for being applied in high comfort constructive systems. The two kinds of microcapsules were microcapsules synthesized by Spray Drying (SD), with low density polyethylene (LDPE) and ethylvinylacetate (EVA) as shell and microcapsules synthesized by suspension polymerization (PS), with polystyrene (PSt) as shell. Both microcapsules contain the paraffin wax Rubitherm®RT27 as core material. Llightweight gypsum composites were developed containing mass ratios of thermoregulating microcapsules/hemihydrate (MC) and water/hemihydrate (R) ranged between 0 to 0.55 and 0.57 to 0.9, respectively. The effect of changing the water and microcapsules contents on physical, thermal and mechanical gypsum properties such as density, porosity, thermal stability, thermal conductivity (k), heat capacity (cp), the accumulated heat power (qacc) and the maximum compressive strength were studied.

Results showed that the higher the microcapsules content, the lower the density, compressive strength and flexural strength. Nevertheless, all the developed materials satisfied the mechanical European regulation EN 13279-2 which limits the mechanical resistance of gypsum composites for building construction to 2 MPa for compressive strength, 1 MPa for flexural strength, and 0.6 g/cm3 for density.
In the thermal characterization was found that the higher MC, the lower the slope of the temperature profiles when the temperature reaches the region in which the PCM starts to melt. Besides, the addition of microcapsules improves the TES capacity and allows to achieve a lower constant temperature on the external surface of the samples with a 0.7 mass ratio of water/hemyhidrate.
Through Scanning Electron Microscopy (SEM) is also observed that microcapsules can be located on the needle gypsum occupying the pores and hence, changing its capillary porosity.

Conclusions
- The higher the microcapsule content, the lower the density and k and the higher the cp and qacc, due to the thermoregulating action of the PCM.
- It was possible to produce lightweight gypsum containing a mass ratio microcapsules/hemihydrates of 0.55 and 0.45 for PS and SD, respectively.
- All developed materials exhibited a homogeneous distribution of the microcapsules.
- A TES capacity of 45.44 J/g was reached for the lightweight gypsum composite having a MC mass ratio of 0.55 and its application can reduce the energy consumption and thus the CO2 emissions to the atmosphere.

7566 | Mechanical Properties of Aluminium Matrix Composites (AMCs) Produced by Additive Manufacturing

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Aluminum alloys are currently produced by the additive manufacturing technique known as Selective Laser Melting (SLM), in particular with compositions suitable for casting. The microstructure of these alloys is peculiar, since the very fast cooling occurring after the melting induced by laser provides an ultra-fine microstructure and this effect is responsible for the significant increase of the mechanical properties that is observed with respect to conventional casting processes. Moreover, as a powder based process, SLM also provides great opportunity to consolidate second or multiple material particles with metal powders to form novel metal matrix composites (MMCs). In order to be used inside a powder bed system, discontinuous ceramic particles are generally used.
In the present study, aluminium matrix composites (AMCs) were fabricated through SLM. The aluminum alloy is an AlSiMg alloy, containing 10% Si and 0.3% Mg. This alloy has a high fluidity of the liquid phase that makes easier the preparation of pore-free samples. Different reinforcing phases were used: in particular nanometric MgAl2O4 and TiB2 powders. In order to prepare the starting materials, aluminum alloy powders were mixed with the ceramic phase using a ball milling system. Nano-sized ceramics were chosen in order to avoid problems and inhomogeneity during the building of the samples, and in order to take advantage of the unique mechanical and physical properties at the nanoscale even employing a little quantity of reinforcements. The composites obtained were firstly characterized regarding density and porosity, since the first concern with SLM is the optimization of the parameters needed to obtain a dense material. In a second time, they were subjected to different mechanical tests to evaluate their micro-hardness, Young's modulus, tensile and Charpy impact strengths.

7568 | Failure Analysis of Advanced Composites under Impact by Cohesive Zone Method

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The objective of this study is to investigate the delamination damage of laminated composites subjected to low velocity impact. A three-dimensional finite element analysis is conducted to determine delamination area, shape and location. The impact analysis is performed by using an explicit finite element method which utilizes a central difference rule for the integration of the equations of motion through time. The composite structures are modeled using eight-node solid elements. The critical interfaces between layers are represented by special interface elements based on Cohesive Zone Method (CZM). A combined approach considering damage initiation and damage growth phases in a single model is utilized in this method. A stress based failure criterion and damage mechanics approach are used to simulate initiation and propagation of delamination, respectively. The model is validated by experimental results from literature. An good agreement is obtained for the results of the current analysis and experimental data from literature.

7570 | Mechanical and Thermal Characterization of Jute Fiber Reinforced Polypropylene Composite: Effect of Acacia Catechu as Crosslinker

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The severe environmental restriction for using pollution-creating materials has turned the researcher community to develop a material which will be eco-friendly. The natural fiber based composites are coming forward to solve this problem. Natural fiber-reinforced polymer composites materials are cost-effective, environmentally friendly, light-weight and also durable are being considered for diversified applications, such as furniture, building materials, automotive industry and many more. But the polar nature of natural fibers makes them incompatible with non-polar olefinic polymer matrices. In this regards, the main research of natural fiber-reinforced polymer composites is to provide a suitable compatibilizer or coupling agent between the reinforcement and the polymer matrices. In this concern, jute fiber based polyolefene (polypropylene) composite with a natural coupling agent, Acacia Catechu (AC) (local name is khoir) was fabricated by compression molding. Mechanical properties for example tensile strength, bending strength, charpy and fall in impacts of the resulting composite were studied. Bending strength of the treated composite was found to increase compared to the untreated sample but there was no notable change in tensile strength. Furthermore, treated fiber exhibited better thermal stability than that of untreated fiber. On the other hand fall in impact strength values were not found to increase. Among the concentrations, 0.5% acacia catechu treated fiber based composites showed the best performances. The loading of AC was found to increase with increase of soaking time as well as increase of concentration.

7578 | Static and dynamic analysis of beam with uncertain material properties

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Abstract
In this study, static and dynamic analysis of beams with uncertain material properties are studied. Young modulus and density of the beam is assumed as uncertain. A perturbation solution is applied in order to see the effect of deviation from mean material properties on bending, buckling and vibration of the beam. Linstedt-Poincare perturbation technique is used in the formulation of the perturbation method.

7579 | Static Analysis of Changing Cross Section Thin Walled Composite Beams

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At this study a finite element software will be developed to analyse static response of changing cross section thin walled composite beams. Software will read beam geometry from a STL file and will slice beam into cross-sections. For each cross-section software will calculate stiffness matrix with thin walled composite beam theory. Every stiffness matrix will be different due to cross section change. With displacement based finite element method these stiffness matrices will be embedded into element stiffness matrices of 7-DOF beam elements. So every cross section will be represented with a 7-DOF beam element. Boundary conditions and loading will be applied from element nodes. Results will be compared with previous studies and other finite element softwares.

Thanks for your attention

7581 | Elasticity Analysis for Bending of Sandwich Beam with Composite Metal Foam Core

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Nowadays sandwich structures have become more popular in many industrial fields such as aerospace, naval, automotive etc. Sandwich structures are defined as a thick core layer between two thin layers which are fairly tough. Material of the face layer may be isotropic, composite or laminated composite. Main functions of the face layers are to keep the structure together and transfer the load to the core. The materials for the core of sandwich can be chosen such as wood, honeycomb or cellular metals. Metal foams are known to combine the low density with high strength. Due to the unique properties such as uninflammability, sound, vibration, electricity and thermal insulation, low weight and relatively low price metal foams are very attractive for the core material.
In the bending of sandwich beam, the bending load is carried by face layers while the transverse shear loads are carried mainly by the core. There are many paper in the literature on analysis of the bending of sandwich structures. Classical lamination theory and various shear deformation theories are applied for analysis of sandwich beams. In this study elasticity bending analysis of sandwich beam is investigated. The relation between density of metal foam core and deflection is studied.

7582 | Mechanical characterization of chestnut husk spines - A previous study

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Introduction
The use of natural fibres as reinforcement in polymeric matrix composites is gaining popularity sustained not only by a logical search of more ecological alternatives to the conventional fibres in the development of renewable products but also by economic reasons. Although the conventional glass and other synthetic fibre-reinforced plastics possess high specific strength, their fields of application are limited because of their inherent higher cost of production and their lack of recycling possibilities.
The use of natural fibres from autochthones plants without commercial value for “green” composites production should be enhanced once the higher value-in-use may mean increasing the content of a local material (a natural fibre) in the local production of a part (a composite) for the assembly of an otherwise international product (a car part, as example) (Wallenberger and Weston, 2004).
This work’s objective is to provide one first approach to mechanical characterization of chestnut husk spines natural fibres in order of its future usage in

the production of natural fibre reinforced composites.
Procedure
Fibres to be tested have been extracted from year chestnut husks using a cutting tool and naturally dried. Characterization passed by previous tests performed in “traditional” form, using calibrated weights in order to obtain previous values for fibre strength. The obtained values oscillated between sustained weights of 17,5 N as minimum until 19,8 N as maximum leading to a range of yield strengths between 23 and 54 MPa. These were considered promising results for natural fibres and gave the moto to evolve to further tests.
First attempts to perform standard tests over chestnut husk spine fibres was made by gluing them using cyanoacrylate over metal plates or by manufacturing epoxy anchorages to fit tensile test machine grips. Both methods failed due to spine slippage from the anchorages. With previous knowledge that natural fibre characterization is a hard task due to the fibre specificities I was needed to develop special devices to allow them to be essayed according the ASTM D2343 standards.
Results obtained following the standard showed as being coherent with the previous obtained results
Conclusions
From the extracted data in yield strength tests over chestnut husk spines it can be concluded that those represent a promising complimentary choice to other natural fibres in natural fibre reinforced composites manufacturing whose application can extend from decorative plates until specific appliances with medium strength. Also, usually local non-valuable resources are explored as an alternative sub product.

7595 | A three dimensional inelastic damage model for fiber reinforced laminates

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Damage evolution and plastic evolution for polymer matrix composite laminates is presented. The both evolution models are defined using Continuum Damage Mechanics coupled with Classical Thermodynamics theory. The model is able to represents the unrecoverable deformations as well as state of damage under the multi-axial three dimensional loading conditions. Coupling between the rates of damage variables for unidirectional and cross ply laminates is stated in clear fashion. Most of the material parameters are calculated from the simple uni-axial and shear tests. The model capability is demonstrated by comparing the numerical simulations results of a bar under uni-axial loading condition with the available test data.

7614 | Photoluminescence study of In2Se3 compounds thin films on SLG substrates

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This work examines the photoluminescence (PL) β-In2Se3 polycrystalline thin films prepared using Physical Vapor Deposition (PVD) technique on optical properties. Relationships between both surface morphology and substrate temperature (from ambient to 300 °C) are systematically studied by using scanning electron microscopy (SEM) and spectrophotometer. Then, X-ray diffraction (XRD) is used to determine the crystallinity of the grains in these polycrystalline films.
The photoluminescence (PL) β-In2Se3 thin films, as a function of the composition is studied. A green luminescence because of the transition between vacancy of Sulphur defect level (VS) and vacancy of Indium (VIn) defect level and a red luminescence because of the transition between interstitial Indium defect level (Ini) and Oxygen replacing Sulphur (OS) defect level was identified in this cmpound. Temperature dependent PL studies were used to calculate the thermal activation energy of Ini, VIn and OS. We have found two Gaussian components, peaked at 2.124 and 2.153 eV. The full width at half maximum (FWHM) of the PL peak at 2.153 eV is 6 meV, indicating good crystal quality for the β-In2Se3 From the excitation energy and temperature dependent PL studies it was observed that the VIn and Ini defect levels controlled the conduction mechanism under illumination. The broad luminescence makes this material an ideal material for optoelectronic devices like second generation solar cells, photodetectors and luminescent down converters.

7624 | Interlaminar toughening of fibre reinforced epoxy laminates by polycaprolactone electrospun nanofibres

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Delamination and brittle matrix fracture has since long been a problem of fibre reinforced composites. This paper investigates if polycaprolactone (PCL) nanofibre nonwovens can increase the interlaminar fracture toughness of resin transfer moulded glass fibre/epoxy laminates, without causing problems during impregnation and without negatively affecting other (mechanical) properties. The mode I fracture toughness was shown to be dependent on both the nanofibre content as well as on how the nanofibres were introduced into the laminates. Almost 100% improvement in fracture toughness could be achieved by electrospinning the PCL nanofibres on both sides of the glass fibre mats prior to impregnation. This led to a mode I fracture toughness of over 1200 J/m2. Tensile and dynamic mechanical properties of the toughened laminates were not affected by the PCL nanofibres. It could be concluded that even state of the art infusion resins with a high intrinsic fracture toughness can benefit significantly from nanofibre toughening.

7631 | Multi-scale modelling the effect of stress and strain on mass transport in polycrystalline composite media

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Polycrystalline composite media manufactured using electrodeposited technique are tough, ductile, strong and have good wear and corrosion resistance in many environment, but impurity mass atom (i.e hydrogen, sulfur etc..) pickup during electrodepositing is a major source of premature catastrophic failure and embrittlement in polycrystalline composite media [1,2]. Determination of mass transport and diffusivities are prerequisites for the investigation of catastrophic failure and embrittlement. The nature of residual stress and strain in polycrystalline composite media plays a key role in the transport and diffusivity of mass. In the present work, multi-scale modelling the effect of stress and strain-dependent mass diffusion in polycrystalline composite media

has been investigated. Multi-scale microstructural finite element model have been developed by reconstructing the electron backscattering diffraction (EBSD) data collected from polycrystalline composite media. The numerical simulations of permeation test using multi-scale microstructural finite element method have been conducted in Abaqus. Finally, the effects of stress and strain on mass diffusion using permeation test simulation have been validated and then discussed.

7640 | FLAME RETARDANTS NANOCOMPOSITES-SYNERGY EFFECT OF COMBINATION CONVENTIONAL ANTYPIRENES WITH NANOFILLERS ON THE LEVEL FLAMMABILITY OF THERMOSET RESINS

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The consumption of thermoset resins as a building polymers is approximately over one million tone word wide. The thermoset resins are proven construction materials for the technical and highly demanding applications of the transportation, electrical and building part industry. Heat stability, high thermal , low shrinkage, excellent mechanical properties are typical for their type of polymers. Above applications in addition to the mechanical properties also requires a good flame retardants of the materials.
This paper present the evaluation was made of effectiveness of flame retardancy of halogen-free flame retardants(FR) as nitric compounds that act with polyphosphorus melamine and modified nano—sized agents (organomodified montmorillonite, expandable graphite, nanosilica) in relation to unsaturated polyester resins, epoxy resins and glass-reinforced on base this resins laminates as a final products.
The flame retardancy and thermal stabilization of modified polymers has been investigated by Oxygen Index (LOI), by termogravimetry analysis (TG) ; (TG-FTIR, TG-MS) and by using Cone Calorimeter (CC) method. The fine-plates, phase morphology of nanocomposites was investigated by scanning electron microscopy (SEM). We confirm that nanocomposites formation is an important concept for the flame retardants industry to enhance easily the FR properties of the products. Laminates made of modified and crosslinked polyester/epoxy resins meet requirements concerning heat, thermal stability and LOI over 28-34 % flammability, reduced 30-50% HRR and THR by CC method.The multi-ingredient compositio of flame retardants turned out to make significant progress in achieving the desired level of flammability in thermoset resins. No adverse impact of modification was ascertained on basic strength properties of final products.
References:
[1] S. Bourbigot and S. Duqusne: J. Mater. Chem.2007, 17,2283.
[2] E. Kicko-Walczak, M. Półka: Przemysł Chemiczny 2010, 89(1), 66.
[3] K. Wu, K. Kandola, E. Kandare, U.Hu: Polym.Comp. 2011,32.378.
[4] E. Kicko-Walczak, G. Rymarz: Przemysł Chemiczny 2013, 92(4), 504.

7647 | Nonlinear dynamic analysis of FGM plates by Finite element method

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The functionally graded materials composites plates are structures under study in regard to their continuous interesting characteristics that avoid stress concentrations and interesting mechanical properties. These structures are often subjected to severe dynamic environment, which requires the use of robust numerical methods.

The purpose of this work is to use the finite element method with implicit and explicit dynamic integration schemas to follow the temporal evolution of the behavior of these structures with FGM materials subjected to various dynamic loads.

7651 | Localized surface plasmon resonance for Quantum Dot-gold nanoparticle hybrid

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Recently, the quantum dots (QDs)-metal coupling structure has become research focus because of the complex interplay of enhancing and quenching physicochemical processes due to the surface plasmons (SPs).In this paper, we have synthesizedCdSe/ZnS quantum dot(QD)-gold nanoparticle(Au NPs) hybrid in aqueous solution via bi-functionallinkermercaptoacetic acid (MPA).The localized surface plasmon resonance (LSPR) effect of QD-Au NPs has been demonstrated by increased fluorescence intensity and reduced exciton lifetime carried out by time-resolved PL measurement. The absorption peaks of CdSe/ZnS QDs and Au are both located at 520 nm. It is investigated that PL intensity of QD-Au hybrid can be affected by the amounts of Au and pH value of hybrid solution. The phenomenon of fluorescence enhancement can be maximized under the optimized pH value of 9.5. LSPR enhanced QD-Au hybrid will be beneficial for the potential applications in the area of biological imaging and detection.

7654 | Efffective mechanical properties of 3D textiles including yarn yarn contact interactions

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3D textiles like interlocks used as preform find nowadays a wide use in industrial applications such as aerospace industry due to their high mechanical performances and especially their good resistance to delamination. It is important to be able to predict the impact of the yarn organization and mechanical properties of such 3D preforms on the effective mechanical properties, before the stage of resin injection. Micromechanical predictive models have been developed, based on the discrete asymptotic homogenization method; they give access to all effective moduli including flexural rigidities and internal length due to flexion and torsion reflecting microstructural effects.
The geometry and organization of the yarns together with their mechanical properties when modeled as undulated beams feed an input file of the homogenization computations. The unilateral contact between yarns including transverse yarn compressibility are accounted for based on Hertz theory, and it is shown that the variation of the contact area between yarns has a noticeable impact on the overall response of the preform at the unit cell level.

The consideration of internal gradients of the fields (strains, stresses) leads to the setting up of enhanced continuum models, like second order gradient or micropolar continuum models. The computed effective properties are validated thanks to FE simulations performed over representative volume elements endowed with periodicity conditions. The systematic nature of the homogenization technique allows a comparison of different preforms in terms of indicators which are elaborated based on their homogenized properties.

7665 | Effect of the erosive wear promoted by dusts on the impact strength of composite laminates

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Composite materials have been increasingly used because of their high specific strength and stiffness, good fatigue performance and corrosion resistance. However, in many cases, there are some problems in their application as consequence of the poor tolerance to damage. On the other hand, solid particle erosion is a progressive loss of original material from a solid surface due to mechanical interaction between that surface and solid particles. In fact, it is widely recognised that polymers, and their composites, have a poor erosion resistance. For example, their erosion rates are considerably higher than metals and the erosion rate of polymer composites is usually higher than for neat polymers. Some studies show that the erosion resistance of polymers is two or three orders of magnitude lower than that of metallic materials. According with the open literature, several studies can be found and the mechanical properties most discussed, after erosive wear exposure, are: hardness, tensile strength and modulus of elasticity, fracture toughness, yield stress and yield strain, rebound resilience, ultimate strength, elongation, etc. However, according to the authors' knowledge, studies of low velocity impacts after erosive wear exposure were not yet performed. In fact, low velocity impact events promote different type of damage, where the delamination between different oriented layers is predominant in composites and without exterior signs detectable by visual inspection.
Therefore, the aim of this work is to verify the influence of the erosive wear exposure on impact strength. Spherical balls were used as erodent and variables like mass of the erodent, impingement angle and the effect of velocity were analysed. The results were discussed in terms of load-time, load-displacement and energy-time diagrams. It was possible to conclude that the impact strength of the composite laminates decreases with exposure to the erosive wear, where the different parameters studied present a significant effect on the maximum impact load, maximum displacement and energy dissipated. Similar influence was observed on the multi-impact performance.

7667 | Synergistic damage evolving model for matrix cracking under quasi-static loading

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Aiming at the evolution of matrix cracks subjected to quasi-static tensile load in composite laminates, a synergistic damage evolving model based on energy approach was proposed. The model was analyzed in multi-scale: in micro-level, crack surface displacements were calculated by a three-dimensional finite element analysis; in macro-level, with the assumption, that ply cracks have already propagated over the section area of the cracking plies, and cracks always distribute uniformly in the evolving process, the total energy released rates due to formation of new cracks were obtained with the crack surface displacements. Evolving process was predicted by the crack initiation energy-based criterion.
Actually, the evolution in the composite laminates is not totally same as the assumption. Damage evolving inhomogeneous parameter is adopted to revise the model. And the initial damage is considered, that critical energy released-rate is regarded as a random variable satisfying a specific distribution.By finite element parametric modeling, damage interaction and the influence from the stiffness of the adjacent plies to the normalized crack surface displacement are studied. These displacements, deemed as the micro responses of the cracks, are not only the key parameters of the characterization of damage, but also determine the energy released-rate and affect the prediction of the evolving process. The stiffness property decrease is influence by damage and material nonlinearity. In this model, modified shear nonlinearity model proposed by Hashin-Tsai was adopted.
According to calculating flow, matrix crack evolving processes in glass fiber reinforced polymer with the configurations [±θ/904]s and [0/±θ4/01/2]s were analyzed. Meanwhile, damage interaction, residual stress, matrix nonlinear responses, material initial damage distribution, damage evolving inhomogeneity were taken into consideration. The results showed that the present model is capable to predict the evolving procedure of matrix cracks during quasi-static loading.

7668 | Effect of the core''s discontinuity on the impact strength of composite sandwiches

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Structural sandwich composites have been widely used in many engineering applications as consequence of their superior structural capacity in carrying transverse loads, superior bending stiffness, low weight, excellent thermal insulation and acoustic damping. They are composed by thin skins covering a low density core, where the skins are made of metal alloy sheet or fibre-reinforced polymer laminates in order to promote high in-plane mechanical properties. On the other hand, the core takes care of separating and fixing the skin, carrying the transverse shear load and providing other structural or functional duties such as impact tolerance. For this purpose a large variety of low-density materials are used in the core, being the most common: metallic honeycomb, polymer foam, syntactic foam, Nomex and balsa wood.
Balsa wood, for example, presents densities from 40 to 380 kg/m3 making one of the lightest woods available. However, the balsa planks (boards) have finite dimensions, which promote discontinuities of the core and, consequently, the mechanical properties are affected. Therefore, the length of these discontinuities (gap length) is analysed in terms of impact strength, because sandwich composites are very susceptible to the impact loads that occur during the operational or maintenance activities. For this purpose, gap lengths of 0, 5, 10 and 20 mm will be analysed and the results will be compared with other ones obtained for sandwiches manufactured with continuous cores (control samples). Finally, the benefits promoted by resins nano-enhanced will be also studied. Nanoclay Cloisite 30B, specially modified for better dispersion and interface adhesion matrix/clay, were dispersed in 3% of resin weight.
The results are discussed in terms of load-time, load-displacement and energy-time diagrams. The highest maximum impact loads and elastic

recuperation were obtained with resin enhanced by nanoclays. The opposite tendency was observed for the displacement at peak load, where the lower values were found for nanoclays filled sandwiches. In terms of core's discontinuity, the absence of material decreases the impact strength and all parameters are very dependent of the gap length. For example, when the gap length increases, it is possible to observe that the maximum load and the energy dissipated decrease, but the displacement increases. However, the resin enhanced by nanoclays promotes significant benefits in terms of impact strength. Finally, higher gaps promote lower number of impacts to obtain the full perforation of the skin, but resin enhanced by nanoclays, one more time, promotes benefits in terms of multi-impact strength.

7695 | Synthesis and characterizationof Zn1-xMnxFe2O4 magnetodielectric material antenna for wireless communication

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High speed data rate is the prerequisite of the upcoming wireless communication. Dielectric material based antenna receiving immense attention due to their unique electrical properties at microwave frequencies. An attempt has been made to fabricate and analyse Zn1-xMnxFe2O4, where (x=0.2-0.8) magneto dielectric material antenna for wireless communication based patch antenna.Magneto dielectric materials have remarkable potentials as an antenna substrate due to their exceptional principle of biased and unbiased state. The high permittivity of unbiased ferrite reduces the patch dimensions; concurrently the biased ferrite has an influence on frequency agility, gain and bandwidth enhancement.Mn-Zn Ferrites with low loss tangents (both dielectric and magnetic) and low dielectric permittivity are very useful in the design of magneto dielectric antenna for millimeter wave communications. This is also an inexpensive, efficient, simple, and compatible with the planner antenna technology. In this paper, Sol-gel method was used to fabricate magneto dielectric material by using high purity ZnO, Fe2O3 and MnCO3 in stoichiometric proportions. Structural and morphological studies of magneto dielectric materials were examined by field emission scanning electron microscopy (FESEM) and X-ray diffractometer (XRD) analysis. The XRD pattern displayed the characteristics peaks of Mn-Zn ferrites ceramics with single phase spinel crystal structure. The structural morphology observed by using FESEM and energy dispersive x-ray spectroscopy (EDX). The dielectric properties (dielectric constant, loss tangent) were measured as a function of frequency between 20 Hz to 1 MHz for the mixed ferrites Zn1-xMnxFe2O4.The performance of the patch antenna was measured using the Agilent vector network analyzer (VNA).

7700 | On the structural design of the Portable Temporary Mataf Pedestrian Bridge

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This paper presents the structural design of the Temporary Mataf, two-story composite walkway-bridge in Mecca, Saudi Arabia. This bridge is connected through several access ramps to Grand Mosque and Al-Umrah gates.

The application of this Structure is to provide the comfort of the current capacity of the worshipers even while the Grand Mosque is under the construction. Therefore, this project has alleviated crowd density of worshipers, increased the capacity of the pilgrims and provides a shorter period of Tawaf.
In order to design an ultra-lightweight, highly stiff and large span structure for the simple, fast and safe erection, ring structure is constructed from carbon fiber reinforced composite components with steel connections. Moreover, the access ramps are built from Carbon fiber pillars and steel beams. Whole structure can be removed and reconstructed as needed without the use of heavy machines which is the important feature according to the flow of the pilgrims in the Mataf area.
Furthermore, investigation of Vulnerability of this lightweight structure to the dynamic loads and the study of the structural interacting behavior of the steel connection and carbon fiber reinforced composite members are depicted in this paper.

7705 | Composites Manufactured with Green Epoxy Resin and Tungsten Mine Wastes

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According to the Eurostat, the mining and quarrying activities in all Europe are responsible by 55% of the industrial waste. In terms of Portugal, these values are around 20% of the total waste. In fact, Portugal has some world class deposits at Neves-Corvo (Cu, Sn) and Panasqueira (W), but also several deposits producing salt, feldspar, uranium, kaolin, ball clay and fire clay, ornamental stones and some other mineral substances. Nowadays, is the main UE producer of copper, tin and tungsten concentrates, but in terms of ornamental stones is considered the 6th world producer.
Panasqueira, for example, is the biggest wolframite mine in the world, excluding China, and is located in the municipalities of Covilhã and Fundão (Castelo Branco district, in center of Portugal). The mining is situated between the Gardunha and S. Pedro de Açor mountains where the topography ranges in altitude from 350 to 1080 m. The first prospecting licence was granted in 1886 while the first exploitation started in 1888. Several million tonnes have been deposited and, currently, around 100 tonnes are being added each day. Basically two types of mine waste are generated: coarse aggregates derived from rock blasting (a by-product used in minor quantities in bituminous mixtures or simply disposed) and waste mud coming from the plant and conveyed by pipelines for lagoons built specially for this purpose. The coarse aggregates present a diameter between 5 and 25 mm, while the mud contains very fine particles with diameters less than 2 mm.
In terms of coarse aggregates, literature presents several solutions to their reuse, especially on earthworks and construction. For the last option, these materials have suitable properties for technical-artistic applications (conservation, restoration and/or rehabilitation of historic monuments, sculptures, decorative and architectural intervention) or simply as materials for building revetments. Polymer-based composite materials are a good alternative for these applications and some studies can be found on the open literature about aggregate/polyester matrix.
Therefore, the main goal of the present work is to study a polymer-based composite using a green epoxy resin, SR Greenpoxy 55 and SD Glass One hardener supplied by Sicomin. Greenpoxy 55 is an epoxy system with a single hardener, where 55 % of the molecular structure is of plant origin. The fictitious molecule contains 11 carbons, 6 being from biomass origin. It thus contains 55 % of “green” carbon. The hardener follows the same logic. This system was hand-mixed with coarse aggregates, in convenient proportions, and the mechanical properties were obtained by bending tests performed according to ASTM D790-2. The tests were performed at a displacement rate of 0.5, 5 and 50 mm/min, in order to obtain its effect on the flexural strength of the composites studied. All three point bending tests were carried out at room temperature and for each condition 5 specimens were used.
It has been also reported on the literature that these composites are susceptible to degradation by aggressive environments. In order to analyse these

effects, standard specimens were immersed in several aggressive solutions and the effect of the time exposure on the flexural strength was evaluated. The flexural tests were used because, comparing the tensile and bending tests, the last ones show to be the most sensitive to the change of exposure conditions.

7709 | Modeling Dynamic Anisotropic Damage

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We develop a geometric dynamic anisotropic damage model. The coupled phenomena analyzed here deal with a loading wave, which damages the material and changes the propagation properties of the material. In this way the damage processes induced by it perturbs the speed and the profile of the loading wave. The geometric damage model, represented by micro-cracks growing under dynamical loading, is able to describe the link between the micro and macro-scale characteristic times and the rate of deformation. The micro-crack growth is activated in some privileged directions according to the applied macroscopic loads and the velocity of the micro-crack propagation is estimated by the dynamic stress intensity factor. A discontinuous Galerkin numerical scheme for the numerical integration of the damage model is also proposed. The scheme is robust and precise. Several two-dimensional boundary value problems are selected to illustrate the model and to analyze the robustness of the numerical algorithm.

7715 | Optical properties of bimetallic composite nanoparticles

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In this work, the optical properties of core-shell composite nanoparticles containing Au and Ag nanoparticles is investigated using the Maxwell-Garnett formalism. Bimetallic nanocomposites are the combination of two metals of the nanoscale size range which has more degrees of freedom compared with monometallic nanocomposites. The sensitivity of the plasmon resonances to the fraction volume of inclusions and the dielectric function of the host matrix is studied. These materials are useful for plasmon based sensors and bioscience applications.

7716 | Buckling analysis of an ocean composite turbine blade

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Buckling analysis of an ocean current turbine blade using FEM (finite element method) is presented here. Renewable energy emerging resources such as ocean energy has gained much importance due to the recent energy crisis and to obtain cleaner energy. To maintain the ocean turbine in operation healthily, preventive methods and fault detection criteria is necessary. In ocean turbine, buckling analysis is a common parameter and may be diagnosed. A code is developed to feed those pressure distributions into the FE(finite element) model of the blade. Through this analysis, load factors and buckling shapes of the first four buckling modes of the blade under seven different current speeds and seven different composite materials composition are computed.

7730 | Microwave Assisted Synthesis of Cellulose-Supported Metal-Oxide Nanoparticles

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ABSTRACT

Microwave radiation was applied to synthesize nanoparticles of ZnO or NiO supported on pretreated cellulose by NaOH.
Optimization in terms of radiation time and metal concentration was also investigated. The produced fibers were characterized by means of XRD, FTIR, SEM, UV-Vis and Raman spectroscopy.

7731 | A Discrete Layer Finite Element Model for Cylindrical Piezoelectric Composite Shells

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This work presents a new discrete layer finite element to model thin as well as moderately thick orthotropic and laminated piezoelectric composite cylindrical shells. The element formulation is derived from the first order shear deformation theory of shells. The plane stress twenty-two degrees of freedom element is modeled with inplane displacements defined at the interfaces of the element layers, through-the-thickness radial displacement, and electric potential at each of the top and bottom surfaces of the layer. A field consistency approach is implemented to insure that the element is free from locking due to membrane tangential, membrane shear and transverse shear strains. The field consistency approach used eliminates the inconsistent terms from the original displacement shape functions that correspond to the targeted strains. The new element is validated through a series of benchmark problems and has shown accurate and fast converging results.

7752 | EVALUATION OF CARBON NANOTUBE AND CARBON FIBER REINFORCED POLYMER COMPOSITE FOR LIGHT WEIGHT AUTOMOTIVE PART

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Reducing weight and improving the mechanical properties of automotive parts have been very important because they can improve the fuel efficiency in automotive industry. Polymer composite is one of the key options to achieve light weight and high mechanical properties by mixing polymer with carbon fibers, glass fibers, carbon nanotube and so on. In our research, carbon nanotube/carbon fiber reinforced polymer composite (polypropylene and polyamide) was fabricated by an injection molding to get proper mechanical properties and low density as well as relatively low cost for mass production of automotive sunroof frame. The optimum mixing ratio of carbon nanotube was selected by evaluation of mechanical properties, and density. To evaluate the mechanical properties, tensile test and bending test were carried out. And the density was calculated with the measured weight and its geometry. The developed composite could show the feasibility of industrial usage with reduced weight and sufficient mechanical properties.

7802 | Adsorption of self assembled systems made of nonionic surfactants onto layered materials

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Amphiphilic molecules, such as nonionic surfactants, tend to form aggregates on interfaces which determine various applications in the area of detergency, ore flotation, oil recovery agents, or composite materials. The structure of the assembled aggregates could be similar, with nevertheless some tiny differences, to those existing in bulk solution. Aggregation mechanisms on solid surfaces; differs from bulk solution by involving additional forces with the surface and even how surfactant self-arranges by optimizing its arrangement of both hydrophilic and hydrophobic portions in micelle forms.
Among various kinds of non-ionic surfactants, amphiphilic molecules containing n-CnH2n+1(OCH2CH2)mOH surfactant (abbreviated as CnEm) have received particular attention due to their ability to self-assemble in various liquid crystalline phases above the critical micelle concentration (cmc). Recently, the intercalation of a normal C10E3 bilayer in a natural Mt resulting to the condensation of a bulk lamellar phase above cmc points out the link between the packing of the surfactant and its bulk phase state.
The aim of this work is to study the role of the surfactant state in bulk solution for the adsorption onto layered materials, by focusing on the structure and the dynamics of aggregates made by various nonionic surfactants. The results obtained by a set of complementary techniques (X-ray diffraction, small angle X-ray scattering, solid state nuclear magnetic resonance, FTIR, thermo-gravimetry analyses) show for the whole studied surfactants the importance of its bulk phase state for the adsorption and the assembled aggregates confined within the interlayer space of host materials, but also the hydrophobic/hydrophilic ratio of the nonionic surfactants.

7890 | PREDICTION OF COMPRESSIVE STRENGTH AND ULTIMATE STRAIN OF AXIALLY LOADED FRP-CONFINED SQUARE CONCRETE COLUMNS BY FUZZY INFERENCE SYSTEM

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Keywords: Concrete column; Square section; Confinement; FRP sheet; Fuzzy logic.

Summary. A model based on fuzzy inference system (FIS) is developed to estimate the compressive strength and ultimate strain of FRP-confined concrete specimens with square sections. The results indicate that the accuracy of the proposed FIS model is quite satisfactory as compared to a large experimental database as well as the existing models proposed by various researchers.

1 INTRODUCTION
This paper deals with FRP-confined concrete with square section, which is still not fully addressed as compared to circular sections. Most of the existing models for FRP-confined concrete are regression-based ones which assume an arbitrary function of some variables. However, the current models vary greatly in the manner they incorporate different parameters. To remove the assumptions inherent in the regression based models, the FIS approach offers an attractive solution. Herein, the approach of FIS is employed to predict the enhancement of both strength and strain capacity of FRP-confined square columns. The FIS method, which has been already applied by the author [1] to another problem, has not yet been used for modeling the FRP-confined

concrete.

2 DEVELOPING FIS MODEL FOR FRP-CONFINED CONCRETE
Amongst different techniques to identify a FIS model, subtractive clustering [2] is utilized in this paper. Intuitively, each cluster center represents a fuzzy rule as follows: "IF an input is near a cluster center THEN the output is near the output value of the cluster center." Weight of each rule is defined by Eq. (1), where b, r, f'co, tfrp, ffrp and Efrp are section width, corner radius, concrete strength, FRP thickness, FRP strength and stiffness, respectively. The parameters containing a star denote the cluster center's coordinates. The consequent part of the fuzzy rule is expressed by Eq. (2) which is a linear combination of input parameters. The unknown coefficients in Eq. (2) are determined through the least squares estimation. For the problem in hand, three cluster centers are extracted from the available experimental database. Table 1 lists the input coordinates of the cluster centers along with the coefficients in Eq. (2). More details are presented in the full paper. The final output (i.e. compressive strength) is calculated by the following equation.

3 CONCLUSIONS
Fig. 1 compares experimental results with predictions by the proposed FIS model for compressive strength and ultimate axial strain. The experimental data were assembled from the open literature and included 182 FRP-confined specimens for compressive strength and 66 specimens for ultimate strain. Besides, predictions by two existing models developed by Lam and Teng [3] and Campione and Miraglia [4] are shown in Fig. 1. It is evident that the accuracy of the proposed FIS model is quite satisfactory and the model compares favorably with the experimental data. In addition, the proposed FIS model outperforms the available regression models developed by various researchers.

REFERENCES
[1] K. Nasrollahzadeh and MM. Basiri, “Prediction of shear strength of FRP reinforced concrete beams using fuzzy inference system”, Journal of Expert Systems with Applications, 41(4), 1006-1020, (2014).
[2] S L. Chiu, “Fuzzy model identification based on cluster estimation”, Journal of Intelligent and Fuzzy System, 2, 267–278, (1994).
[3] L. Lam and JG. Teng, “Design-oriented stress-strain model for FRP-confined concrete in rectangular columns”, Journal of Reinforced Plastics and Composites, 22(13), 1149-1186, (2003).
[4] G. Campione and N. Miraglia, “Strength and strain capacities of concrete compression members reinforced with FRP”, Journal of Cement and Concrete Composites, 25(1), 31–41, (2003).

8083 | Transient responses analysis of curved laminated composite beam by a developed reverberation-ray matrix method

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This study proposed a developed reverberation-ray matrix (DRRM) analysis method to analyze the transient responses of curved laminated composite beams based on classical laminated beam theory (CLBT) and the first shear deformation theory (FSDT) subjected to impulse force load. The developed reverberation-ray matrix is demonstrated in the global coordinate system, which represents the multi-reflected and scattered waves in the ply-dropped laminated composite beam. To validate the developed analysis method, we analyze the velocity response and discuss the wave propagation of a curved laminated beam under a smoothed triangular impact load. The axial-flexural and axial-flexural-shear coupled effects due to ply stacking sequences are also analyzed. The velocity transient responses of the curved laminated composite beam are also solved by the developed reverberation-ray matrix method (DRRMM) under a half-cycle pulse force. Compared with the finite element method (FEM), the proposed approach provides results that are in good agreement with previous findings. The DRRMM has some advantages of the simpler and faster solving process, very few DRRM computing elements, the higher order accuracy of solutions in frequency domain.

8133 | FINITE ELEMENT MODELLING OF SHEAR STRENGTHENED REINFORCED CONCRETE BEAMS

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This research aims at creating precise finite element models for FRP shear strengthened concrete beams. It is inspired by the fact that the determination of the structural behaviour of the shear strengthened beams requires advanced numerical methods of which results are substantiated by credible experimental findings. The models are developed here to assess the shear and interfacial types of behaviour of beams strengthened using the hybrid externally bonded (EB)/ mechanically fastened (MF) fibre-reinforced polymer (FRP) systems. The interfacial behaviour between the hybrid EB/MF-FRP and the concrete is accounted for, here, using specially developed interface elements. A user-defined subroutine for the microplane constitutive law for the concrete material is incorporated in the model. Results are presented in terms of the ultimate load carrying capacities, load–deflection relationships, and interfacial stress/slip distributions. Numerical results are validated against available experimental results and show reasonable agreement.

8145 | STUDY OF STRUCTURE, PROPERTIES, AND BIOLOGICAL ACTIVITY OF THE POLYSTYRENE FILMS FILLED WITH FULLERENE

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STUDY OF STRUCTURE, PROPERTIES, AND BIOLOGICAL ACTIVITY OF THE POLYSTYRENE FILMS FILLED WITH FULLERENE

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Incorporation of carbonic nanoparticles (such as fullerenes) into a polymeric matrix is perspective method for modification of the polymeric material. The composites produced get novel physical and chemical properties that considerably expand the areas of their application. Polystyrene (PS) is one of the synthetic polymers capable of containing the carbonic nanoparticles.
To fabricate the film composites we used atactic polystyrene (Aldrich, US; molecular mass is 140000, polydispersity is 1.64) and fullerene C60

("NeoTechProduct", Russia). A solvent casting of perspective components from solutions has been employed for film fabrication. Polystyrene has been dissolved in o-xylene in the 17 % concentration, and C60 has been dissolved in o-xylene in the 0.035 % concentration. Then we have mixed two solutions, and have filtered the obtained mix with 0.2 □m filters. The mixed solutions have been stirred for about 1 day before being cast onto glass substrate. Since the solvent have been evaporated over several days, we have produced thin solid film. Unmodified polystyrene film has been formed by the cast method as well.
The structural characteristics of polystyrene films and PS/C60 composites have been researched by the infrared spectroscopy, ultraviolet spectroscopy, and X-ray diffraction technique. According to IR-spectroscopy data it was suggested that intermolecular interaction between polymer's phenyl ring and fullerene molecule occurred in the composite. Analysis of UV spectra has confirmed the assumption on the interaction of polystyrene electron-donor molecule with π-electronic system of fullerene. It was revealed by X-ray diffraction technique that there exited an intermediate-range order in these materials. Insertion of fullerenes into polymer matrix has increased a correlation length.
To assess bioactivity we have studied the influence of polymer materials researched on free-radical processes in blood serum. Lipid peroxidation has been evaluated by induced chemiluminescence and spectrophotometry. We have disclosed that fullerene-containing composites were able to inhibit the lipid peroxidation. Possibility of such inhibition depended on medium in which the films were fabricated.
Antimicrobial activity of the polystyrene-fullerene composites has been tested against Gram-positives (Staphylococcus aureus) and Gram-negative (Escherichia coli, Pseudomonas aeruginosa) microorganisms and mushrooms (Candida albicans). The test results have shown absolute death of the microorganisms under the composite film.

8152 | Numerical analysis of flexural behavior of CFRP-strengthened timber finger-joint

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The aim of this paper was to study the flexural behavior of timber beams externally reinforced using Carbon Fibre Reinforced Plastics (CFRP). Experimental and predicted results are presented. A non-linear FE analysis is proposed in order to complete the experimental analysis of the flexural behavior of timber finger-joint. Numerical simulations are based on the Cohesive Zone Model (CZM) of Abaqus software to allow for accurate description of the progressive damage of the bond-lines up to final failure. The predicted and measured load–midspan deflection response results in addition to the failure modes are compared. It was observed that the predicted FE results are in good agreement with the experimental measured test data.

8155 | Modeling the compressive properties of carbon foam using the FE analysis

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The aim of this work is to develop a predictive model that describes the compression properties of carbon foams. A non-linear FE analysis was applied in order to determine the behavior of the sample foams. The material variables and ranges used in the study were density (250–550 kg/m3), fiber weight fraction (1–5 wt%), and fiber length (6–12 mm). The responses analyzed were the compressive modulus and strength. In addition, the foam size cell distribution was investigated as a function of density. The results showed that the density and the morphology of sample foams exhibit a strong influence on the responses of the model. Therefore, the used of a 3D FE model for predicting carbon foam mechanical properties is an appropriate tool that affords a global perspective of the influence of different effects on material behavior.

8165 | Investigations on hybrid carbon fibre composites with nano and micro-silica particles

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This work investigates the effect of silica micro and nanoparticles on the physical and mechanical properties of carbon fibre composites (CFC) and epoxy matrix phase using a Design of Experiment (DoE) procedure. The effect of the PDDA surface treatment agent was also evaluated during the dispersion of the silica nanoparticles into the epoxy matrix phase. A microstructural analysis via SEM and TEM was performed to further assess the results. A full factorial design (2^13^1) was conducted to identify the effects of silica particle size and particle addition on the following responses: tensile strength/modulus, flexural strength/modulus and apparent density. To the best of the Authors' knowledge, this is the first study that uses a rigorous DoE technique to assess the effect of the manufacturing and chemical process parameters over the mechanical properties of hybrid epoxy/carbon fibre composites. PDDA functionalised silica nanoparticles were able to provide a homogenous dispersion, with a decrease of the apparent density and enhancement of the mechanical properties in the hybrid CFCs. Compared to undispersed CFC laminates, the use of 2wt% functionalised nanoparticles permitted to increase the flexural modulus by 47% and the flexural strength by 15%. The hybrid CFCs showed also an increase of the tensile modulus (9%) and tensile strength (5.6%).

8167 | The role of defects gettering at the inter-grain interfaces of the polycrystalline Cu(In,Ga)Se2 based-solar cells

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In this work, two-dimensional device simulator Atlas SILVACO-TCAD was employed to study the performances of substrate TCO/In2Se3/Cu(In,Ga)Se2

(CIGS)/Metal thin film solar cells. The impacts of grain sizes and defects gettering at the inter-grain interfaces (grain boundaries, GB) in the CIGS absorber bulk have been investigated. The Poisson equation and the electron and hole continuity equations are solved subject to the boundary conditions. In this model we consider the grain boundary interface as a thermionic field emission. The variation of grain sizes in the CIGS bulk was studied and the corresponding design optimization was provided. The best energy conversion efficiencies have been obtained with large grain sizes higher than 2 μm for 3 μm-CIGS thick. The simulation results predict a strong detrimental effect of GB recombination, which is enhanced by the presence of small band-bending in the direction that attracts minority carriers. An efficiency of 17.1% (with Voc ≈ 0.68 V, Jsc ≈ 34 mA/cm2 and FF ≈ 0.76) has been achieved with small band-bending at about 3 nm. The presence of the valence-band offset in the absorber layer is benign to solar-cell performance by limit the carriers recombination. The valence-band offset is predicted to be 0.2–0.4 eV in magnitude and localized to a very thin layer at the grain surface in which the surface reconstruction takes place. All these simulation results give some important indication to lead a higher efficiency of substrate In2Se3/CIGS/Metal solar cells for feasible fabrication.

Key words- Substrate solar cells, Cu(In,Ga)Se2, In2Se3 buffer, grain boundaries, Atlas SILVACO-TCAD.

8177 | Microstructure characteristics of rotary swaged Al/Cu/Al composite

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Al-Cu-based clad composite materials feature optimized combination of properties, such as high electrical and thermal conductivity and low density, as well as the advantage of competitive price in comparison with pure Cu. In this experiment, we manufactured tri-layered Al/Cu/Al clad composite using rotary swaging. The initial diameter of 25 mm was cold swaged down to a 10mm rod. To decrease residual stress after forming, heat treatment is usually applied. However, as a result of a heat treatment, brittle CuxAly intermetallic phases can occur in the area of bonding of the individual layers. After swaging, we divided the samples into three groups. One was investigated in the as-swaged condition, the second group was annealed at 300°C for 30 min and on the third one 350°C/30 min heat treatment was applied. These three states we subsequently investigated using optical microscopy, scanning and transmission electron microscopy. Phases in intermetallic layers which occurred after annealing were investigated and described. The phases were mostly identified as AlCu and Al2Cu. The influence of swaging and heat treatment on grains within all the samples was investigated as well. Comparison of the results of grain size with the initial state showed significant grain size refinement after swaging. The average grain size after swaging was smaller than 8 μm. After swaging, <111> fiber texture developed in both the individual materials.

8191 | OPTIMIZATION BY CENTRAL COMPOSITE DESIGN OF A NEW COMPOSITE ADSORBENT (BEIDELLITE/POLYANILINE) PRODUCTION FOR ADSORPTION OF ACID YELLOW 194

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Keywords: optimization, beidellite, polyanline, adsorption, wastewater
Summary. Adsorption techniques are widely used to remove pollutants from wastewaters, especially which are not easily biodegradable. Researchs, deal with the production of alternative sorbents to replace the costly adsorbents, has intensified in recent years. Attention has focused on composite materials which are generally produced with various natural solid such as beidellite, cheap natural clay with low cost and polymeric materials such as polyaniline due to its low cost, easy synthesis, both chemically (in powder form) and electrochemically (as a film), and the environmental stability. The Polyaniline/Beidellite composite materials (PAN/BEI) can be easily prepared via HCl and NH4S2O8[1]. However, the production conditions of PAN/BEI affect the treatment efficiencies and process cost. Thus, this paper deals with finding optimum production conditions of PAN/BEI for maximum removal efficiencies of Acid Yellow 194 (cobalt-complex dye) and minimum chemical consumptions by central composite design. In this study, the five most important operating variables: molarity of HCl (molar), amount of NH4S2O8 (g), amount of beidellite (g), amount of aniline (ml), and mixing time (min) are selected as independent variables as seen in Table 1. 46 different PAN/BEIcomposite materials are produced according to Table 1.

Table 1. Process factors and their levels for production of composite materials

The prepared 46 of PAN/BEI are used in batch experiments in order to observe the dye removal efficiency (experimental conditions: pH= 3, T= 25 oC, ms = 0.15 g adsorbent, V = 50 ml dye solution, Cdye = 200 mg/L, t = 24 h, and = 200 rpm). The maximum dye removal efficiency is obtained as >97% (qe = 64mg/g) by PAN/BEI which is prepared with 2 molar of HCl, 2 g of NH4S2O8, 1 g of beidellite, 1 ml of aniline and 240 min of mixing time. Then the adsorption isotherms were applied to examine the efficiency of removal with this PAN/BEI. The 2-factor interactions (2FI) models were developed by The Design Expert 8.0.4 software (trial version) and it was clearly seen that the experimental data fit well to model predictions statistically (R2≥0.91, Adj-R2 = 0.87 and “Prob>F”<0.0001). In this study, estimated coefficient of functions is given in Eqn.1 for dye removal efficiencies;

Egn.1

The positive and negative signs in front of the terms refer to a synergistic effect and an antagonistic effect respectively. As seen in Fig. 2, molarity of HCl, amount of beidellite and mixing time had a negative influence on dye removal efficiency. However, amount of NH4S2O8 (g) and amount of aniline (ml) had a positive influence (Eqn.1). According to the results, the central composite design is a suitable method to optimize the productions conditions of PAN/BEI while keeping the dye removals maximal and the prepared PAN/BEI has an important potential for using as an adsorbent in metal-complex dyes such as Acid Yellow 194 from textile wastewater effluents.

Figure 1. The effect of experiments conditions on removal efficiencies.

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REFERENCES
[1] M. Milojevic-Rakic, A. Janosevic, J. Krstic et al., “PolyanilineAnd Its Composites With Zeolite Zsm-5 For Efficient Removal Of Glyphosate From

Aqueous Solution", Mic.Mes.Material., 180, 141-155(2013).
[2] E. Maćkowska, R. Gogolin, W. Dumczal And J. Gaca, "Studies of The Kinetics of Dye Decomposition In Water Solutions", Polish J. Environ. Studies, 12, 425-429 (2003).

8194 | NANOFIBERS OF ACRYLATE - CONJUGATED POLYMER COMPOSITES

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Summary. Nanometre-sized Core- Shell structured Acrylonitrile copolymer /conjugated polymer composites and their nanofibers are prepared .

1 INTRODUCTION
The synthesis of colloidal composite particles with a core–shell morphology is
challenging area due to the diverse applicability of these particles as biocatalysis,biosensors ,electronic compounds and as drug delivery systems.The presence of vinylacetate in Poly(Acrylonitrile-co- Vinylacetate) , P(AN-co-VAc) have the significant effect to their thermal behavior and are also of interest as precursors in the production of high strength carbon fibers.
Conjugated polymers found great interest due to their electrical conductivity , to improve their mechanical properties , our group has focused on the synthesis of conjugated polymer coated core–shell particles of acrylonitrile based copolymers and production of nanofibers i.e., nanoparticles of Polypyrrole (PPy) composites were synthesized by oxidative polymerization in various polymer cores such as Poly(Acrylonitrile-co-Methylacrylate) [1] Poly(Acrylonitrile-co-Vinyl Acetate) [2-5],etc., and spectrophotometric ,and morphological analysis were performed on thin film or nanofiber form in detail . Core–shell structures are obtained using an acrylic copolymer as core in the presence of emulsifier, followed by polymerization of a monomer of conjugated polymer as shell onto these core/templates.
In this study multi-stepped emulsion polymerization was applied to increase processability of conjugated polymers, and to obtain a hybrid nanocomposite structure.
2 RESULTS
Acrylic copolymers were synthesized by single-batch emulsion polymerization as core-polymer using alkaline persulfate as initator and in the presence of surfactant in aqueous medium. After free radical polymerization step, without addition of any further initator, different amounts of monomer of conjugated polymer were added into this emulsion medium to polymerize it as a shell-structure at room temperature.
Similar aprroach was applied for the synthesis of P(AN-co-VAc)/Fe2O3 and P(AN-co-VAc)/Fe2O3@PEDOT core-shell nanocapsules with uniform size and morphology by mini-emulsion polymerization .Nanoparticles and nanofibers obtained as products ,were characterized by FTIR-ATR, UV-Visible Spectrometer and DSC,TGA and their electrochemical impedance behavior is investigated by Electrochemical Impedance Spectroscopy . Fitting with equivalent Circuit Modelling(ECM) of the EIS data exhibited a good correlation between the calculated and the experimental values.Morphological properties of products are investigated by scanning electron microscopy (SEM) , atomic force microscopy (AFM) and TEM .
Due to prevention of agglomeration of nanoparticles (NPs) by bound surfactants, surface-coated particles are more freely aligned than the uncoated NPs. This enhanced the dispersion stability of NPs by increasing surface charge and electrostatic repulsion or by reducing interfacial energy between particle and solvent. High degree of homogenity and molecular order induced by molecular dispersion of conjugated polymer on copolymer matrix without phase separation by improving the transport properties and stability of conjugated polymer, which are critical for high-performance organic electronics.

REFERENCES
[1]YerlikayaY.,Unsal C.,Sarac A.S., , Adv. Sci. Eng. Med, 6 (2014) 301-310
[2]Arman B.,Sarac A.S., , Soft Nanoscience Letters 4,2(2014) 42-49
[3]Cetiner S., Kalaoglu F., Karakas H., & Sarac A. S., , 12,2 (2011)151-158.
[4]Cetiner S, Sen S., Arman B Sarac A.S ,J.Appl. Polym.Sci, 127 , 5 (2013)3830-3838
[5]Yanilmaz ,M.,Sarac,A.S. Textile Research Journal (2014) DOI: 10.1177/0040517513495943

8205 | Geometrical and FE approaches with remeshing procedure for composites woven fabric forming

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Geometrical and mechanical approaches are proposed for the simulation of the draping of woven fabric onto complex parts. The geometrical discrete approach allows to define the ply shapes and fibres orientation in order to optimize the composite structural properties. The FE continuum meso-structural approach with remeshing procedure is proposed in order to take into account the mechanical properties of fibres and resin, the various dominating mode of deformation of woven fabrics during the forming process and the contact-friction between the tool and the deformable fabric.
Some numerical simulations of forming process are proposed and compared with the experimental results in order to demonstrate the efficiency of the proposed approaches.

8214 | Active Cellular Structures

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Advanced programmable materials with the ability of reversible, real-time control of moduli and topology can be used to manufacture the energetically efficient and multifunctional morphing structures of the future. Furthermore, these capabilities in solids can find significant application in advanced mechanical components, protective structures and biomedical devices. Here, we propose a novel concept for controlling the linear and non-linear elastic properties of cellular structures via electromagnetically triggered mechanisms in the cellular solid. Three structural systems with orthotropic material properties were proposed and studied numerically, experimentally and analytically. Using the proposed concept, the elastic modulus can be controlled over 2 to 4 orders of magnitude. The Poisson ratio of the isotropic structure can be varied from 0 to 0.5 continuously. The adjustments over nonlinear elastic (i.e. buckling) behavior of the structure are achieved by activation of supplementary cell walls in the lattice through electromagnetic actuation. Magnetic actuation will hamper the first symmetrical buckling pattern of the structure and force the structure to buckle according to a higher buckling

pattern with smaller sinusoidal wavelength in the cell walls. The uniaxial buckling strength of the structure was tuned over 2 orders of magnitude.

8218 | ELASTIC BUCKLING LOADS FOR NONUNIFORM COMPRESSION MEMBERS WITH ELASTIC END RESTRAINTS

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Members with nonuniform distribution of geometrical and/or material properties, such as functionally graded material distribution, partially constant or continuously variable axial and flexural stiffnesses due to the use of composite materials, are nowadays widely used in various engineering applications mostly to achieve better distribution of strength, stiffness and weight and, in many other cases, to satisfy some predefined functional and/or architectural requirements and for strenghening purposes. However, since most of the design provisions have guidelines only for uniform and prismatic members, design engineers need guidance on design of such nonuniform members, particularly under the effect of compression. There is little work in literature on stability of nonuniform members under compression. Yet, most of these studies are based on the assumption that the compression member has ideal boundary conditions (fixed, pinned or free) at its ends. Ideal boundary conditions can realistically model the real end conditions in some special cases; however, in many cases, the ends of the columns are neither fully fixed nor exactly hinged. Thus, to derive general design expressions, it is essential to include the effects of elastic end restraints in stability analysis of nonuniform compression members. On the other hand, buckling analysis of nonuniform members with elastic end conditions leads to complex differential equations for which it is usually impractical or sometimes impossible to obtain exact solutions. This paper shows that Homotopy Perturbation Method (HPM) can successfully be used to predict buckling loads of nonuniform members with elastic end conditions. In the study, the efficiency of HPM in predicting the buckling loads of compression members with elastic end restraints is, first, verified by comparing the HPM results for prismatic and uniform columns with the exact solutions available in literature. Then, the buckling loads of compression members with different geometric/material nonuniformities and with different types of elastic end restraints are computed and presented in tabular forms, which are believed to provide guidance to engineers using non uniform compression members in their preliminary design.

8240 | Parameters Identification of NiTi/Epoxy Composite Using Inverse Method

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In this work a near equiatomic NiTi shape memory wire epoxy matrix composite was studied and the material parameters were identified. Two types of samples, namely tensile and heterogeneous composite specimens were manufactured by casting followed by curing and post curing process. The mechanical behavior of samples has been determined using standard tensile test. The effect of wire volume fraction was investigated as well. The tests were conducted at room temperatures and at a constant cross-head speed.
The samples with complex geometry were designed and fabricated in order to estimate the elastic properties of the composite material in two directions (perpendicular and parallel to the wire axis). An identification method has been developed to identify the material parameter. The method is based on the surface measurements of specimens. For this purpose, specimens with complex geometry (Meuwissen-type) and with random speckle were subjected to the tensile load. The heterogeneous displacement/strain fields generated due to the complex geometry of the composite samples are measured and treated using the Correli-Q4 and Vic2D software on the basis of digital image correlation. A finite element model, using ABAQUS standard, serves as numerical counterpart for the experimental set-up. An inverse method was established in this work and the material parameters were identified. The results were then compared to the results obtained by Mori-Tanaka method. Moreover, the numerical strain fields obtained using the identification parameters was compared to the experimental ones. A good correlation was found in both cases.

8241 | Mechanical behaviour and modeling of shape memory alloys materials and estimation of their ability of the strain energy absorption

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Abstract:
The shape memory alloys (SMA) have properties that allow them to be used as actuators in an inert structure in order to obtain a so-called « smart materials » adaptable structure. In this article, a few definitions concerning the super-elastic effect and memory alloys have bee first introduced. Then, a predictive model of their behaviour induced by simple mechanical solicitations (bending and tensile stresses) has then been proposed. This behaviour is broken up into two linear parts with two different elastic modules. The analytical model is built up in order to estimate the ability of these alloys to absorb the strain energy induced by a simple external loading. However, the thermo mechanical parameters of the SMA are determined experimentally. The obtained results reveal differences in absorption level of this strain energy depending on the state at which is the alloy, i.e. at the austenitic or martensitic phase.

In fact, these results allowed us to determine the different transformation temperatures of the SMA, on one part, then their Young modules on the other part, so that to validate the model of the stress-strain behaviour law. The quantification to evaluate the capacity of the SMA to absorb the strain energy is essential in order to improve the performances as well as to optimise the conception of these types of intelligent materials.

Keywords: Thermo mechanics, strain energy, Shape memory alloy, smart materials, martensitic transformations.

8262 | The Effect of Polymer Filling on Dynamic Response of Metallic Corrugated Core Sandwich Panels under Air Blast Loading – Experimental Study

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Sandwich structures with corrugated cores have attracted a lot of interest for multifunctional applications. Previous studies have revealed that while the metallic corrugated sandwich panels have a superior blast resistance to monolithic plates with same mass at low impulses levels, they are more susceptible to fracture in the most severely loaded scenarios. In this paper, effective approaches to enhance the blast resistance of sandwich structures with corrugated cores by filling the spaces within core with polyvinyl chloride (PVC) foam and polyurethane elastomer are explored. A sheet folding and laser welding method has been used to fabricate the empty corrugated core sandwich panels. The polymer fillers were manufactured using a computer-controlled numerical milling machine (CNC) from polymer sheets to produce trapezoidal cross-section prisms having the same shape of the interstices of the corrugated core. Blast experiments of three sandwich panels were conducted in an explosion tank. They are a corrugated core sandwich panel with no filling which is the benchmark, a corrugated core sandwich panel filled with PVC foam and one filled with polyurethane elastomer. Experimental results demonstrated that a considerable improvement of blast performance in view of the back face sheet deformation came from the addition of polymeric filler. Due to the synergies between the polymeric fillers and steel corrugated core, the buckling strength of core members would be enhanced, and the buckling wavelength of the core webs would be significantly reduced. The PVC foam fillers suffered crushing deformation accompanied with crack fracture, while the polyurethane elastomer fillers only underwent plastic deformation at the panel center. It is found that for the PVC foam filled corrugated core sandwich panel, the joints between back face sheet and core webs at the panel center were likely to fail, due to the lateral support force from the PVC foam fillers. The deformation of back face sheet of a corrugated core sandwich panel filled with PVC foam is similar to that of one filled with polyurethane elastomer. However, the former is much lighter than that of latter. The corrugated core sandwich panel filled with PVC foam is therefore more effective than that filled with polyurethane elastomer.

8273 | Low-velocity impact damage initiation of flax fibre reinforced composites: effect of projectile diameter, temperature and water absorption

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In recent years natural fibre has been utilised as an environmentally friendly reinforcement to replace asbestos and fibreglass in strengthening thermosetting and thermoplastic polymers for various applications. A number of investigations have been carried out to assess the potential of natural fibres as reinforcement in polymers, some comparative studies between laminates reinforced with different species of natural fibres and polymers have been published. It has been found that these light weight natural fibre composites possess better electrical resistance, good thermal and acoustic insulating properties and higher resistance to fracture. There are some reported works about low-velocity impact strength and energy absorption of natural fibre composites in literatures, including the influences of fibre type, fibre surface treatment, fibre volume fraction, microvoid content, moisture content, loading velocity and projectile geometry.

However, compared to conventional reinforcements such as glass and aramid fibres, problems come from the plant structure such as defects, can cause anisotropy within the materials, causing relative low mechanical properties. Therefore, the application of natural fibre composites is still limited to non-structural components e.g., panels, ceilings, partition boards and interior car components. One of the principal reasons for this limitation is the sensitivity of natural fibre composites to impact loading and its low impact strength as compared to glass fibre reinforced thermoplastic and thermosets composites. Actually, it is always difficult to assess the impact resistance of a fibre reinforced polymer composite since the damage modes are very complicate such as delamination at the interface, matrix cracking fibre breakage and fibre pulls out, which play important roles on progressive failure mode and energy absorption capability of composite structures. Understanding the deformation and damage mechanisms involved in the impact of composite targets is important in the effective design of a composite structure. In the low-velocity impact process, sudden load drops on the impact force-time plots indicates strain energy release due to damage propagation within the plate. The damage initiation of impact on laminated composite structures is one of the most crucial aspects during the entire impact process.

The mechanical properties and fracture properties of natural fibre reinforced composites will deteriorate when exposed to various environments which will affect the service life. Thus, one of the main concerns for the application of natural fibre reinforced composite materials is their susceptibility to temperature and moisture, and the effect on their physical, mechanical and thermal properties. Therefore, it is important to know the effect of environmental degradation on the damage initiation of natural fibre reinforced composites. Few researchers have studied the effect of temperature on the impact response of composite structures. Erickson et al [1] showed that temperature can have a significant influence on energy absorption in sandwich structures. It was found that the effect of temperature was less evident in the strength and stiffness properties of the glass fibre reinforced laminates. Icten et al [2] conducted tests on glass fibre reinforced epoxy beams at temperatures down to -20 °C and found that damage is greater in samples tested at the lower temperatures. Im et al [3] observed a reduction in damage as the temperature increased during high velocity impact tests on carbon fibre/epoxy and carbon fibre/PEEK composites.

Nature fibres are a natural structure made of cellulose fibres which contains numerous hydroxyl groups that are strongly hydrophilic. The rate of water absorption of a composite depends on many variables including fibre type, matrix, temperature, the difference in water distribution within the composite, reaction between water and the matrix, among others [4]. Then, natural fibre reinforced polymers can take up a high amount of water, which generally causes a reduction in mechanical properties [5].

The objectives of the present work is to investigate the effect of projectile diameter, temperature and water absorption on damage threshold and damage initiation in flax fibre reinforced epoxy resin laminates subjected to low velocity impact loading. The experimental was designed to reveal the damage transpire when a natural fibre reinforced composite laminate is subjected to low-velocity impact under various environmental conditions. The findings can be used in an attempt to identify general trends and guide subsequent research aimed at controlling and reducing the degradation of residual properties of impacted composite laminates.

8276 | The Preserving and Improvement of Historical Structures based on Qualified a RC Structure: A Case Study

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In restoration, repairing and strengthening applications of historical structures, it is accepted that transfer new generations and maintain preserving of historical heritage is an important factor. However, performed such applications within the scope of retrofitting of the mentioned structures should be carried out that not lose integrity with the originality of the structure by employing an interdisciplinary approach. This study focuses on restoration studies in architecture and improvement applications without interfere the originality of cultural heritage and thus, the study aimed to be reference for this type of projects. In the present study, Faculty of Arts and Sciences block building located in Istanbul University that registered as Protection required of cultural asset by the Protection of Cultural Assets District Board is investigated. It is examined that retrofitting techniques in the block building is performed repairing and strengthening applications by carbon fiber, steel mesh, steel profile and sprayed concrete over structural elements such as external wall, infilled walls, column, beam and foundation.

8282 | Effects of alumina particles on the steady state time in synthesis of Al7014- 3 wt. % Al2O3 nanostructured composite by mechanical alloying

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Nanostructured Al7014- 3 wt. % Al2O3 composite was synthetized by mechanical alloying using micrometric constituents in different milling times including 10, 20, 30, 40 and 50 hours. To analyze the samples X-ray diffraction (XRD) analysis, laser particle size analysis (LPSA) scanning electron microscope (SEM), transition electron microscope (TEM) and microhardness measurements were carried out. The results revealed that alumina particles decelerated reaching the steady state since without addition of reinforcement, after 30 hours milling the steady state was obtained while after adding alumina particles it took 40 hours to reach the steady state. In addition, the average particle size and crystallite size of the resultant powders in composite particles were higher than those without addition of reinforcement. Also, the level of hardness in composite powder was lower than that in alloy powder.

8283 | Synthesis of an impact resistant hybrid GFR Epoxy/nanocaly composite

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Addition of organoclay to polymer matrix has recently attracted industry attention due to improved physical properties with an overwhelming potential in crude oil and water pipe applications. In this work, electrical grade-corrosion resistant (E-CR) glass fiber mats were used to prepare glass fiber reinforced epoxy (GFRE) nanoclay composites using hand layup method. Three different hybrid GFRE composites were synthesized using 0, 1.5 and 3 wt% loading of I.30E nanoclay to improve water uptake resistance along with the impact response of laminates. The composites were tested under low-velocity impact between 10 and 50 J. The addition of nanoclay improved the peak load and reduced absorbed energy while improving the threshold energy level, reducing impact damage and increasing the stiffness. Addition of 1.5 wt% nanoclay resulted in optimum properties with up to 23% improvement in peak load, 11% increase in stiffness and 66% reduction in damage. The improvement decreased on addition of further clay owing to clay agglomeration observed in samples of higher clay loadings.

8285 | Stochastic Effect of Grain-Elongation on Nanocrystalline Materials Strain and Strain Rate Produced by Accumulative Roll-Bonding and Equal Channel Angular Pressing

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Stochastic Effect of Grain-Elongation on Nanocrystalline Materials Strain and Strain Rate Produced by Accumulative Roll-Bonding and Equal Channel Angular Pressing

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Abstract:
Accumulative Roll-Bonding (ARB) and Equal Channel Angular Pressing (ECAP) are severe plastic deformation (SPD) techniques that are acknowledged to produces elongated grains during the deformation of nanostructured materials. The conventional models relating grain size to properties considered only the equivalent radius r. Parameters such as semi minor axis radius r2, semi major axis radius r1 and major axis radius r3 are not considered. In this paper a stochastic model of grain-elongation for 3-D grain has been developed by considering the equivalent radius r, semi minor axis radius r2, semi major axis radius r1 and major axis radius r3 to study the effect of size on strain and strain rate for (ECAP) and (ARB) processing routes. The proposed models are tested with grain elongation data obtained during grain growth. It is also shown that the more the elongation the higher the properties. It is also observed that properties vary in different ways with equivalent radius r, semi minor axis radius r2, semi major axis radius r1 and major axis radius r3. It is further observed that the yield stress as a function of strain is similar to that of the Hall-Petch and Reverse Hall-Petch Relationship. From the developed stochastic model of grain-elongation for 3-D grain that deal with the equivalent radius axis r, semi minor axis r2, semi major axis r1 and major axis radius r3, more properties for nanomaterials have been revealed that were ignored from the conventional models that dealt only with the equivalent radius r.
Keywords: grain-elongation, yield stress, strain, strain rate, Accumulative roll-bonding (ARB), Equal channel angular pressing (ECAP), nanomaterial's, mechanical properties, nanostructures, stochastic models, equivalent radius, semi minor axis radius, semi major axis radius, major axis radius.

8294 | Fire behaviour of thermally insulated RC beams strengthened with EBR-CFRP strips: experimental study

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This paper presents experimental investigations on the fire behaviour of reinforce concrete (RC) beams flexurally strengthened with carbon fibre reinforced polymer (CFRP) strips installed according with the externally bonded (EBR) technique. The tested specimens were simultaneous subjected to a service load and to the standard fire. Different fire protection schemes, with thinner insulation layer applied along the bottom soffit of the beams and thicker ones at the CFRP anchorage zones, were studied. This investigation aimed understanding in further depth the structural effectiveness of the strengthening system during a fire exposure and experimentally evaluated the efficiency of the adopted fire protection strategy in extending the CFRP mechanical contribution during fire. The (potential) beneficial effect of applying mechanical anchorages at the extremities of the CFRP strips and the usage of a bonding adhesive with high glass transition temperature (Tg) on the fire performance of the strengthening system were also evaluated. The obtained results showed that thicker fire insulation layers applied at the CFRP ends allowed to the strengthening system retain its structural effectiveness through a cable mechanism after the bonded interface had been destroyed in the central zone, and therefore extending its structural effectiveness up to 70 min of fire exposure. With the adopted insulation schemes, the debonding of the CFRP system occurred when the average temperature in the adhesive at the CFRP anchorage zones attained values from 1.2 Tg to 1.5Tg. The obtained results confirmed that the usage of mechanical anchorages or high Tg adhesives can also extend the structural effectiveness of the strengthening system.

8297 | Stochastic characters of nanostructures in nanomaterials contribute to nanomaterials mechanical property controversies

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There are varying and conflicting reports about nanomaterials constituent structures, mechanical properties and their interrelationships in the published literature. Varying processing routes, processing conditions, grain size distribution and grain shape distributions are suggested as reasons behind these conflicts. The present paper further expounds on the reasons for the varying and conflicting results by employing the tools of stochastic theory. Specifically, the principle of the Compound Poison Process is used to related individual grain strain to the overall material strain. The strain, strain rate and yield stress relationships are then proposed both individual grain observations and the entire material observation. The proposed models are tested with grain growth data from polycrystalline nano-aluminium samples.
It is revealed that a change in nanomaterial yield stress may be accompanied by change in grain strain without any change in entire nanomaterials strain. Thus, a microscopic observation can reveal a change in the grain strain while at the same time the strain gage would reveal no change in the entire nanomaterials. Many salient features and conflict results of the relationship between grain sizes, yield stress and strain are revealed when using different modelling approaches. The present paper further proposes that the varying reports might, further, be due to the use of different experimental approaches as results of different models.

8300 | The optical absorption ability of coaxial double-walled TiO2 nanotubes sensitized with FeS2 nanoparticles

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TiO2 nanotube arrays with coaxial double-walled structure have larger specific surface area compared with single wall nanotube, and the nanotubes demonstrate the expected potential depending on the outstanding properties of the geometrical features, remarkable optical, electrical and chemical properties. In this article, the coaxial double-walled nanotubes were successfully fabricated by oxidizing Ti substrates, and then the FeS2 nanoparticles of narrow band gap were loaded in the nanotubes as the sensitizer for forming the photoanode. In the fabrication process of FeS2/TiO2 nanotube system, the Fe2O3 nanoparticles as the precursor were electro-deposited on the nanotube array coatings firstly, and secondly, the sulfuration was employed for the conversion of Fe2O3 to FeS2. The FeS2/TiO2 was characterized by the field emission electron microscopies, X-Ray Diffraction, Raman spectroscopy. The optical absorption spectra confirmed that the FeS2/TiO2 nanotubes with coaxial double-walled structure caused a shift to higher wavelength absorption and showed improved optical absorption capacity.

8301 | ACTION OF THE ENVIRONMENT ON THE DURABILITY OF FIBRE COMPOSITES WITH CEMENT MATRIX

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Fibre concretes are modern building materials. Their excellent strength and deformation characteristics have already been sufficiently proven, however, their durability has not been established so far. During hydration and later during stressing, the firm bond between cement matrix and polymer or steel fibres can be disrupted. And thus tensile discontinuity appears which, together with the existing capillary system, decreases the durability of concrete. In general, durability depends on the properties of the surface layer of concrete but also on its internal structure. A number of testing methods have been described which assess the quality of capillary-porous system of concrete on the principle of measuring gas and liquid permeability.
The surface permeability tests were carried out on concrete slabs of four concrete formulas. The reference concrete (PC), two formulas of fibre concrete (corresponded to the formula for the PC with only PP fibres with a length of 54 mm amounting to 0.15% (SSFC 0.15) and 1.0% (SSFC 1.0) of the concrete volume added), and one formula with type 1 concrete recyclate (PP fibres at an amount of 1.0% (SSFRAC 1.0) of the concrete volume added). At the age

of approximately two months, permeability tests of the surface layers of concrete of the four formulas were carried out. The first test using the TORRENT method assessed the air permeability of the surface layer on the basis of monitoring pressure of the decreasing vacuum in the concrete under the attached chambers of the bell. The second test using the ISAT method evaluated the passage of water with a constant pressure of 20 cm of water through the surface of concrete of a specific area. The third test using the GWT method assessed the passage of water through the surface of concrete at a constant pressure of 0.2 bar. The fourth test was used to determine the coefficient of diffusion resistance for carbon dioxide using the method specified in EN 1062-6 Part 6: Determination of carbon dioxide permeability.
The determination of the surface layer permeability of fibre concrete and reference concrete slabs by means of TORRENT, ISAT and GWT methods proved the objectivity of all the three methods with a view to the comparable relative results of air and water permeability. The reference concrete PC showed the lowest permeability for both media, the fibre concrete with 1.0% of PP fibres SSFC 1.0 demonstrated a slightly higher permeability, fibre concrete with 0.15% of fibres SSFC 0.15 had even higher permeability, and the permeability of the fibre concrete made of recycled concrete with 1% of fibres SSFRAC 1.0 was high. It is interesting that the determined coefficients of diffusion resistance of concretes with dense aggregate with and without fibres correlate indirectly with the values of their permeability, but in the case of fibre concrete with concrete recyclate SSFRAC 1.0 the correlation is direct, i.e. the high permeability corresponds to a high coefficient of the diffusion resistance. This high value of diffusion resistance of concrete made of concrete recyclate is arguable, because the method based on EN 1062-6 is strongly dependent on the marginal conditions (position of the sample taken, size of aggregate, orientation). It could be explained by a chemical change of portlandite in the concrete recyclate into a more bulky carbonate, however, the time of three weeks in the environment of concentrated CO2 is too short. The results obtained will effectively supplement the planned research into the durability, or potentially permeability of fibre concretes under stress.
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8319 | Facile Preparation of Superparamagnetic Mesoporous Fe3O4@m-SiO2 Hollow Nanocomposite Microspheres and Their Application in Drug Delivery

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Past few decades in the field of materials science, great efforts were continuously devoted to the research on hollow microspheres with attractive properties, well-defined morphologies and wide ranged applications. In virtue of the existence of large fraction of void space in hollow structures, they were most commonly used in the delivery systems as container of drugs, genes, peptides and so on. Among various hollow microspheres, the silica-consisted ones are the most investigated due to their special advantages such as nontoxicity, highly biocompatiblity and mechanical stability. Especially, silica hollow microspheres with mesoporous structures are more suitable for the drug delivery via their diffusion-limited effects. The inner cavity can be used as the micro-reactor or storage reservoir, while the mesoporous shell will provide the pathways for encapsulation of substances.
Most of the fabrications on hollow microspheres were relied on the template-assisted method, such as hard template (inorganic spheres or polymer beads) and soft template (emulsions or vesicles). The hard cores should be removed by dissolving in good solvent or calcinated at high temperatures, which would bring in multifarious processes and consume a huge amount of time. Moreover, the calcination method will bring in sintering and structure breaking.
Magnetic nanoparticles (γ-Fe2O3 or Fe3O4) could be controlled by external magnetic field, and introduced into the drug delivery systems to endow their excellent magnetic control. Moreover, they can be also applied as MRI contrast agent or in hyperthermia therapy. Thus, fabrication of the Fe3O4 nanoparticles encapsulated in hollow mesoporous silica spheres for avoiding multifarious process and the structure breaking or sintering problems is deserved for deeper research.
Herein, we reported the fabrication of superparamagnetic mesoporous Fe3O4@m-SiO2 hollow nanocomposite microspheres by a very simple method. Monodispersed P(St-AA) microspheres were obtained by soap-free emulsion polymerization, and Fe3O4 nanoparticles were in-situ formed on the surface of P(St-AA) microspheres. Silica shell was then formed during the sol-gel process simultaneously with the dissolution of P(St-AA) core, avoiding the troublesome treatments to remove the inner template. The effects of variables such as the feeding amount of ammonia and TEOS on the structures were investigated. The as-fabricated magnetic hollow microspheres have good magnetic responsiveness, which can be applied in the field of drug delivery.

8321 | Surface modification of zirconia substrate with bioactive nanocomposites for enhancing biocompatibility

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1. Introduction
Ceramics are attractive dental materials because of their superior aesthetics, inertness, and biocompatibility. However, ceramics are generally brittle and subject to premature failure, especially in repeated contact loading and moist environments. Zirconia has attracted a great deal of attention owing to its good chemical and dimensional stability, its mechanical strength and toughness, and biocompatibility, which was introduced into medicine and dentistry as an ideal replacement for metal. Zirconia is frequently used in the high load-bearing sites such as orthopedic and dental implants, but it does not naturally form a direct bond with bone and thus does not provide osseointegration.
Hydroxyapatite (HA) is a major inorganic component of mammalian bones and has been shown to have a high biocompatibility. Moreover, recent studies have revealed an enhancement of the biological behavior of HA after the silicon (Si) doping. The doping of HA with Si would be a potential method to improve their bioactivity either in vitro or in vivo. With their high area to volume ratio, Si-substituted HA nanocomposites are expected to be excellent materials for biomedical applications. In this study, an attempt was made to develop a new sol-gel technique for the synthesis of Si-substituted HA nanocomposites with different morphology in the presence of alginate as a template and the surface modification of zirconia substrate. The prepared nanocomposites were systematically examined by considering their morphologies, compositions, chemical structures, crystalline phases and thermal properties. Moreover, the ability of bone-like apatite formation on the surface of Si-substituted HA nanocomposites by immersion in simulated body fluid (SBF) was evaluated. In addition, the cytocompatibility of zirconia coated with nanocomposites was evaluated by assaying cell proliferation.

2. Experimental
A synthesis of Si-substituted HA sol is as follows. Ca(NO3)2•4H2O, (C2H5O)3P, and Si(OC2H5)4 were used as raw materials for preparing the sol and dissolved in ethanol. Then, pH was adjusted to 4 by the addition of 0.1 N HCl. The mixture solution was stirred vigorously for 24 h at 40 °C and aged at 60 °C for 6 h. The resulting sol was evaporated for 1 h to increase the viscosity and to obtain the sol solution with a solid content of 80 w/v%. This sol solution was mixed with 0.02 w/v% alginate solution for coating on the surface of zirconia substrate, followed by thermal treatment at 600 °C for 1 h. The

characterization and biocompatibility assay were carried out in detail.

3. Results and discussion
Surface modification of zirconia substrate was performed by coating with Si-substituted HA nanocomposites, which were prepared by simple sol-gel technique and thermal treatment in the presence of alginate. All samples showed spherical type of nanoparticles and the content of Si affected the particle size of Si-substituted HA nanocomposites. EDX, FT-IR and XRD analyses confirmed successful introduction of Si-substituted HA nanocomposites on the surface of zirconia substrate. In addition, the results from simulated body fluid immersion (SBF) test and cell viability assay exhibited the improved in vitro bone bioactivity of surface modified zirconia substrate.

4. Conclusions
We fabricated the surface modified zirconia substrate with Si-substituted HA nanocomposites for enhancing the biocompatibility and bioactivity of zirconia through the sol-gel technique and thermal treatment method. This is very simple and effective method for the fabrication of biocompatible ceramics.

8323 | MITC9 SHELL ELEMENTS BASED ON REISSNER MIXED VARIATIONAL THEOREM FOR THE ANALYSIS OF ANISOTROPIC MATERIALS

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Anisotropic materials are materials whose properties are directionally dependent. Unlike isotropic materials that have material properties identical in all directions, anisotropic material's properties such as Young's Modulus, change with direction along the object. Common examples of anisotropic materials are wood and composites.
In the two dimensional modelling of multilayered plates and shells, the main interest is to study the mechanical response, that may change in the thickness direction. In particular, the transverse shear and normal stresses are required to be continuous in each layer interface (Interlaminar Continuity, IC).
Among the computational techniques developed for layered constructions, a predominant role is played by Finite Element Method (FEM). In this regard, two variational formulations are available to reach the stiffness matrices, the Principle of Virtual Displacement (PVD) and the Reissner Mixed Variational Theorem (RMVT). The PVD, formulated with only displacements, cannot describe a priori IC for transverse stresses. On the contrary, they can be a-priori assumed in the framework of RMVT, which consists of a mixed principle for multilayered structures.
It is known that when FEM is used to study shell structures, the phenomenon of numerical locking may arise: the so-called membrane and shear locking. A well known remedy for the locking is the use of the Mixed Interpolated Tensorial Components (MITC) technique.
In previous authors' papers, a strategy similar to MITC approach in the RMVT formulation has been introduced in order to construct an advanced locking-free finite element based on Carrera's Unified Formulation to treat laminates made of isotropic or ortotropic layers with fibres orientation 0° and 90°.
The present work extends this element to the analysis of anisotropic composites with layers arbitrarily oriented. In particular, the MITC approach through the RMVT formulation is revised in order to take into account the coupling between the transverse shear stress components σ_{xz} and σ_{yz}.

References:

[1] Cinefra M., Chinosi C., Della Croce L., Carrera E., Refined shell finite elements based on RMVT and MITC for the analysis of laminated structures, Composite Structures, 113, 492-497, 2014.

8325 | Carbon nanotube coated glass fiber using ionic interaction and their thermoplastic composites

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Thermoplastic matrix composites have attracted much attention due to rapid process speed for mass production. But, thermoplastic composites have lower mechanical properties than thermosetting composites. Some researches using nano- or mirco- particles for reinforcing thermoplastic resin are published. However, the particles increase viscosity of resin and cause the lowering of processabiliy as a result. We used the particle coating method to overcome these problems.
The thermal gradient control is also important process in manufacture of thermoplastic composites. Thermal heat from exterior make thermal gradient in process. Therefore, composites integrity becomes worse due to lower resin fluidity at the inside. To solve this problem, the direct heating from interior of composites is needed.
In this study, glass fabric was coated by carbon nanotube (CNT). The CNTs were used reinforcement for mechanical properties and heating element for composite processing. CNT and surfactant solution were used to coating and the fabric was coated by hydrophobic interaction between fiber and CNT. The composites were fabricated by laminated molding of coated fabric and polypropylene film. Mechanical and electrical properties of composites were investigated.

8331 | An isogeometric collocation approach for laminated plates using higher-order shear deformation theory

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In this work we present the application of collocation method for NURBS-based isogeometric analysis to the solution of laminated plates. The

corresponding equations of kinematics, constitutive and equilibrium will be presented with the strong form equations of the problem in displacement based formulation. These equations belonging to strong form will be solved by using isogeometric collocation method.
The aim of isogeometric analysis (IGA) is unifying Computer Aided Design (CAD) and Computer Aided Engineering (CAE). Non- Uniform Rational B-Splines (NURBS) is a kind of IGA that most commonly used in engineering problems. The major strengths of NURBS are that they are convenient for free form surface modeling, can exactly represent all conic sections, and therefore circles, cylinders, spheres, ellipsoids, etc.. When a NURBS model is constructed, the basis functions used to define the geometry can be systematically enriched by h-, p-, or k-refinement without altering the geometry or its parametrization. This means that adaptive mesh refinement techniques can be utilized without a link to the CAD database, in contrast with finite element methods. This appears to be a distinct advantage of isogeometric analysis over finite element analysis. NURBS are higher order functions with high continuities between the elements. This is reason why IGA has shown to provide better results in terms of accuracy and computational effort, compared to low order FE analysis, in various fields of analysis. Until now, generally isogeometric analysis has been implemented by Galerkin formulations.
On the other hand Collocation Method is a simple and efficient numerical method for solving differential equation, which can generate a numerical solution satisfying the differential equation at a set of discrete points, called collocation points [1]. The major advantage of collocation is the reduced number of evaluation points compared with the Galerkin method. If an unknown NURBS basis function is employed to approximate the analytical solution of a differential equation and its order is high enough, the collocation method can be applied to the strong form of the differential equation. Based on this fact, Auricchio et al. proposed the well-known isogeometric collocation (IGA-C) method [2]. IGA-C typically achieves better convergence rates than IGA (or FEA) Galerkin.
A novel numerical approach using a NURBS-based isogeometric Galerkin method associated with third-order shear deformation theory (TSDT) is formulated for static analysis of laminated composite plate structures [3].
Present paper, extends the study [3] by using isogeometric collocation method. A plate model relies on third order shear deformation theory in which shear correction factors are no longer involved. A formulation of generalized displacements using the NURBS basis functions can yield higher-order continuity and hence the requirement of C1-continuity of the TSDT is easily achieved. We also present an analytical cost comparison between the isogeometric Galerkin method [3] and the isogeometric collocation method.

References
[1] Cottrell J., Hughes T.J.R., Bazilevs Y., “Isogeometric analysis: Toward integration of CAD and FEA”, Wiley, 2009.
[2] Auricchio F., Beirao Da Veiga L., Hughes T.J.R., Reali A. and Sangalli G., (2010), “Isogeometric Collocation methods”, Mathematical Models and Methods in Applied Sciences, vol.20, no.11, pp. 2075-2107
[3] Thai-Hoang C., Nguyen-Xuan H., Bordas S.P.A., Nguyen- Thanh N., and Rabczuk T., (2012), “Isogeometric analysis of laminated composite plates using the higher-order shear deformation theory”, Mech. Adv. Mater. Struct., Taylor & Francis.

8343 | Effect of temperature on the creep characterization of dental composite resins

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Introduction:
There are many dental filling materials for treatment of tooth decay, composite resin is one of the most common materials due to its esthetic tooth color, maximum amount of tooth preservation, single visit for fillings, strong and durable. However, the creep characterization of the composite resin is a significant aspect of the mechanical performance of polymer-based materials.
Objective:
The purpose of this study was to evaluate the effect of temperature on the creep behavior of dental composite resins
Materials and methods:
Three types of the dental resin-composites were evaluated in this study: FiltekTM Z250 XT, Estelite flow quick and G-ænial Universal Flo. Each type of the three dental resin-composites included 15 specimens. Stainless steel split molds were used to prepare cylindrical specimens for creep examination. Creep curves were recorded over loading and unloading periods at three level of temperature: 17, 37, and 57 oC . Statistical analysis was performed by two-way ANOVA at significant level of a= 0.05.
Results & Conclusion:
The higher temperature group exhibited great creep behavior. The creep characterization in the three types in the following order: Estelite flow quick ≅ G-ænial Universal Flo > FiltekTM Z250 XT. Difference in time dependent deformation and recovery of dental composites were influenced by types and temperatures.

8364 | An OVERVIEW OF COMPOSITE THERMAL DOUBLERS FOR SPACECRAFT BUS STRUCTURES

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Thermal doublers, bonded onto structural composite panels, are often tailored to provide the desired combination of thermal conductivity, elastic modulus, and coefficient of thermal expansion to spread the heat and minimize potential residual stresses. Since the use of composites in spacecraft bus structures, different types of composite thermal doublers have been designed, and fabricated to manage the increasing heat loads from critical components such as avionics boxes, and Travelling Wave Tube Amplifiers (TWTA). Selection of a specific composite thermal doubler has been governed by the combination of a few key parameters: desired properties, availability of high thermal conductivity materials, ease of fabrication and integration, and cost. While satisfying the thermal and mechanical requirements, the size of composite thermal doublers may be as large as 65 cm. x 65 cm. and thickness ranging from 0.76 mm to 1.25mm.

Lockheed Martin Space Systems has used different types of composite thermal doublers on multiple space missions. For example, the low modulus (≤28 GPa) carbon-carbon (C-C) composite with thermal conductivity (~160 W/m-K), and high modulus C-C with inplane thermal conductivity (~300 W/M-K) and through-the thickness conductivity (~30 W/m-K) have been used in several applications. However, the high heat load components such as TWTA have dictated the need to use high performance thermal doublers which offer thermal conductivity ≥ 400W/m-K in one inplane direction (X) and ~200W/m-K in

the Y direction. Several K1100/Thermalgraph/RS-3 and K13D2U/Thermalgraph/RS3 based composite doublers have been successfully fabricated and tested to satisfy the thermal and mechanical requirements. More specifically, the K1100/Thermalgraph/RS-3, and K13D2U/Thermalgraph/RS3 thermal doublers have been successfully integrated and flown on the Mars Reconnaissance Orbiter spacecraft, on a lunar mission spacecraft respectively. With the limited demand and usage of K1100 and Thermalgraph materials for aerospace applications, these materials are no more in production. Using a commercially available eGraf 500, recently, Lockheed Martin has designed and developed K13C2U/eGraf 500/ EX1515 based composite thermal doublers with inplane thermal conductivity of 300 W/m-K for a spacecraft mission. A few of the spacecraft missions have also used aluminum or carbon composite encapsulated annealed pyrolytic graphite based thermal doublers with inplane conductivity between 1000-1200 W/m-K. An overview with specific details of the development, test, and integration effort of different composite thermal doublers are discussed in this paper.

8366 | Design and Manufacturing of a Low Acoustic Impedance (LAI) Transducer for Health Monitoring of Composite Plates

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Closed-surface defects such as voids and inclusions are among the most common types of damage occurring in polymeric composite materials. Conventional Non-Destructive Testing (NDT) techniques such as ultrasonic testing (UT) are not always suitable for these types of the defect as –for instance– pitch-catch based techniques are ineffective in detecting damage near the surface. A novel method of detecting defects for Low Acoustic Impedance (LAI) targets which relies on energy transmission has been proposed in the past by the authors. Unlike UT, it has been shown that our novel LAI technique is particularly suitable for near-filed application. The proposed technique's novelty lies in the fact that the active piezoelectric transducer is resonated radially rather than through the thickness. When resonated radially, the transducer displays a stable resonant frequency peak and lower 'effective acoustic impedance' compared to the 'thickness-extension' mode and as such the technique is particularly indicated for polymeric composite plates.
This paper presents the design philosophy and the manufacturing steps implemented to produce a LAI prototype transducer to be used in diagnosing defects in composite plates. First, a two-dimensional analytical model describing the interaction between the transducer and the system is briefly introduced. The results from the analytical model are used to introduce and justify some of the design selections made to manufacture the prototype transducer. Subsequently, the steps involved in manufacturing the LAI device are outlined and briefly discussed. As part of the design process, a parametric study to investigate the effect of the transducer's frame size is presented. Also, the steps undertaken to reduce the electromagnetic (EM) noise interference and unwanted environmental effects such as wetting of the transducer are presented. In terms of operation, the effects of normal pressure and the target's surface roughness on the device's signal have been investigated experimentally and a sensitivity study presented. Finally, a water-roof, EM noise insensitive, LAI prototype is built and tested. The prototype was shown to effectively detect near-the-surface damage on fiberglass-epoxy composite stroke by an impactor in the 10 to 30 kJ range. The experimental results prove the ability of the proposed design to effectively quantify the defects' magnitude and clearly establish the dimension of affected region.

8368 | PATH FORWARD – LOW COST HIGH VOLUME MANUFACTURING OF CARBON FIBER COMPOSITES

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The carbon fiber polymer matrix composite market is a high value and rapid growing sector with numerous opportunities to create economic growth. Worldwide opportunities in automotive parts, wind turbine blades, sporting goods, off-shore drilling as well as aerospace markets estimated to be billions of US dollars. Today, use of carbon fibers is expanding from aerospace applications into more mainstream mass-market. Interest also moving towards development of high volume fast cycle thermoplastic composite processes and it is also seen that integration of low-cost carbon fiber into rapid processes is crucial step of commercialization of affordable carbon fibers and their composites. The combination of these technologies will extend the ability to rapidly and sustainably manufacture affordable composite products. This paper discusses the emerging technologies to manufacture low-cost carbon fibers as well as their composites.

8369 | The effect of MWCNTs on the low field ac conductivity of PZT/PVDF nanocomposites

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The effect of multiwalled carbon nanotubes (MWCNTs) on 0-3 piezoelectric nanocomposites of polyvinylidene fluoride (PVDF) and lead zirconate titanate (PZT) has been investigated. A 20 vol. % PZT/PVDF composition was chosen as the base matrix for the 3-phase composites. The composites were prepared by solution casting followed by hot pressing at 25MPa. The weight fraction of MWCNTs was varied from 0.002 to 0.01. In order to ensure their adequate dispersion, functionalized CNTs were used. Detailed investigation into the low field ac electrical behavior of the PZT/PVDF/CNTs composites was done by impedance spectroscopy in the mHz to MHz range, from room temperature to 160 ºC. The low field behavior of the ac conductivity of the 3-phase composites manifests two different Arrhenius temperature dependences. The conductivity in the low temperature zone is a result of the Maxwell Wagner Sillars (MWS) effect while at higher temperatures the rise is a result of the mobility of the crystalline segments besides other intrinsic conductivities. The two different temperature zones suggest that the ac conductivity of composites does not correspond to a single thermally activated process. Also the CNTs impart a higher conductivity to the 3-phase composites as compared to the 2-phase composites. The energy of activation (Ea) in the low temperature region is higher than that at higher temperatures implying that the conductive processes at higher temperatures are more viable.

8372 | Development and Characterization of C/C-SiC-Cu brake disc

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A new production process was developed for full-size Carbon/Carbon-SiC-Cu (C/C-SiC-Cu) brake discs. A C/C-SiC-Cu disc consisted of two friction layers and a structural layer. PAN-based carbon fibers (T700, 12K, Toray, Japan) were used as a reinforcement elememt. Carbon fibers were submerged in phenol resin to coat their surfaces. Coating protects the surfaces of the carbon fibers during mixing process. Dried fibers were chopped into short pieces, 3~30 mm. The chopped carbon fibers were mixed with phenol resin powder by a mixer for 100 seconds. The volume fraction of the fibers was 70 vol. %. The brake disc was composed of three layers: upper and lower frictional layers and inner structural part sandwiched between the two frictional layers.

Each layer was formed separately. To fabricate the green bodies, temperature increased to 170°C and was maintained for 30 minutes. The apparent density of the preforms was 1.7g/cc . To pyrolyze the preforms, the temperature increased at the rate of 10°C up to 1000°C in a thermo gravimetric analyzer under inert gas environment. The volatile compounds in the phenol resin started to evaporate at about 200 °C and the weight of the preform decreased as the temperature increased. At 1000°C the weight loss was about 50%. The preforms were finally heat-treated at 2000°C. The size of the frictional layers were ϕ380×ϕ240×20t. The structural layer was ventilated as a common brake discs. The three pieces were bonded by hot pressing. Finally the C/C composite was infiltrated with molten Si and Copper at 1550°C. By using specimens made from the disc, thermal and mechanical properties were characterized and micro-structural analysis was carried out. In addition, tribological tests was performed under various conditions. Counterpart friction material was a comercial brake pad. It was found out the developed C/C-SiC-Cu disc had a goog tribological performance.

8373 | Synthesis and characterization of a novel composite pre-polymerized coagulant, polyaluminum ferric silicate chloride, for water and wastewater treatment

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The aim of this study was the synthesis and characterization of alternative composite inorganic coagulants resulted from the incorporation of polysilicates and ferric salts in the structure of commonly applied polyaluminum chloride (PACl) in the coagulation–flocculation (C/F) process in order to increase its efficiency for water and wastewater treatment. The new product is called polyaluminum ferric silicate chloride (PSiFAC) and is synthesized under various conditions and preparation method (co-polymerization or composite polymerization). Major typical properties of the prepared coagulants were examined, i.e. pH, turbidity, conductivity, Al species distribution (e.g. keggin-Al13), employing the ferron technique, and basicity (%). The composition, structure and morphology of the composite coagulants were studied in detail as well, with the application of FT-IR and SEM techniques. The results show that the new composite materials have high basicity (66%) and Al13 content (51%). The study of FT-IR spectra exhibit intensive peaks, among others, at around 1098–1100 and 831–833 cm−1 which can be attributed to the stretching and bending vibration of Fe–OH–Fe and Al–OH–Al respectively in the coagulant, indicating the existence of the polymerization. SEM micrographs show the resulting amorphous structures on the surface of the composite coagulant, as well as clinging block-shaped crystals, probably because of the formed NaCl. Overall, the FTIR and SEM analysis of PSiFAC samples indicate that the preparation method has no effect on the structure and morphology of the samples but indicates differences in their physicochemical properties.

8375 | Effect of damping of fiber-reinforced epoxy composites on the volume fractions of glass fiber

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The damping property of the composite is one of the main factors that influences the structural dynamic characteristics. With the increasing demand for high damping of intelligent composite materials, the need to consider the damping properties changed with vibration frequency, amplitude, environmental temperature is more than ever before. Also, frequency-dependent and temperature-dependent composite design have been a hot area of research. The fiber-reinforced epoxy composite is one of the commonly used high performance composite materials, for its high specific intensity and strength and excellent damping and corrosion-resistance property, has been widely used in composite structures such as in aviation, aerospace, automobile, engineering machinery.
The paper considers epoxy resin matrix CYD-128 and its composites reinforced by the different volume fractions of SWU414 fiber. The Poxy resin reinforced by the glass fibre according to different volume fractions (60%, 50%, 40%, 30%, 20%, 0%) are considered as test specimens. The damping properties of test specimens were estimated by dynamic mechanical analysis (DMA). The DMA can measure the energy storage module, loss module and loss factor of the fiber-reinforced epoxy composite changing with frequency and temperature. With these experimental data, we identify the relaxation parameters using different damping models, including Biot model, ADF model, GHD model and fractional derivative model. By considering the different volume fractions of glass fiber, the best damping model to describe the fiber-reinforced epoxy composites is disscussed. The finite element (FE) method is used to analyse the dynamic responses of the fiber-reinforced epoxy composites with different damping models. Several conclusions concerning the applicability of the damping of the fiber-reinforced epoxy composites are formulated on the basis of results of both the experimental data and an extensive numerical analysis.

8376 | Experimental Research on Concrete-Filled FRP Composite Pile-Soil Interaction under Bidirection Horizongtal Cyclic Loading

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This paper presents the results of a model exprimental study designed to analyze the behaviors of the pile-soil interaction of fiber reinforced polymer (FRP) tube filled concrete-core under bidirection horizontal cyclic loading and horizontals static loading in sand. The instumented FRP-Concrete composites model piles were installed by jacking or driving into an artificially-created sand deposit in south-east China. A series of tests provided continuous measurements of bearing characterisitc of concrete-core FRP pile as well as the development of interaction of pile-soil, changing the size or frequency and circulation number of horizontal static loading and horizontal cyclic loading respectively.The significant softening for the soil arround the FRP piles had been occurred under the larger horizontal circulation load. The horizontal resistance of FRP piles had been strengthened by increasing the magnitude of load and weakened by improving the number of cycles. Two kinds of effects of loading frequency and circulation number should be considered simultaneously for understanding the pile-soil interacion of FRP piles especially for medium dense sand. The influence of horizontal cyclic loading to horizontal coefficient of proportion of the ground installed FRP piles was analyzed firstly in order to obtain the development of horizontal cyclic loading to subgrade resistance coefficient. The horizontal subgrade resistance coefficient may be improved during loading increasing the cycle count. A new design method for calculating subgrade resistance coefficient of FRP piles in sand is proposed.

8384 | Improvement of the Flame Retardancy of Plastized Poly(Lactic Acid) by Means of Phosphorus Based Flame Retardant Fillers

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In recent years, biodegradable polymeric materials have attracted more attention due to the increase in environmental pollution and quick decrease in the petroleum energy sources. Among the biodegradable polymers, Poly(lactic acid) (PLA) plays a dominant role due to its low cost, availability from renewable resources and relatively superior performance characteristics [1]. But unfortunately, PLA has poor fire resistance property just like common synthetic thermoplastics owing to its own intrinsic chemical structure. This limits its important applications and development, especially its potential application in many areas [2].Therefore, the improvement of flame resistance performance of PLA is still an important task [3]. Besides, only a few studies on the fire retardance of PLA have been performed until now. According to these studies, although the combustion properties of PLA can be improved by using flame retardants to the matrix, the composites become more brittle at the same time. Therefore, it is necessary to improve the flame retardancy and toughness of PLA simultaneously. [3].

The aim of this study is to improve the flame resistance and toughness of PLA with addition of low amount of flame retardant fillers and plasticizers simultaneously. Poly(ethylene glycol) (PEG) was used as plasticizer for PLA and the amount of PEG was fixed as 10wt % in the PLA matrix. Ammonium polyphosphate (APP), boron phosphate (BP) and tri-phenyl phosphate (TPP) were selected as flame retardant additives. Among these flame retardant additives, boron phosphate was synthesized from raw materials contain of boron and phosphate by using microwave heating technique. The flame retardant fillers with 10 wt. % loading were added separately into the PLA/PEG matrix. A series of plasticized PLA-based flame retardant composites were prepared by using melt blending and injection molding methods. Characterization of these composites were performed by conducting tensile strength, differential scanning calorimeter (DSC), scanning electron microscope (SEM), Limiting Oxygen Index (LOI), UL-94 vertical burning analyses. The best flame retardancy performance was obtained by using 10 wt. % APP when compared to other flame retardant additives in the plasticized PLA-based composites. In addition to this, tensile tests showed that the highest elongation at break value was observed with the addition of 10 wt. % TPP into PLA/PEG matrix.

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Keywords: PLA-PEG Composites, Flame Retardancy, Phosphorus based fillers

Refferences

[1]. J. Zhan, L. Song, S. Nie, Y. Hu, Polymer Degradation and Stability, 94, (2009), 291-296.
[2]. W. DE-YI, A. Leuteritz, Y.Z. Wang, U. Wagenknecht, G. Heinrich, Polymer Degradation and Stability, 95, (2010), 2474-2480.
[3]. S. SOLARSKI, F. Mahjoubi, M. Ferreira, E. Devaux, P. Bachelet, S. Bourbigot, Journal of Materials Science, 42, (2007), 5105-5117.

8389 | Applying Composite Structure Techniques of Materials to Design 3D Printed Plastic Functional Parts with Enhanced Properties

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Plastic 3D printed functional parts or tools have short life and very limited use compared to metal parts, this has resulted in the plastic parts only predominantly suited for prototype and low volume production and not fully utilizing the advantages of 3D printing. Significant efforts have been made to address this problem but the parts` useful lives have not been substantially increased. This could be due to the fact that the root causes of their short lives have not been categorically identified and objectively addressed. Using a selected part/tool, this paper identifies the root cause of the short functional plastic part`s life using the tools of cause and effect analysis and employs composite structure techniques of materials to enhance the part`s material characteristics that increase its life while taking advantage of 3D printing parts (such as digitally structuring the material for strength, making complex geometries and fast production). Optimum reinforcement and matrix materials and their distribution and volume fractions that suit the design requirements are identified and tested. 3D printed parts are made and longer part/tool life is validated by testing and using it. Due to use of cheaper material and production method compared to that of conventional metal parts, the benefits of this study include reducing the part or product manufacturing cost and hence selling price. The effort presented in the paper to also meticulously simulate metal tools may pave the way to eventually replace them.

Keyword: short functional plastic part life, 3d printing, composite structure techniques of materials, cause and effect analysis

8393 | Experimental evaluation of aged CFRP panels with defects

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Carbon fiber reinforced plastics (CFRP) is highly suited for the aerospace industry. As such, it is of great importance to reliably evaluate the influence of defects on the failure of a structure. Since the failure of such structures is not always immediate, failure may not occur until the damage is compounded by environmental effects incurred as the structure is aged. This study aims to evaluate CFRP panels with embedded defects. The CFRP panels studied include samples with foreign object inclusion (FOI) defects at varying depths within the panel and impact damage defects created with different impact energies. The strength of CFRP panels with embedded defects, with and without exposed to an artificial aging process, were measured by uni-axial tensile testing. The measured Young's modulus and tensile strength of various samples are compared. The influence of ageing process on the samples having different defect type, defect extent will be discussed.

8402 | Towards UV-composites using dual cure photoinitiating systems?

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UV-composites have been only scarcely reported in the literature. The lack of interest mainly arises from the low penetration of the light inside the materials, preventing a good conversion of the resin in the depth. In this paper, the dual-cure polymerization of an acrylate resin was investigated by combining a conventional technique (temperature measurement at the surface and in the deep zone) with confocal Raman microscopy. Polymerization was first characterized using a thermal initiator alone. Results showed that the thermal system polymerizes slowly and gradually, generating a thermal front that propagates from the bottom of the sample to the surface. Then, a photoinitiator was added to this thermal system. Unexpectedly, at the beginning of the reaction, the addition slows down the thermal polymerization reaction. But quickly, the reaction is accelerated and an almost fully cured material is obtained in a shorter time than the net thermal system. This behaviour highlights a surprising synergistic effect between the photoinitiator and the thermal initiator in the dual-cure polymerization of thick materials. The opens the door to the formation of composites Under light irradiation.

8411 | Lower bound approaches for ultimate load prediction of composite laminates

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The determination of the ultimate strength of a composite laminate is a challenging problem in the field of composite structures, as witnessed by a huge amount of literature on the subject. However, because of anisotropy and heterogeneity of composite laminates, it is difficult to predict such strength. On the other hand, the failure process in a laminate, that has reached its ultimate strength, can arise with different failure modes due to matrix crushing, fiber rupture, fiber buckling, delamination and/or a combination of the above phenomena. The failure process is also influenced by the laminate lay-up, the number of layers, their orientation and stacking sequence.
To avoid the detailed and often cumbersome description of all the above post-elastic phenomena, a simplified, but valid alternative to predict the strength capability of a composite laminate can be given by the application of nonstandard limit analysis. The latter allows to evaluate a lower and an upper bound to the collapse load multiplier in a direct manner, so resulting a relatively simple method of practical connotation for design purposes.
In this context is framed the present paper that treats orthotropic composite laminates under biaxial loading and plane stress conditions. A multilayered domain is considered in which each layer obeys, by hypothesis, a Tsai-Wu type criterion and, in particular, a second order polynomial form of it, the latter assumed as yield condition.
The lower bound to the collapse load multiplier is here computed with two different numerical procedures. The first one grounds on an iterative procedure, known as Elastic Compensation Method, which mimics the incipient collapse of the laminate by many sequences of elastic analyses. The second one starts hypothesizing, for each layer, a stress field distribution that satisfies boundary conditions and equilibrium with the applied loads. It then applies an optimization nonlinear algorithm to determine the searched lower bound.
The effectiveness and validity of the proposed approach are shown by solving a few numerical examples.

8414 | MECHANICS OF DEBONDING OF FRP STIFFENERS FROM QUASI-BRITTLE SUBSTRATES

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Fiber-Reinforced-Polymer (FRP) materials are commonly used to repair and strengthen concrete structures by gluing strips or plates to their external surface. Experimental tests on single-lap FRP-joints have provided a wealth of evidence that the dominant failure mode is the detachment of the FRP stiffener from the support, occurring a few millimeters underneath the adhesive interface and triggered by high stress concentrations at the extremities of the stiffener. Fracture gradually propagates firstly parallel to the interface and then in the substrate, until complete separation between the two adherents occurs. Remarkably, the final stage is characterized by the initiation of an inclined crack at the free end of the stiffener, penetrating into the substrate and producing a characteristic wedge-shaped spall, which remains bonded to the FRP strip.
Review of the state of the art indicates that, in order to model the response of FRP joints, a common practice is to use complicated constitutive laws for the interface, while neglecting the deformation of the substrate. However, such models can only give partial interpretation of the various aspects of the phenomenon. Our aim here is to show that an elementary interface law, but with consideration of the substrate elasticity, allows to describe the the debonding process in all its complexity.
The model problem here considered is that of a thin elastic stiffener of finite length, bonded to an elastic half-space in generalized plane stress, pulled at one end by an axial load. The thickness of the stiffener is supposed very small, so to neglect its bending stiffness and assume that shear stresses only are active at the interface. The strain compatibility between the stiffener and the substrate provides a singular integral equation for the contact problem, whose solution is obtained as a series of Chebyshev's polynomials. The debonding process is supposed to be triggered in pure mode II by an energetic balance, i.e., when the release of elastic strain energy equals the surface energy associated with material separation.
If the bond is perfect, the theory of elasticity predicts stress singularities at both ends of the stiffener. We show that the shear stresses in a neighborhood of the singularity at the loaded end is sufficient to counterbalance, in practice, the whole applied load, while the experimental evidence shows instead the existence of an effective stress transfer length (effective bond length), over which the load transfer occurs gradually. A very simple, step-wise cohesive interface law is thus considered, according to which slippage can occur at constant shear stress until a limit slip is reached, beyond which failure occurs. Following Barenblatt, the length of the cohesive zone is found by imposing the annihilation of the stress intensity factor at the interface. If the stiffener is sufficiently long, there is a maximal reachable length for this cohesive zone, which carries almost the entire applied load and that, therefore, represents the effective bond length. The second singularity at the free end of the stiffener plays a minor role, since the part of the load associated with it is negligible.
To describe the phenomenon of the final wedge-shaped spalling of concrete, an energetic competition is engaged between failure of the adhesive joint and oblique fracturing of the substrate. However, to reproduce the experimental finding, it is crucial to assume that crack propagation occurs in steps of finite length (quanta), of the same order of the intrinsic material length scale. From this parameter, one can evaluate when the inclined crack starts to form and the characteristic angle of the wedge-shaped bulb.

Results obtained from this very simple analytical model are in excellent agreement with experimental data drawn from the technical literature.

8416 | Dynamic Buckling of Empty Closed Cylindrical Nano-Tube Viruses under Time Depended External Pressure

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Viruses are nanometer-sized living objects which carry the genetic codes (DNA or RNA) of the body and they are coated by a protein shell known as capsid. In this paper, an analysis for the dynamic buckling of empty (without genetic materials) closed cylindrical capsid shells subjected to external pressure varying as a power function of time is presented.
The modified Donnell type dynamic stability and compatibility equations are obtained by using the classical shell theory. Analytical solution is assumed to satisfy the simply supported boundary conditions and Navier method is applied to obtain the closed-form relations of buckling loads. Critical buckling loads are obtained by considering the different values of the loading parameters. The results show that the critical parameters are affected by the variations of loading parameters and by the time.

8417 | Preparation and characterization of polypropylene reinforced by electrospun nano-cellulose

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Electrospinning is a very simple and versatile method of creating polymerbased high functional and high performance nanofibers that can revolutionize the world of structural materials. The electrospun fiber diameter determines properties of the nanocomposites such as mechanical, electrical, hydrophobic and optical properties. It was previously shown that both the strength and the conductivity of the film/mat of fibers produced by electrospinning are sensitive to fiber diameter. Moreover, size of the fibers along with morphology influences the hydrophobic behavior of polymers. Filtering applications are also affected by the fiber size. Most important of all, fiber size will affect the cell behavior on the fibers. Therefore, it is important to have control over the fiber diameter which is a function of material and process parameters.In the present study, the effects of fundamental parameters including applied voltage, drum rotation, needle speed, and collecting distance of fibers on the diameter and morphology of electrospun celluse acetate nanofibers were studied to produce ultrafine polymer fibers. Cellulose acetate (CA) was dissolved in acetone/DMAc (2:1) under constant stirring at room temperature. The applied voltages were set as 18, 20, 22, 24, 26 kV, and five levels of 90, 100, 110, 120, 130 mm of collecting distance were used in this investigation. The drum rotations were 50, 150, 500, 1000, 1500 rpm. The needle horizontal speeds were 10, 25, 50, 75, 100 mm/min. Based on the systematic parametric study, it is possible to produce a small diameter of the electrospun cellulose fibers with average diameter 70nm. This will also be helpful for electrospinning of various polymers.

8422 | MECHANICAL PERFORMANCE OF JUTE FIBER REINFORCED COMPOSITES

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Natural fibers, a new group of environmentally friendly materials, have been in considerable demand in recent years, combining technological, economic and ecological aspects [1], playing a key role in the emerging “green” economy, being widely used in automotive applications [2] as consequence of their good mechanical properties, low cost and low density. The main objective of this work was to produce and characterize an epoxy composite reinforced with different types of jute fibers with suitable properties and reduced price to be used for the top cover of a trailer. Kenaf, sisal, banana, jute flax, pulp, wood flour, oil palm, pineapple leaf and coir are the main natural fibers used as reinforcement [2]. Jute fibers are 100% biodegradable; they are associated with good mechanical strength and can replace synthetic fibers in applications where resistance is not a determining factor. A major restriction in the successful use of vegetable fibers in durable composite applications is their high moisture absorption and poor dimensional stability (swelling), as well as their susceptibility to rotting. Fiber swelling can lead to micro-cracking of the composite and degradation of mechanical properties [3].
This paper is focused on the characterization of the epoxy composite reinforced by jute fibers. Thus, a set of composite materials reinforced by jute fibers with different bidirectional woven fiber mat: coarse, medium and fine (C, M and F) with densities of: 1.5, 1.2, and 1.1 g/cm3, respectively, were processed by vacuum bagging. Laminated composite plates were manufactured by alternately applying layers of woven jute fiber mat and epoxy resin. The woven jute fibers were oriented in the same direction. After the 24-hour cure cycle at the temperature of 20 °C, all laminated composite plates were post-cured in an air circulating oven at a temperature of 60 °C for 16 hours, as recommended by the manufacturer.
The composites materials were immersed in water up to 60 days in order to characterize the hydro-degradation. Mechanical tests were performed to obtain the bending strength and stiffness modulus and impact response. The bending tests were conducted in displacement control at a ramp rate of 1 mm/min in three-point bending mode, using an electromechanical universal testing machine Zwick/Z100, and according to the ASTM D638 standard. Dynamic mechanical analysis was conducted by a Perkin DMA 8000 using the corresponding software to collect and analyze the experimental data. Low-velocity impact tests were performed using a drop weight-testing machine CEAST 9350, using semi-spherical tip impactor according to ASTM D3763 standard on square section samples of 100x100 mm.
Bending strength and flexural modulus decrease with increasing time of immersion in water. Comparing the stiffness and the strength of the composites immersed for 60 days and with non-immersed specimens it was observed a reduction in percentage (about 50% and 35%, respectively) similar for all reinforcement materials. The best performance in terms of the bending stiffness and strength and impact response was obtained for coarse fiber mat composites.

References

[1] Bandrzej A. et al, (2001). Natural-fibre-reinforced polyurethane microfoams. Journal Composites Science and Technology 61:2405–11.
[2] Rashdi A.A.A. et al, (2010). Combined effects of water absorption due to water immersion, soil buried and natural weather on mechanical properties of Kenaf fibre unsaturated polyester composites (KFUPC). International Journal of Mechanical and Materials Engineering (IJMME), Vol. 5, 1:11-17.
[3] Jawaid M. et al, (2011). Woven hybrid composites: Tensile and flexural properties of oil palm-woven jute fibres based epoxy composites. Materials Science and Engineering A 528 (2011) 5190–5195.

8431 | Effect of Curing on Fatigue Behavior of Notched Out of Autoclave Carbon Composite Laminates

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During the past decade use of lightweight materials like polymeric composites in various applications such as aerospace, automotive, marine etc. has grown considerably. These polymeric composites are usually subjected to various types of loading including tensile, compressive, shear, flexural, impact, fatigue etc. During fatigue loading, the structure is subjected to repetitive or fluctuating stress which leads to damage in the forms of cracks, which subsequently grows into unstable crack propagation resulting into catastrophic failure of the structure. Therefore, it is essential to understand the governing factors and build models which are able to predict structural composites behavior under fatigue loading.
In this research, effect of curing on tensile and fatigue behavior of woven carbon composites laminates fabricated form MTM 46 prepreg using vacuum bag molding were investigated. To panels each consist of sixteen layers of plain weave MTM 46 supplied by Cytec were cured as per supplier recommendation cycles. The tensile and fatigue behavior of laminates were studied following ASTM D3039 and ASTM D3479. The fatigue behavior of the notched coupons was investigated to determine the fatigue life and the endurance limit. Tension-tension fatigue tests with R ratio of 0.1 and frequency of 3 Hz was performed. The stiffness degradation as the function of fatigue cycles was recorded. The obtained data demonstrated degradation started immediately after first cycles; even at stress level lower than endurance limit of the laminate. This behavior reveals that matrix cracking and weakened fibers` breakage start immediately after applying load to the specimens. This finding shows the importance of matrix strength which was studied by altering curing process and subsequently changing the degree of cure. The results indicate that composites strength under fatigue loading can be optimized by changing the curing characteristic of matrix.

8438 | An experimental study on steel fibres as shear reinforcement

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An experimental study on steel fibres as shear reinforcement

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An experimental study was carried out examine key structural reposes of steel fibre reinforced concrete (SFRC) beams with shear links. This comprises compressive, tensile and shear strengths as well as ductility and energy absorption capacities. A key issue assessed is whether the use of steel fibres can result in a significant reduction in conventional reinforcement without compromising ductility and strength requirements set out by the design codes. In this respect, the spacing between shear links was relaxed while steel fibres were added to see whether or not the loss of shear strength can be compensated for in this way. This is particularly useful in situations where the shear reinforcement required can lead to congestion of shear links, for instance in seismic design. The experimental programme comprises tests which were carried out on cubes under compressive force, notched cubes under splitting tensile force and beam specimens with two different spacing values between shear links, namely: 45mm and 90mm. Additionally, four variations of fibre volume fraction were also considered in the study, which were Vf = 0%, 1%, 2% and 3%. One beam was tested for each link spacing and volume fraction and a further beam was tested at a spacing of 30mm and Vf = 3%, thus totalling nine beam specimens. Cube compressive test and split tensile test was performed to determine the compressive and tensile strength of the concrete mix with different steel fibre content. Two cube specimens were tested in compression for each volume fraction totalling eight and similarly eight cubes were examined under tensile splitting loads. The dimensions of the beams were 100mm * 100mm * 500 mm and the dimensions of the cubes were 100mm * 100mm * 100mm. The steel fibres used in the experimental study were hooked-end DRAMIX RC-65/35-BN steel fibres with length 35mm and diameter 0.55 and a corresponding aspect ratio 64.
For the cube specimens, it was found that there was a linear increase in the compressive strength values in proportion to the increase in volume fraction of steel fibres added to the concrete mix. The average percentage change in cube compression strength was found to be 7%, 20% and 25% for Vf = 1%, 2% and 3%; respectively compared to the specimen with no fibres. It was also found that the tensile splitting strength (representing the residual tensile strength) also increases with the addition of steel fibres indicating that the fibres at these high dosages are active in bridging the orthogonal cracks. The experimental study on beams revealed that the addition of steel fibres enhanced the shear strength of the beam. Crucially the experiments has shown that the relaxation of shear link spacing from 45m to 90mm (i.e. by 100%) can be compensated for by adding steel fibres at Vf = 1% or above. Initially, when the spacing was relaxed and no fibres were added, there was a drop of ~10% in load-carrying capacity. When fibres were added at Vf = 1% (with relaxed spacing of 90mm), this has resulted in an enhancement of 5% of the strength compared to the specimen with link spacing of 45mm and no fibres (i.e. control specimen). The enhancement increased to 15% and 33% when fibres with Vf = 2% and 3% were added, respectively, compared to the control specimen. The addition of fibres also helped arrest the crack propagation. The studies provided insight into how the steel fibres can help reduce congestion of shear links.

Keywords: concrete, steel fibres, volume fraction, shear strength

8439 | Experimental investigation of strength and confinement in SFRC

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Experimental investigation of strength and confinement in steel-fibre reinforced concrete

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An experimental study was carried out with the aim of examining the structural behaviour of steel fibre reinforced concrete (SFRC) and the influence of volume fraction (Vf) on the bi-axial state of strains due to axial compressive loads as well flexural strength. In particular, the study has focused on investigating the confinement provided by the steel fibres. This was achieved by measuring strains both axially (i.e. compressive) and laterally (i.e. tensile) on prism SFRC specimens as well as the applied axial compressive stresses. The experimental programme comprises tests which were carried out on cube, prism and beam specimens in order to establish the compressive strength, axial and lateral strains, and flexural load-deflection curves; respectively. For each set of specimens, tests were carried out using varied steel fibre contents, namely: one plain and three steel fibre volume fractions (0.5%,1% and1.5%). So for the cube specimens, three cubes of size 100mm * 100mm * 100mm were studied for each volume fraction totalling twelve specimens. Similarly, two prisms of size 100mm * 100mm * 300mm were tested for each volume fraction totalling eight specimens and two beams of size 100mm * 100mm * 500mm were adopted totalling eight specimens. The steel fibres used in the experimental study were hooked-end DRAMIX RC-65/35-BN steel fibres with length 35mm and diameter 0.55 and a corresponding aspect ratio 64. The fibres were added to a standard concrete mix of proportion 1:2:3 with a water-cement ratio of 0.55. The specimens studied did not have any other form of reinforcement added such as steel bars.
For the cube specimens, it was found that there was a gradual increase in the compressive strength values in line with the increase in volume fraction of steel fibres added to the concrete mix. The average percentage change in cube compression strength was found to be 1.5%, 4.4% and 16.5% for Vf = 0.5%, 1.0% and 1.5%; respectively. Thus, it can be concluded that although there was a consistent increase in strength, it was only the higher dosage of Vf = 1.5% that has resulted in a practical increase. Crucially however, the prisms bi-axial strain results show that the ultimate axial compressive strains increase as the fibre amount is raised demonstrating that the fibres improve the post-peak softening response (with ultimate strains as high as 0.006 compared to 00.0035~0.004 found in plain concrete prism specimens). The increase was consistent even with the lowest amount of fibres of Vf = 0.5%. It was also interesting to find that the lateral tensile strains were gradually reduced as the fibre dosage was increased showing that the fibres enhance the confinement (in the orthogonal direction to the applied compressive load). This can only be captured by measuring both axial and lateral strain rather the common uni-axial testing approach. Considering the crack patterns of the specimens, it was also observed that the addition of fibres has led to a reduction in crack propagation. The experimental study on beams revealed that the addition of steel fibres enhanced the flexural strength to the beam. The percentage increase in the load-carrying capacity for the beams was 90% with Vf = 0.5%, 133% with Vf = 1.0% and 250% with Vf = 1.5%, which is quite considerable. Additionally, there was also a consistent enhancement in ductility (and corresponding energy absorption capacity) as fibre dosages were increased. The addition of fibres also helped arrest the crack propagation and made the SFRC beams stiffer in comparison with their plain concrete counterparts.

8441 | FORMATION Y2Al5O12 - YAlO3 COMPOSITE IN ZONE OF LASER HEATING AL2O3- Y2O3 MIXTURE

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The phase formation in the zone of laser irradiation of powder mixture 56 mol. % Al2O3- 44 mol. % de Y2O3 has been investigated by the XRD, electron microscopy, EDS methods. The laser treatment was realized with λ = 1064 nm, P = 10, 20, and 45 W. Linear traversing speed of the laser beam was 0.26, 0.14 and 0.038 mm/s. It was established that the phase formation in selective laser irradiation zone is accompanied with formation of crystalline phases, corresponding to the diagram in the region of formation (60-50) mol. % of Al2O3. In this region from eutectic melt the YAlO3 and Y2Al5O12 are crystallized. At such content of components in the initial Y2O3-Al2O3 mixture impossible to synthesize mono-phase ceramics [1]. Since heating of the compacted powder material in the zone of laser irradiation has a temperature gradient: on the surface the temperature is higher than the sample volume, depending on P (capacity) and v (beem) of laser treatment, in the phase diagrams can be found traces of Al2O3 and Y2O3. The surface of ceramic material has a macro-texture. On the surface of deposited trace ablation products, which have a complex structure. Similar effects were observed at laser treatment of such binary mixtures as Al2O3 – TiO2 and Y2O3 - TiO2 [2, 3].

8445 | New 2D local model of vibration of unidirectional multilayered symmetric sandwich structure hinged at two edges.

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●The edges of the sandwich structure (e.g. beam) with a thick middle layer can be connected to the supports by means of pins. This solution may be applied to acoustic baffles. The combination support-pin is called a hinge. The hinge support may be movable or unmovable. The movable hinge support is called the simple support. In further text the term ‘hinge support’ means unmovable hinge support while the term ‘simple support’ means the movable hinge support. Based on the definitions introduced above, we can say that in the simply supported structure we have one hinge support and the second simple support. This presentation is devoted to the structure with two hinge supports (called hinge-hinge structure).
●The ideal kinematic conditions for the hinge support are as follows, ux(x=xp,z=zp)=0, uz(x=xp,z=zp)=0, whereas the ideal kinematic condition for the simple support is as follows uz(x=xp,z=zp)=0. The symbols ux, uz, xp, zp, mean, the in-plane displacement, the out-of-plane displacement, and coordinates of the axis of the pin (xp, zp), respectively. For the structure symmetric with respect to the middle plane it is assumed in the further text, for convenience, that origin of the coordinate system is placed within the middle plane. Obviously, the symmetry implies that axes of pins of the hinge or simple supports of the symmetric structure are also placed within the middle (symmetry) plane. Consequently, zp=0 and coordinates of the axes of pins of the hinge or simple supports in the case are as follows, (xp,0) and (xp+L,0) or (0,0) and (L,0) or (-L/2,0) and (L/2,0), where L denotes length of the structure.
●The above kinematic conditions for the supports are idealized as actual diameters of the pins are greater than zero. In further considerations it is assumed that this idealization does not imply a significant error. Obviously, to obtain complete conditions for the hinge and simple supports the equation Mxx(x=xp)=0 should be added to the above kinematic conditions, where symbol Mxx(x=xp) denotes the edge moment.
●It is noted that the ideal kinematic conditions for the supports are usually not satisfied exactly within the mathematical models of beams, strips and

plates. Here are some examples illustrating the fact. In the theory of beam based on the assumption of plane cross-sections displacements are defined as follows ux =-z∂w/∂x and uz =w(x). Equating the uz to zero at the point P(x=xp,z=zp) is formally unattainable in the plane cross-section theory. Instead of it, the theory predicts that out-of-plane displacements of all the cross-sectional points at the support are zero. The same defect occurs in the more advanced model of simply supported beam, ux =-g(z)∂w/∂x and uz =f(z)w(x)=f(z)sin(mπx/L), m=1,2,3, …, where g(z), f(z) are unknown functions and L denotes length of the structure [1]. It is also impossible to satisfy the kinematic equality uz(x=xp,z=zp)=0 in the latter beam model since the kinematic conditions uz(x=0,z)=uz(x=L,z)=0 are satisfied for each z in the range <0,h> or <-h/2,h/2>, where h is thickness of the beam. As far as the author knows, the ideal kinematic conditions for the hinge support and simple support have not been satisfied in any published analytical model of beams and plates.
●The main objective of the presentation is to show the new 2D local model of vibration of unidirectional multilayered symmetric sandwich structure hinged at two edges, outlined in the title, in which the ideal kinematic conditions and the corresponding moment conditions for the both hinge supports are satisfied. The 2D local model was obtained within linear elastodynamics without limitations on parameters and number of the layers. Its final (numerical) form consists of three coupled transcendental equations, F1(α,ω)=0, F2(γ,ω)=0 and F3(α, γ, ω)=0, where ω denotes eigenfrequency and α, γ are unknown geometrical parameters. The set of equations is similar to the final form of the model presented in [2].

8446 | Thermo-mechanical loading

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The combined presence of extreme mechanical loading conditions, due for instance to blast and impact, and very low or very high temperatures may have important effects on damage initiation and evolution in laminated composite systems used for structural applications. A novel approach based on a homogenization technique is proposed in order to: (i) accurately describe the complex and discontinuous stress and displacement fields generated in highly anisotropic laminated plate structures with imperfect and cohesive interfaces and delaminations by thermo-mechanical loadings; (ii) overcome the limitations of current approaches, which are typically based on a discrete-layer approximation of the systems and involve a large number of unknowns. The proposed model yields dynamic equilibrium equations for plates with imperfect/cohesive interfaces and delaminations which depend on a limited number of unknowns, independent of the number of layers and equal to those of classical single-layer theories. The model extends to thermo-mechanical problems the energetically consistent formulation recently proposed by (Massabò and Campi, 2014, Composite Structures; Massabò and Campi, 2014, Meccanica) for multilayered plates with imperfect interfaces and delaminations subjected to mechanical loading only.
Massabò R., Campi F., Assessment and correction of theories for multilayered plates with imperfect interfaces, Meccanica, (2014), DOI 10.1007/s11012-014-9994-x.
Massabò R., Campi F., An efficient approach for multilayered beams and wide plates with imperfect interfaces and delaminations, Compos Struct (2014), 116, 311-324, DOI: 10.1016/j.compstruct.2014.04.009.

8462 | The rigid polyurethane foams from renewable raw materials for application in cosmetic industry

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1. Introduction

In the recent years there has been an increasing interest in polyurethane foams, due to their lightweight, excellent insulating characteristics, attractive mechanical properties, high strength-to-weight ratio and durability [1]. Relatively easy access to natural plant fillers affects lowering the production costs of the material, as well as possibility to assign to products peeling qualities, leads to an increase of their competitiveness in the cosmetic industry. Good physical and chemical properties together with a relatively low cost of the industrial-scale production by utilization of vegetable oils make them the most significant renewable resource in the chemical industry [2,3]. This presentation covers the synthesis and investigation of rigid polyurethane foams from rapeseed oil-based polyol with natural fillers for application in cosmetic industry.

2. Experimental

2.1. Materials

As a part of the study rigid polyurethane foams were fabricated using rapeseed polyol (PR), synthesized in Cracow University of Technology. In the process of the synthesis other substances such as surfactants, blowing agents, catalysts, and Ongronat 4040 TR, which is a mixture of MDI mixed isomers and oligomeric MDI, from BorsodChem company were also used. The powdered plant shells and fruit stones were added as a filler and provided 10%, 15% or 20% polyol premix. The synthesis of polyurethane foams was conducted in a one-step method.

2.2. Methods

Scanning electron microscopy was used to examine differences in structures of the products according to various compositions of reaction mixtures. Dimensional stability, water absorption, apparent density, and changes in aging were determined in accordance with Polish Standards. Chemical composition of the rigid polyurethane foams was examined by IR absorption spectroscopy. Investigation of the thermal degradation was performed using thermogravimetric analysis techniques and differential scanning calorimetry was used to determine the phase-transition temperatures and the thermal effects. Biocompatibility of materials were investigated by using the in vitro toxicity test of the human monocyte and keratinocyte cell line models.

3. Results and discussion

The observation of the cross-sections of the rigid polyurethane foams resulted in finding a closed-cell architecture. Materials with the different architecture were obtained depending on the quantity, size and type applied natural filler. The results of thermogravimetric analysis showed that the received materials

are thermally stable at high temperatures. The temperature corresponding to a mass loss of 5% is contained in the range of 248-260°C. The resulting materials exhibited high resistance to aging conditions and high dimensional stability. Introduction the natural filler to the foam system caused an decrease in apparent density. The rigid polyurethane foams with rapeseed polyol and natural fillers exhibited low toxicity for the human monocytes and keratinocytes model.

4. Conclusions

Research has indicated the possibility of using rapeseed polyol and natural plant fillers to produce rigid polyurethane foams. We have successfully developed the products based on renewable raw materials with properties suitable for applications in the cosmetics industry.

Acknowledgement
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References
1. Tan S. Abraham T. Ference D. Macosko C.W. Rigid polyurethane foams from a soybean oil-based Polyol. Polymer 2011; 52: 2840-2846
2. Hou C. Czubernat K. Jin S.Y. Altenhof W. Maeva E. Hou I.C, Bandyopadhyay A. Sain M. Gu R. Mechanical response of hard bio-based PU foams under cyclic quasi-static compressive loading conditions. Int. J. Fatigue 2014; 59:76–89
3. Lligadas G, Ronda JC, Galia M, Cadiz V. Renewable polymeric materials from vegetable oils: a perspective. Materials Today 2013;16(9):337-343.

8469 | Multifunctional composite lattice structures

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In this study sandwich-walled cylindrical shells with aluminum pyramidal truss core of constant curvature suitable for multifunctional applications were fabricated employing an interlocking fabrication technique for the metallic core. The skins were made of carbon-fiber reinforced composites and co-cured with the metallic truss core. Thereafter, axial compression tests on some representative samples were carried out to investigate the failure modes of these structures and compared with an analytical failure map developed to account for Euler buckling, shell buckling, local buckling between reinforcements and face-crushing. The experimental data closely matched the analytically predicted behavior of the cylinders. In particular, it was found that local buckling and face crushing modes can exist together and are the most important modes of failure of the fabricated structure. In addition, a study on the bending response of semi-cylindrical samples is also presented using a combination of analytical modeling, three-point bending experiments and finite element (FE) based simulations. The aluminum pyramidal cores of these samples were also constructed using the novel interlocking method before curing them with composite face sheets to fabricate the final structure. A theoretical model was developed to analyze the experiments and develop failure criteria. Three failure modes: i) Face wrinkling, ii) Face crushing, and iii) Debonding between face sheet and truss cores, were considered and theoretical relationships for predicting the collapse load associated with each mode were developed. The experiments were carried out on two sets of specimens with differing face sheet thickness which clearly indicated the important role played by core debonding in determining the peak load of the structure. Localized buckling instabilities were also reported for samples with thinner face sheets. The role of debonding in determining strength was further highlighted by a comparison with FE simulations with suppressed debonding. This study highlighted the superior structural performance and failure properties of these structures thus demonstrating their suitability for their integration into the next generation of ultralight multifunctional systems.

8492 | Some Aspects Concerning the Masonry Coupled Walls Behavior

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Confined masonry is one of the most used structural systems for low and mid rise buildings in Romania. The present work investigates the influence of various parameters on the structural behavior of confined masonry structures. A numerical simulation is carried out using ETABS software on plane models of a structural shear wall. Considered parameters are: way of defining the loads, wall and coupling beams dimensions, reinforcement of beams and columns and coupling beam type. Conclusions are drawn on the structural behavior of the structure as well as on the influence on simplified procedures on numerical modeling results.

8496 | STOCHASTIC VIBRATION ANALYSIS OF FGM PLATES WITH INITIAL GEOMETRIC IMPERFECTIONS

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Functionally graded structures (FGSs) have gained considerable attention in the recent years, especially in high temperature environments due to their advantages of being able to withstand high temperature gradient while maintaining their structural integrity. The superior properties of the graded material generally associate with uncertainties in their constituent material properties. Furthermore, FGSs are usually fabricated at high temperature, and the geometric imperfection are usually developed due to the metallurgical changes while it is cooled to room temperature. It is indispensable to analyse the characteristics of HGSs with uncertainties in constituent material properties and geometric imperfection. The presence of these imperfections in structures may significantly influence the vibration characteristics. Therefore, the study of the combined effect of the material uncertainties
and geometric imperfection is important to obtain the realistic response of the structure.

It is accomplished from the literature that the research work on the vibration of imperfect FGSs with uncertain material properties has not been reported in the literature to the best of the author's knowledge.

In the present study, a stochastic finite element formulation based on a higher-order shear deformation theory is developed with initial geometric imperfections . Results show that generally, initial geometric imperfections lead to an increase in fundamental natural frequency of the plate. Numerical results with different parameters also have been presented which shows the effectiveness of the present formulation.

8500 | Research on the temperature control performance of paraffin/ HDPE/polyurethane coatings

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Thermal energy storage is perspective for increasing efficiency in energy conservation. Phase change materials (PCM) are one of the most preferred methods to thermal energy storage because of their high energy storage density and stable phase change temperature. Among the present investigated PCM, paraffin has been widely used due to its large latent heat and proper thermal characteristics such as little or no super cooling, low vapor pressure, chemical stability and self-nucleating behavior.
To prevent the leakage of melted paraffin when it is changed from solid to liquid, polymeric matrices have been used as the encapsulant or supporting-network to prepare the form-stable or shape-stabilized phase change composite. In this present work, the high density polyethylene (HDPE) was used as the supporting-network to prepare the form-stable paraffin/HDPE composites. Then the composites were pulverized into powders to act as the functional filler for the phase change (PC) coatings with polyurethane as adhesive. The effects of coating thickness, PCM content, conductivity and heating temperature on the temperature control performance of the coatings were characterized in the work. Results indicated that phase change coatings showed obviously temperature control performance and could inhibit the temperature change of the coating. Big thickness and PCM content can contribute to the temperature performance of coatings. Both final stabilized time and the difference in temperature between coatings and nude plate would increase with heating temperature, especially for coatings with big thickness. Materials with high thermal conductivity can improve heat transfer process and decrease the stabilized time of the PC coatings.

8513 | Origami-inspired Self-deployable Shape Memory Composite Structures

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Engineering systems typically require complicated infrastructures for assembly and/or deployment. The controlled folding and unfolding of space structures are potentially complicated by the independence of individual folds. However, the artificially constructed by origami pattern, with a periodically coupled mountain and valley folds, circumvents this difficulty by allowing the entire structure to be folded or unfolded simultaneously. Origami is the art of folding a piece of paper into a three-dimensional form and/or folding it into a flat state. Origami should be applied in mechanical engineering to obtain stiff and lightweight structures manufactured by folding flat sheets and to obtain flexible deployable mechanisms.
In this research, the development and fabrication of self-deployable shape memory composite structures constructed by origami pattern are discussed. The shape memory composite structures are fabricated with woven fabric composites based on shape memory polymers (SMPs). The SMP has the ability to store a deformed shape and recover an original shape. The shape memory behavior is typically induced by a change in temperature. Thermomechanical characteristics of SMPs are experimentally observed through tension, shape recovery rate, and thermal cycling tests. Moreover, the constitutive equations of SMPs are developed and its accuracy is verified. Based on the preliminary test, carbon fiber reinforced composites based on epoxy-based SMPs are fabricated for the shape memory composite. For the practical application of the shape memory composite, their shape recovery performance is evaluated using a bending test. The design and construction of the fold and unfolding mechanism based on origami pattern are discussed. Moreover, efficiency of the origami-inspired shape memory composite structures should be demonstrated for the application of self-deployable space antenna.

8521 | Production and Characterization of Reinforced WC Composite with Steel (Eurofer97)

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The production of hard metal is growing worldwide due to its widespread use, mainly for cutting tool.
It is obtained through carbides of refractory metals like: Tungsten, Molybdenum, Titanium, Vanadium, Niobium, Tantalum and chorom; that providing high toughness, hardness and wear resistance to other materials. Basically, the most commonly used compositions are tungsten carbide (WC) and binder metalswhich can be cobalt (Co), iron (Fe) or nickel (Ni). This work aims to analyze the influence of ferritic-martensitic Eurofer97 on sintering behavior of WC, in order to evaluating the possibility of cobalt substitution by steel in WC-Co hard metal. The WC- Eurofer 97 composite was produced by the PM process. For preparing the powders, wet high energy milling, with cyclohexane, was used for 5 hours. The powders uniaxially compressed by 200 MPa pressure, and t5he sintering of green sample was done in a vacume resistance furnace at 1250°C with heating rate of 20°C/min and 60 min of isothermal step. As received WC and steel powders were characterized by x-ray diffraction (XRD), particle size testing and scanning electron microscopy (SEM). The sintered composite was also characterized by SEM and hardness Vickers test.

8524 | PROCESSING AND CHARACTERIZATION OF DIAMOND WIRE BEADS

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Diamond wires are used in the cutting of ornamental stones, and are composed of a steel wire on which diamond beads are mounted. Diamond beads are comprised by a diamond-metal matrix composite, sintered or hot pressed, and then brazed on a steel tube. Brazil is an importer of this tool, even considering its global position in the stone market. This work processed diamond wire beads according to the industrial route: mix of the metal + diamond powders – diamond composite, followed by hot pressing at 800°C/35MPa/ 3 minutes. It was used the commercial alloy DIABASE-V21 and diamond crystals - size 425µm. Beads structure and microstruture were characterized by scanning electron microscopy, X-ray diffraction, energy dispersive spectrometry and X-ray spectroscopy. Wear tests were preformed in a physical simulator. For comparative purposes, commercial beads from South Africa, Italy and China industries were used. The results indicated the success in producing diamond beads in Brazil, once all the obtained results were similar. It is expected to stimulate brazilian companies to process diamond wires in the country.

8525 | A NEW DIAMOND COMPOSITE FOR USE IN CUTTING TOOLS FOR THE STONE INDUSTRY

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The slabbing and cutting of ornamental stones requires the use of diamond tools, such as diamond wires, blades, saws, etc. The present work aims to process the new composite 50%Fe-25%Cu-25%Nb- diamond for use in tools for the rock industry. Niobium (Nb) was never used in diamond cutting tools. The composites were industrially hot pressed at 800°C/35MPa/3 min. Structural and microstructural features were carried out using X-ray diffraction, confocal laser microscopy, and scanning electron microscopy. Compression tests were conducted to acess the elastic properties. Wear tests, with emphasis on the mechanisms occuring during the wear process were performed. For comparative purposes, It was used the commercial alloy DIABASE-V21. The results showed the favoring formation of solid solutions by the presence of Nb, which improved mechanical properties and wear resistance. It points to the positive possibility of using the developed diamond composite in cutting tools for the stone industry.

8530 | Contribution to the study of the mechanical behavior of bio-based composite materials

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The nature gives solutions of several physicals problems, particularity in the manufacturing of composites materials. This work contains extraction method of natural fibers and mechanics characterization of Artichoke (Cynara cardunculus L) fibers which were naturally producing in Algeria north region. This paper shows the manufacturing method and evaluations of mechanical behavior by tensile test of bio-composites materials reinforced with long and short natural fibers.

8541 | Design of the composite journal bearing for turbine/generator application

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Polymer composites are widely used in journal bearings due to their low friction coefficient and high seizure resistance, which play an important role during rotating machinery operation. However, the reliability of composite bearings should be verified by various tests before its application to the

turbine/generators because their operating conditions such as pressure and temperature is higher than those of the other application area such as marine applications and machine tools. In this study, mechanical properties of the carbon fiber reinforced phenolic composite were measured under operating temperature of the turbine/generators, and composite journal bearings were prepared and tested under various operating conditions.

8543 | Recycling of waste cork for manufactured of the composite materials

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Abstract:
This study is undertaken in the objective of economising the maximum of the cement in the manufacture of a light composite material based on waste of expanded cork intended mainly for thermal insulation. The study which we introduce here is, in one hand the promotion of the waste of cork and of the slag of high stove and to envisage the influence of several parameters on the behaviour of the composite, on the other hand. Indeed, we studied the influence, of the addition of the sand and of the blast furnace slag by substituting the cement, on the physical, mechanical and thermal behaviour of the composite material as well as the dimensional variations. The waste of cork is mixed in volume with the cement (Cement/Cork:1/3). The composites are curing in three different environments. According to the experimental results, the mode of conservation influences considerably the density and the mechanical resistance of the composites. The results also show that the mechanical resistance and the shrinkage decrease with the addition of sand. By against, the addition of the slag by substitution of cement improves the mechanical resistance significantly. The test results on thermal conductivity are influenced by several factors. A remarkable improvement of thermal conductivities of composites preserved in the air curing and composites containers of the blast furnace slag. The composites thus manufactured are light, economic and in conformity with the recommendations of RILEM.

Key words: Cement; Waste cork; Slag; curing; Bulk density; Mechanical strength; Shrinkage; thermal insulation.

8555 | Properties of fabrics coated with nanostructurized metallic layers by vacuum deposition

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Vacuum arc plasma technology of evaporation and condensation (PVD cathodic arc deposition) provides broad prospects for obtaining nanocomposite coatings. The high ionization degree, flux density and energy of the particles have a significant effect on the kinetics of formation of coatings and allow obtaining high-quality composites of various compounds at relatively low temperatures of the substrate. This technology is multipurpose, provides high coating process performance, has a low power consumption and several other advantages over traditional methods of coatings deposition of different functionality (galvanic deposition, plating, etc.).
Surface modification of the original textile materials by coating them with functional nanocomposite films and coatings with the specified structure, physico-chemical and mechanical properties can improve the performance of the textile and expand its scope. By using such coatings on the products for various purposes it is possible to vary the mechanical, optical, electrical, magnetic, thermal and chemical properties within a wide range. Nanocoatings deposited on fabrics provide anti-static, radioabsorbing, antiseptic, waterproof and other properties.
This paper studies various types of textiles as the substrates. These included textiles from natural fabrics (jersey, linen, cotton, silk), synthetic fibers (polyester, polyamide, polyaramid, polyethylene, polypropylene, polyacrylonitrile) and their mixtures made from yarns of different weaves, as well as non-woven textiles. To deposit coatings C, W, Cu, Ti, Cr, Ag target materials were used in the coating system. Metal coatings were applied in the vacuum and in the presence of carbon dioxide.
The possibility was investigated of attribution the completely extrinsic properties to new composite materials on the basis of textiles, such as
- protection properties, which protect human organism and equipment against electromagnetic radiation;
- bactericide and anti-static properties for a filter materials;
- bioprotective properties, antimicrobial activity of medical dressing materials, etc.
Flexible shielding materials are developed with radio protective properties. Frequency behaviour of electromagnetic radiation attenuation and reflection of the samples in the band of 8-12 GHz was studied using network analyzer and waveguide measurement path. The electromagnetic radiation attenuation provided by the samples of different groups is in the range of 5 to 10 dB (21-26.5 dB in the case of use of special carbon fabric) and the reflection characteristics vary in the range of -3 to -11.5 dB depending on the matrix surface shape. Studies have shown that the development of the flexible electromagnetic shields and absorbers of electromagnetic radiation based on the metallized textile is perspective and their efficiency in the microwave band (X band) is proved.
To create an antibacterial medical materials, it proved to be most appropriate to use fabrics of polyester and polyamide as a basis for the deposition of nanostructured coatings. It was found that the pronounced bactericidal properties were observed for textile materials with coatings of copper or silver with a layer thickness of ~ 200 nm. Such functionally active textiles having antimicrobial activity, is already being used to treat infected wounds and for other medical purposes.

8559 | The influence of inclusion shape on the effective properties of random nanocomposites

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The mechanical behavior of heterogeneous and in particular of composite materials is governed by the mechanical properties of their individual components, their volume fractions and other parameters defining their spatial and size distribution. In this paper, the effective properties of random nanocomposites with arbitrarily shaped inclusions (graphene nanoplatelet-reinforced composites) are computed in the framework of the extended finite element method (XFEM) coupled with Monte Carlo simulation (MCS). In particular, the influence of inclusion shape on the effective properties of the random media is highlighted. The inclusions are randomly distributed and oriented within the composite and their shape is implicitly modeled by the iso-zero of an analytically defined random level set function, which also serves as the enrichment function in the framework of XFEM [1]. Homogenization is performed based on Hill's energy condition and MCS [2]. The homogenization involves the generation of a large number of random realizations of the microstructure geometry based on a given volume fraction of the inclusions and other parameters (shape, number, spatial distribution and orientation). Using this approach, the probability distribution of the effective elastic modulus and Poisson ratio of the random composite is computed. It is shown that the probabilistic characteristics of the effective properties can be significantly affected by the change in surface to volume ratio of the arbitrarily shaped inclusions especially in the case of large volume fraction.

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References

[1] D. Savvas, G. Stefanou, M. Papadrakakis, G. Deodatis, Homogenization of random heterogeneous media with inclusions of arbitrary shape modeled by XFEM, Computational Mechanics 54(5), 1221-1235 (2014).
[2] C. Miehe, A. Koch, Computational micro-to-macro transitions of discretized microstructures undergoing small strains. Archive of Applied Mechanics 72(4–5), 300-317 (2002).

8561 | FeGa particles concentration influence on the magnetomechanical anisotropy of polyurethane based nanocomposites

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Recent technological breakthroughs and the desire for new materials functions with decreasing working parts generate an enormous demand for novel materials. Composite materials can show superior properties compared with their pure counterparts. The ability of taking the advantage of particular properties of transition elements alloys particles as the constituent materials is the most important motivation for the development of metal-polymer functional hybrids. The present work has been undertaken to research the possibility of using mechanosynthesized intermetallic FeGa particles properties in metal/polymer composite material performance. The choice of Fe-Ga system is explained by its famous magnetostrictive properties. So, these effects and additional spatial particles arrangement in polymer matrix with suitable mechanical module have been applied to achieve the preferable anisotropy of magnetic characteristics with the aim to promote additional magnetostriction value increase. Structure and magnetic properties anisotropy of composites via particles concentration, size and composition have been carried out by scanning electron microscopy, conversion electron mossbauer spectroscopy, X-ray diffraction, dynamical mechanical analysis and magnetostriction measurements. The increase of the magnetostrictive response with tailor-made magnetic anisotropy induced by lattice stress and spatial particle orientation has been demonstrated.

[1] T. Kiseleva, S. Zholudev, A.Novakova et al.Technical Physics Letters. 39 (2013) 1110
[2] Zholudev S.I. , Kiseleva Y.Yu. Hyperfine Interactions 226, (2014) 375

8562 | Structure and magnetic properties of Fe-Ga-In nanocomposites obtained by Fe and Ga-In liquid eutectic mechanosynthesis

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Particles of intermetallic compounds have recently attracted much attention in view of its application as functional composite and hybrid materials fillers. Intensive mechanical activation in planetary ball mill is a simple way to obtain particles of desired structure through mechanochemical interaction even of immiscible systems. This interaction proceeds at the particle surface and interfaces of defected and imperfect grains. In our work we studied mechanochemical interaction of Fe particles with liquid eutectics of Ga-In in Fe-rich concentration corner of the system. It leads the formation of new ternary powder nanocomposites. The liquid-solid mechanochemical interactions underlies particles structure formation. The phase equilibria in binary Fe-Ga, Fe-In and Ga-In systems reveal different elements mutual interactions: limited solubilities, several intermetallics in Fe-Ga system, the absence of intermetallics and mutual solubility in Fe-In system, limited solubility and eutectics in Ga-In system. Recently [1-3] we studied in details the peculiarities of mechanochemical interactions in binary systems Fe-Ga and Fe-In. The missing data on phase equilibria in the Fe-Ga-In system makes it attractive to study behavior elements at intensive mechanical activation with the aim of formation ternary composite particles. We performed mechanical activation of Fe powders with Ga-In liquid eutectics in Ago-2 planetary ball mill. The structure of the ball milled Fe-Ga-In have been researched by X-Ray diffraction with Rietveld structure refinement, Scanning Electron microscopy with element distribution and Mossbauer spectroscopy with analysis of local structure by restoration of hyperfine parameters distribution functions. Properties of mechanosynthesised composite particles have been carried out by Differential scanning calorimetry and temperature and field dependencies of magnetization. It was carried out that the structure and chemical nature of particles interfacial region play an important role in determining magnetic properties of the powder composite.

[1] T. Kiseleva, A. Novakova et al. // Journal of Alloys and Compounds 383 (2004) 94
[2] A. Novakova, T. Kiseleva et al. // Journal of Alloys and Compounds 434 (2007) 455
[3] T. Grigor’eva, T. Kiseleva et al. // Physics of Metals and Metallography 113 (2012) 575.

8566 | Confining Effects on Cylindrical Concrete Members with Reactive Powder Concrete and Carbon Fiber Reinforced Plastics as Retrofitting Materials

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The reactive powder concrete (RPC) is an advanced composite material with excellent mechanical properties such as an ultrahigh compressive and flexural strengths, modulus of elasticity and fracture toughness, and high durability such as low abrasive wear, water absorption, rate of corrosion an chloride ions diffusion, etc. Unlike traditional concrete, RPC has no aggregates larger than fine sand, which is only composed of Portland cement, fine sand, quartz powder, silica fume, steel fibers (optional) and superplasticizer, all mixed at a very low water to cement (W/C) ratio. The major purpose of adding the steel fibers is to transform the highly brittle nature of pure RPC into a ductile material. The confining effects on cylindrical concrete members with RPC using a cost-effective optimal dosage of added steel fiber of a ratio of 2% by volume, or about 156 kg/m3, under curing condition of ambient temperature and carbon fiber reinforced plastics (CFRP) as retrofitting materials are studied in this studied.
Four kinds of cylindrical concrete members were used, including the control set of normal weight concrete (NWC) without retrofit, the confined NWC set retrofitted with CFRP, the confined NWC set of shrunk cross-section retrofitted with RPC with thickness of 10 mm and the confined NWC set of original cross-section retrofitted with RPC with thickness of 10 mm, respectively. The strain gauges were used in the experiment to measure the compressive stress-strain curve of RPC specimens under uniaxial compressive test. The experimental results show that at age of 56 days, the compressive and splitting tensile strengths, static modulus of elasticity, Poisson's ratio, ultrasonic pulse velocity and surface resistivity of RPC specimens are 124.41 MPa, 14.67 MPa, 45.27 GPA, 0.22, 4715 m/sec and 73.25 KΩ-cm, respectively. Using RPC of thickness of 10 mm to retrofit the Φ100 mm cylindrical concrete specimen, the compressive strength increases about 73 % with a ductile failure mode. While, using CFRP for retrofitting, the compressive strength increases about 57% with a brittle failure mode. The compressive strength of composite cylinder specimen loaded on whole section is greater than of NWC concrete by 35 %. On the other hand, the compressive strength of composite cylinder only loaded at core NWC portion is only greater than that of NWC concrete by 22.5 %.

8621 | COUPLING REDUCED ORDER AND LAYERWISE MODELS FOR THE ANALYSIS OF LAMINATED COMPOSITE PLATES WITH VARIABLE STACKING SEQUENCES

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On the one hand, the proper generalized decomposition (PGD) has shown interesting features in the reduction model framework, in particular in the context of separation of coordinate variables in multi-dimensional PDEs. On the other hand, the layer-wise (LW) approach is particularly suitable to model heterogeneous structures with accuracy, but with a computational cost depending on the number of layers (NC).
In this work, a layer-wise approach in the PGD allows us to deduce the displacements as an explicit function of the orientation angles of the laminated composite plate. In this way, the displacements are written under the form of separated variables representations, i.e. a sum of products of unidimensional polynomial of z, bidimensional polynomial of (x,y) and NC unidimensional polynomials of the orientation of each layer.
The approximation of the composite plate is based on the classical Serendipity interpolation functions for the variation with respect to (x,y) and a fourth-order LW description for the variation with respect to z. The function of the angles is piecewise linear. Finally, the deduced non-linear problem implies the resolution of NC+2 linear problems alternatively. This process yields to few unknowns involved in each of these linear problems.
Mechanical tests for laminated structures are presented in order to evaluate the capability and the range of validity of this method.
Note that this approach can be advantageously used in reliability computations. numerical tests will be presented. A one-layer case is first considered to assess and illustrate the behavior of the method. The influence of the discretization of the functions depending on the orientation of the plies is shown. Two-layer and four-layer configurations are also addressed. The accuracy of the results is evaluated by comparison with reference solutions issued from PGD solutions with different fixed stacking sequences.

8637 | Volumetric composition and shear strength evaluation of pultruded hybrid kenaf/glass fiber composites

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In this study, the effects of kenaf loading on the void volume fraction and apparent interlaminar shear strength of hybrid pultruded composites were investigated. Six different glass to kenaf fiber ratios were selected. The volumetric composition (Fibers, matrix and void volume fraction) were determined experimentally using the gravimetrical based methods and the optical microscopy was used for determination of the voids locations. Interlaminar shear strength (ILSS) of both hybrid and non-hybrid (control) composites were determined by using short beam shear (SBS) test method. It was found that the void volume fraction of the composite increase as the kenaf fiber volume fraction is increased. A linear relationship with high correlation (R2=0.98) were observed between the two properties. These results showed good agreement with volumetric model.

8642 | CARBON NANOTUBE-NANODIAMOND HIERARCHICAL NANOSTRUCTURES AND THEIR POLYUREA NANOCOMPOSITES

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A hierarchical carbon nanostructures (HCNs) that comprise various types of carbon nanoparticles with different structural dimensions attract increasing attention due to promise of performance enhancement of materials through the structure promoted synergistic effects. In our work we have designed the HCNs comprising nanodiamond (ND) particles covalently bonded to carbon nanotubes (CNTs) through a novel approach using a molecular linker. This approach is based on wet chemistry that utilizes functionalized nanoparticles as soluble reactive building blocks for HCN design. The as prepared new HCN materials show the pearl necklace-like morphology where up to 50% of the CNT surface is decorated by nanodiamond particles.
Nanocomposites, consisting of polyuria/polyurethane (PU) hybrid polymer matrix and 0.1 and 0.2 wt. % HCNs added as a filler have been fabricated and

their mechanical tensile properties tested. The test data show that adding 0.1 wt. % of nanofiller to PU results in brittle material as indicated by decrease in tensile strength and elongation relatively to PU matrix due to domination of the hard surface of ND in the composite. However, for nanocomposites filled with 0.2 wt.% HCNs, the increase of tensile strength by 64% as well as of elongation in comparison with neat PU was measured. This is probably due to the fact that increase of the HCN's volume fraction in the PU provides more of elastic amino functionalized CNT surface for covalent interfacial interactions with the matrix. In addition, an increase in shore A hardness relatively to neat PU was observed. Demonstrated in this work HCN-induced synergistic reinforcing effect along with the elastic and hardness properties achieved with very low content (0.2 wt. %) of HCNs as a filler and synthetic accessibility of HCNs could make them attractive for applications in a broader range of nanocomposites.

8643 | DEVELOPMENT OF GRAPHENE BASED POLY(LACTIC ACID) NANOCOMPOSITES

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The present research aims to develop a material that having balanced properties between strength and flexibility. Due to the brittleness of Polylactic acid(PLA), epoxidised Palm oil was used to plasticize PLA by melt blending technique using Brabender internal mixer. However, the major drawbacks of this plasticization were the substantial decreases in the strength and modulus of the plasticized PLAs. Hence, a plasticized PLA nanocomposites was developed to get balanced properties by adding Graphene Nanoplatelets (xGnP) or reduce graphene oxide (rGO) as nanofiller . The prepared plasticized PLA nanocomposites exhibited a significant improvement in mechanical properties at 0.3 wt% xGnP loading. The enhancement to some extent of the mechanical properties of the plasticized PLA/xGnP nanocomposites ascribed to the homogeneous dispersion and orientation of the xGnP in the polymer matrix and strong interfacial interactions between both components. Scanning Electron Microscopy (SEM) and Transmission Electron Microscopy (TEM) results prove the enhancement of tensile strength and elongation at break. The addition of rGO into plasticized PLA substantially enhanced the tensile strength without deteriorating elasticity. In addition, the investigation of the thermal properties by means of Thermogravimetry Analysis (TGA) has found that the presence of rGO in the system is very beneficial for improving thermal stability of the plasticized PLA. SEM images of the rGO nanocomposites display homogeneous and good uniformity fracture surface.TEM images revealed that the rGO remained intact as graphene sheet layers and were dispersed well into the polymer matrix, and it was confirmed by X-ray Diffraction (XRD) result which shows no graphitic peak in the XRD pattern.

8651 | Mechanical strength performance of hybrid kenaf/coir unsaturated polyester composite

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Natural fibres reinforced are contributing a very big part in bio-composite and material science. Natural fibres has been proved as a good substitute of synthetic fibres, because it is economical and renewable. Specific strength of natural fibres supports in enhances the mechanical properties of polymer matrix. In tropical region, fibrous plants are in plenty form and some of them are agricultural crops. Coir and kenaf among excellent fibres which hold good mechanical properties. In this study Hybrid kenaf/coir unsaturated polyester composite was prepared with various composition to evaluate its mechanical strength properties. Coir was used to improve the impact strength of the composite since it has high degree of microfibrillar angle at 49 °. Bulk mounding compound was applied in the mixing process at optimum mixing time to ensure the homogeneity of the composite. Results of mechanical properties of untreated , treated and at various hybrid composition was compared and evaluated. Scanning electron microscopy of surface fracture was examined and the effect of alkaline treatment of both fibres were compared. The composite formulation is targeted to be used in semi structural application as the mechanical impact strength is improved as compared to non hybrid biocomposite .

8665 | Composite Nanofiber based Proton Exchange Membranes for Fuel Cell Applications

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Ion conductive composite core-sheath nanofibers were produced via electrospinning within the aim of operating at high temperature temperature range in fuel cells. In this particular study, the spinninability of high performance polymer, sulfonated polyether ether ketone (SPEEK), was studied systematically by varying polymer concentration (6-10wt%) and solvent media (N-Methyl-2-pyrrolidone (NMP), N,N dimethyl formamide (DMF), N,N dimethylacetamide (DMACs)). Hot pressing was applied onto ion conductive nanofibrous webs to form proton exchange membranes. The morphology of electrospun SPEEK webs and membranes were observed by Scanning Electron Microscope (SEM). Membrane characterization was completed by using the methods of differential scanning calorimetry (DSC), thermo-gravimetric analysis (TGA) and fourier transform infrared (FTIR). The contribution of core region SPEEK to proton conductivity was also reported and compared to commercial Nafion membranes.

*poster presentation preferable

8678 | MACRO EXAMINATION OF ADHESIVE BUTT AND TEE JOINT OF A3003 ALUMINUM HONEYCOMB SANDWICH PANELS

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The demand for lightweight structures made of sandwich panels is ever increasing in many Industrial sectors. Numerous research efforts have been taken

by various researchers in this area in terms of weight and cost reduction. Sandwich panel is a composite structure and it is an excellent alternative material in place of weight reduction without sacrificing its strength and stiffness characteristics. Necessity of using a light weight materials in aircraft, navel and other applications, honey comb sandwich panels are used because of its strength to weight ratio, high bending stiffness, fire retardant, insulating and sound proof. In honeycomb panels different configurations are feasible. In this paper, macro examination of adhesive in different configuration of Butt and Tee joint is carried out in A3003 aluminum honeycomb sandwich panels. Qualities of each configuration are discussed and best combinations of configuration are recommended for manufacturing purpose. Adhesive joining procedures for securing Butt and Tee joints with nine different configurations in A3003 aluminum honeycomb sandwich panels have been investigated. The edging and configuration details need careful consideration and also the joint locations require filling with resin impregnated polyurethane foams to achieve thorough adhesion.

8687 | Investigation of Alumina – Transition Metals in Binary Systems as Armor Material

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Alumina has been widely used in cutting tools, textile and electronic industries, medical applications, armor materials, especially high-temperature furnaces with its light-weight and superior characteristics. Aluminum oxide's melting temperature is 2000 ± 30 °C and it is one of the most durable materials to chemicals and mechanical forces.
In this work, alumina–transition metals in binary systems have been investigated and developed for possible armor applications. High energy planetary ball milling with zirconium (YZP) balls was used to produce the alumina based system. The rotational velocity of the mill was 300 rpm. The ball to powder weight ratio was 7:1. Alumina and metals powders were milled for 30 hours until steady-state conditions were achieved.
After milling processing, alumina based powders were pressed using a pressure of 400 MPa, followed by sintering at 1600°C for 2 hours. Mechanical tests such as hardness, compression, 3-point bending, ballistic were carried on the sintered samples. XRD, SEM and optical microscope characterizations were performed on sintered samples.
At the end of this study, metallic additives such as nickel, cobalt and molybdenum were found to improve the properties of alumina, and especially nickel - cobalt dual contribution has been found as the most attractive preference for the use of armor material. Hence, metallic additives have a positive effect on the mechanical properties of alumina.

Keywords: Alumina, Transition metals, Binary system, Armor materials

8696 | Fracture Characteristic degradation of Glass Fiber Reinforced Pipes

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Pips made from glass fiber reinforced polymer has competitive role in petroleum industry. The need of evaluating the mechanical behavior of (GRP) pipes is essential objects. The tension and bending tests are performed to obtain the mechanical properties of (GRP). Whereas both compact tension and single edge notch are carried out to obtained fracture toughness of such materials. The tests are performed before and after immersing in corrosion waste petroleum water for about 1440 hr. The degradation induced in the mechanical and fracture properties are observed. The fracture toughness calculated from single edge notch is more convince than CT. and bending test is more acceptable for such brittle material. All properties are decease and degraded after immersing in the corrosion salty waste petroleum water.

Keywords: GRP, Compact tension, flexural strength, single edge notch

8740 | Structural analysis of fiber-steered, variable-stiffness laminates based on various reference paths

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The further improved properties of traditional composite laminates cannot be fully developed due to the straight fiber alignment. With the development of advanced fiber steering technology, the continuous variations in fiber angles became possible. Variable-stiffness composites change in stiffness throughout their structures by means of the curvilinear fiber trajectories. The angle distribution pattern of fiber trajectories has a great influence on the mechanical properties of fiber-steered, variable-stiffness composite laminates. The aim of this paper is to investigate the influence of various reference paths on the buckling performance of variable-stiffness composite plates. A 45mm×45mm square plate with four simply- supported edges is here treated as an example and its model is established using finite element method. The buckling modes corresponding to five given reference paths, are respectively calculated and compared to each other. The buckling performance of variable-stiffness composite plates is predicted and the effects of steered fiber angle distributions on the maximum buckling load of the variable-stiffness plate are evaluated.

8744 | Analysis and Experiment of Composite Joints Reinforced by Composite Fasteners

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This paper details the design, manufacture process and strength assessment of composite fasteners, followed by testing of their utility to reinforce bonded composite T-joints. A rivet-type fastener was designed and made by using a polyetheretherketone (PEEK) thermoplastic matrix reinforced with carbon fibres. Prototype tooling was as shown in Fig.1b designed and manufactured to enable the manufacture of a variety of fastener shaft lengths and

diameters. The fastener design proved to have good mechanical properties. Under shear loading, it possessed comparable specific strength to aluminium rivets; under tensile loading the strength was lower. The processes for manufacturing the fastener shafts and forming the rivet head were both simple and repeatable, making it a feasible alternative to metal rivets and without the effects of galvanic corrosion when installed in composite structures. Test results showed that, by strategically locating the fasteners in bonded composite T-joints, their strength under pulling loads could be increased by approximately 15%. This improved strength was achieved because the fasteners were used to alleviate peeling stresses, which are typically initiate failure, at the edges of the cleats that join the base panel to the web panel. Due to the small sample of test results, further testing would be necessary to validate the results.
The nature of the manufacture of the fastener meant that all of the fibres ran in the longitudinal direction. Therefore, properties in the shaft x-axis (longitudinal) were the same as the composite material properties in direction 1 and properties in the y- and z-axes (transverse) were the same as the composite material in direction 2. The longitudinal strength of the fastener shaft was, therefore, the same as at 2,489 MPa. For comparison, the ultimate tensile strength of a solution heat treated and aged extruded Ti-6Al-4V (AMS 4934) titanium alloy bar is 1,123 MPa so a CFPEEK rod is over twice as strong in the fibre direction. Based on this strength, the maximum loads that could be carried by the shaft in pure tension were calculated. The recorded loads from the test machine were corrected to include the weight of the upper half of the test fixture (0.96 N). The mean maximum tensile load was 0.92 kN at a mean displacement of 1.98 mm.
The upper half of the test fixture was clamped by the upper jaw and the lower half of the fixture was clamped by the lower jaw. A linear displacement of 1 mm per minute was applied to the lower jaw (downwards) to produce a shear load, on the fastener. Displacements continued to be applied beyond the maximum applied load until the fastener had fully failed. Load values were logged at a rate of 5 Hz. The measured loads were corrected to include the weight of the lower half of the test fixture (1.96 N). A graph shows a mean maximum shear load of 1.65 kN at a mean displacement of 2.1 mm.
The results of the T-joint tests indicate that the joints reinforced with fasteners provided a greater initial failure load. Whilst at first glance the presence of reinforcing fasteners appears to be the reason for the additional strength to the T-joints by alleviating the edge peeling stresses, the results are not conclusive; the data set was too small and the data for comparison of baseline T-joints was from a previous test (T-Joint 1 failed at too low a load for it to be used to verify the results). Therefore, the higher loads for T-Joints 2 and 4 could be due variations in the adhesive (different bath), better adhesion due to curing times or the surface finish, or even variations in the way in which the joints were clamed together during the curing process. To properly validate the deduction that reinforcing the joints improves the strength, further tests would need to be conducted with equal numbers of newly made T-joints from the same batch, with and without reinforcing fasteners.

8764 | THE EFFECTS OF DIFFERENT LEVELS OF EXPANSIVE CEMENT ON THE BOND STRENGTH IN CONCRETE-FILLED FRP TUBES

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Concrete-filled fibre reinforced polymer (FRP) tubes have been used in civil structures for many years. Concrete-filled FRP tube (CFFT) element integrates the best characteristics of both the FRP tube and the concrete which results in increasing compressive load carrying capacity and ductility, as well as enhancing durability of the element. However, the performance of the CFFT is reduced by separation of the concrete core from the FRP tube due to drying shrinkage. This separation not only reduces the composite action and structural integrity of CFFT under compressive loads, it also affects the bond strength between the concrete core and the FRP tube significantly and restricts CFFT from being used as a tensile element. Current techniques available to increase the bond strength are limited to coating the inner surface of the FRP tube and providing shear connectors or circumferential ribs to increase the roughness of the FRP-concrete interface. However, these techniques are hard to achieve especially in the case of CFFT elements with small diameter or very deep height.

Oppositely, adding expansive cement to the filling concrete mixture does not require any special treatment or effort and different levels of concrete expansion, accordingly various internal pressures to the inner surface of the FRP tube, can be achieved by using different levels of expansive cement. This paper aims to present the results of a study on the effects of different levels of expansive cement on the bond strength of CFFTs in order to demonstrate the fact that using expansive cement not only increases the confinement and prevents the separation between the concrete core and the FRP tube, it is also an efficient method to enhance the bond capacity of CFFTs.

An experimental program including fabrication of fifteen CFFT specimens filled with five different concrete mixtures and performing push-out test on the specimens was done. Other parameters influencing the bond quality, such as the concrete-FRP interface roughness, the interface length and the tube dimensions were kept constant. Lateral expansion of CFFT specimens immediately after casting and during hardening of concrete was continuously monitored using strain gauges attached circumferentially to the outer surface of the FRP tubes. An analytical calculation is also presented to model the relationship between the bond stress and the radial pressure due to expansion of the concrete core using Mohr-Coulomb theory.

The results showed considerable enhancement in the CFFT bond strength with the addition of the expansive cement. The results also demonstrated that adding expansive cement to the concrete mix induced tensile hoop strain in the FRP tube which ensured fitting of the concrete core to the inner surface of the tube and produced circumferential prestressing that provides confinement to the core. Use of expansive cement enhanced the composite action and was beneficial in preventing sudden bond failure at FRP-concrete interface. A linear relationship between the bond stress and the radial stress at the concrete-FRP interface was developed using Mohr-Coulomb theory.

8778 | FINITE ELEMENT ANALYSIS OF COMPOSITE STRUCTURES WITH CORNER RADIUS

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In aircraft composite wing C-spars, the C-section corner radius area tends to be slightly thinner than the flanges or web of similar laminate configuration. The corner radius of this C-section is a vulnerable area for failure. The failures are principally caused by through-thickness stresses in the corner radius. It is very difficult to predict the failure load in corner radius. In this work, testing and finite element analysis was conducted to establish a theoretical basis for corner radius in composite structures. Open loading testing was conducted to investigate the stresses and failure in the corner radius of C-section wing spar with varying heights and thickness. The test was performed for two different specimen heights (400 and 200 mm) and two different specimen thickness (7.4 and 3.7 mm) and with simply supported boundary conditions. The test results showed that delamination failure was observed in the corner radius. The failure load for specimens of 3.7 mm thickness was on average 49% lower than specimens of 7.4 mm thickness. The failure load of specimens

of 200 mm height was 7.9% lower than specimens of 400 mm height. Therefore the effect of C-section height on through-thickness stresses in the corner radius was small. The commercial finite element code NASTRAN was utilized for simulation analysis. A three dimensional finite element model with the ye-failure criteria was used to compare the test results. Finally authors suggest an optimal method to predict the failure load of composite structures with corner radius.

8779 | STATIC AND FATIGUE STRENGTH OF REPAIRED COMPOSITE SINGLE-LAP JOINTS

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Composite materials have often been used in aircraft structures due to their excellent material properties, such as specific stiffness and strength. Aircraft composite structures can encounter a variety of damages, such as fatigue damage caused by local environmental conditions and operational condition of repeated loading. As a result, the longer an aircraft flies, the lower the structure strength gets, since it cannot maintain the integrity of the initial design stage. For this reason, ways to extend aircraft structure life through repair of damages have been studied. In this paper, we studied static and fatigue strength recovery of the repaired damaged portion of composite single-lap joints. Two different repair methods were used, composite patch and adhesive injection. Single-lap joint test specimens with three defect size were produced and repaired with the two methods, and then subjected to static and fatigue load tests. Specimens with no defect or repair were also tested for comparison. Thus, the influence on the strength recovery of the structure according to the repair method with the same defect size was evaluated. The changes of the tendency of static and fatigue strengths resulting from the changes of the defect size were also examined.

8780 | INVESTIGATION OF THE EFFECT OF RHEOLOGY CONTROL AGENT, TEMPERATURE AND TIME ON THE VISCOSITY OF EPOXY-BASED ADHESIVES

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INVESTIGATION OF THE EFFECT OF RHEOLOGY CONTROL AGENT, TEMPERATURE AND TIME ON THE VISCOSITY OF EPOXY-BASED ADHESIVES

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ABSTRACT

The aim of this study is to investigate the rheological properties of composite adhesives consisting of epoxy resin and hardener, coated calcite with having the mean particle diameter of 0.9 μm and CABOSIL TS-720 rheology control agent. Rheological properties were determined with increasing the CABOSIL TS-720 content from 1 % to 5 % among the temperatures of 400C and 800C for two different epoxy resin systems called as SHELL and DURATEK by using Brookfield DV-II+ Proviscometer instrument. Viscosity model was developed depending on time and temperature by calculating the viscosity constant, reaction rate constant, proportionality constant, kinetic activation energy and activation energy for viscosity with varying the CABOSIL TS-720 content from 1 % to 5 % for two different epoxy resin systems. Results showed that viscosity was linearly proportional with CABOSIL TS-720 content and inversely proportional with temperature.
Keywords: Composite adhesives, viscosity, mathematical model, temperature, time

INTRODUCTION

The rheology of curing thermosets is known as critical during their processing. Since, the relationship between the processing conditions and the rheological properties of the system under investigation must be understood in the processing of thermosetting resins. There are some difficulties in the measurement of the rheological properties for thermosetting resins owing to the exothermic chemical reaction during cure. The literature related to the rheological properties of composites and the variations during the hardening process were met [1-3]. Also, kinetics of the chemical reactions during hardening had been encountered [4-6].

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REFERENCES
1. Kulichikhin, S.G., ”Kinetics of the change of physical and mechanical properties of binders during curing”, Mekh. Komposit. Mater., 1987; 22(6).
2. MacKinnon , A. J. , Jenkins, S. D. , McGrail, P.T., Pethrick, R. A. ,”A dielectric, mechanical, rheological and electron microscopy study of cure and properties of a thermoplastic-modified epoxy resin”, Macromolecules, 1992, 25 (13), pp 3492–3499.
3. Martin, M.D., Ormaetxea, M ., Harismendy, I. Remiro, P.M, Mondragon, I. ‘’Cure chemo-rheology of mixtures based on epoxy resins and ester cyanates”, European Polymer Journal, Vol. 35, Issue 1, January 1999, pp.57-68.
4. Theriault, R.P., Osswald, T.A., Castro, J.M., ‘’Numerical model of viscosity of an epoxy prepreg resin system”, Polymer Composites, 1999; 20(5): 628-633.
5. Laza, J.M., Julian, C.A., Larrauri, E., Rodriguez, M., ‘’Thermal scanning rheometer analysis of curing kinetic of an epoxy resin”, Polymer, 1999; 40(1):35-45.
6. Roşu, D., Caşcaval, C.N., Mustaţă, F., Ciobanu, C., ‘’ Cure kinetics of epoxy resins studied by non-isothermal DSC data”, Thermochimica Acta, Volume 383, Issues 1–2, 7 February 2002, Pages 119–127.

8781 | Innovative composite non-woven filtering materials for fluid purification

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The requirements of an effective fluid purification which is a common process in everyday life and in various industrial branches can be achieve by applying the deep bed filtration process, especially filtration in deep bed fibrous filters. To improve the efficiency of these media the method of their production based on the molten polymer was modified to create novel composite filtering materials with various dopants (e.g. ceramic, metal oxides, metals or their mixture, nanoparticles, carbon nanotubes). Those additives are for expending contact surface, increasing the surface roughness (antifouling effect), enhance adhesion properties, to perform the chemical destruction of the undesirable compounds. The obtained structures have properties which do not have the classical melt-blown polymer filters produced from only one component. Therefore, such materials have a very high potential in gas and water purification and the possibilities of their use are very wide (e.g. water filters, air conditioning systems, clean rooms, cars).
The aim of this work was to produce innovative composite non-woven filtering media having specific properties, which effectively separate various impurities from fluid. A two-phased process of fiber formation was implemented in order to create a composite, wherein the functional compounds (i.e. nanoparticles, carbon nanotubes) of defined chemical structure and sizes are introduced into the fiber surface. In the first phase twin screw extruder system for forming monofilaments from the mixture of polypropylene matrix and carbon nanotubes (CNT) was used. Due to the controlled mixing of the polymer streams and CNT, produced monofilaments contained required volume fraction of dopants in the polymer. The composite granules for fibers formulation were created by cutting solidified monofilaments. In the next step from these granulate the composite fibers were made using the modified melt-blown technique. This is the very promising method of forming filtering non-woven materials with desired structures made of fibers from nano- to micro-sized. It is based on molten polymer fiberization in the die connected to the extruder, where in its melting section the polymer filaments are stretched to the required size by hot air stream. The selection of the fiber formation conditions, particularly the distribution of mechanical stresses in the structure, allows to achieve the effect of migration of CNT on the fiber surface prior to its solidification. It is very important task to produce the composite where active functional dopants of defined chemical composition and sizes are arranged on the surface of the fiber with the required surface concentration. As a result, a permanent composite with modified, functionally active surface was formed. To further enhance properties of the produced polypropylene fibers with CNTs various compounds could be grafted to attach different functional groups depending on the purpose.
The obtained composite filter materials were tested in laboratory using high quality research equipment from PALAS company. The effectiveness of separation of solid (silica and KCl crystals) and liquid (oil mist DEHS) particles from air was determined. All types of used aerosols are recommended by the standards for this type of experiments.
During this work the technology of production composite fibrous filters working efficiently and longer than commercial filters, having specific properties was developed. This two-steps method allows to produce optimal filtering structures tailored to the specific requirements of the particular case, taking into account the composition of the impurities, acceptable resistance to flow, filtration efficiency required for individual components of the purified medium and the expected frequency of filter replacement.

8808 | Pull-out test experiment on FRP bars

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Experiment shows that the tensile strength from the BFRP anchorage length、diameter、stirrup rate、the concrete strength factors on the bonding properties of the BFRP reinforced concrete. The test methods are suggested by ACI Committee 440. The specimen of L shape and the one of U shape are designed that it's easy to test the tensile strength of continuous FRP rectangular spirals. Through results of the test, the strength of the straight portion of FRP is much stronger than the strength of the bent portion. The strength of FRP spirals will increase with the concrete strength or the embedment length of the bent portion increasing. The loading mechanism of continuous FRP rectangular spirals which is embedded in concrete beams can be better represented by the speciem of U shape compared with the one of L shape. The author suggested that the specimen of U shape can be used when the dimension of FRP stirrups or spirals doesn't meet the ACI Committee 440 test method 's requirements .

8810 | Fabrication of Bioactive Glass Containing Nanocomposite Fiber Mats For Bone Tissue Engineering Applications

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Bone is a dynamic, highly vascularized tissue that transports essential nutrients and oxygen as well as maintaining skeletal integrity. Due to trauma, infection, skeletal disorder, and bone disease, large defects often occurs in bone tissue. Bone tissue engineering offers an effective solution for these large bone defects by repairing, replacing or regenerating the diseased or damaged tissue with the aid of scaffolds. In general, an ideal scaffold should have adequate porosity, interconnectivity, and permeability to allow cellular adhesion, proliferation and infiltration by transporting oxygen and nutrients to the cells; display mechanical properties that are comparable to those of the tissue to be replaced until the cells lay down enough extracellular matrices; exhibit controlled degradation rate that matches with the rate of new tissue regeneration; degrade into nontoxic products that can be easily resorbed or excreted by the body; and be capable of being machined easily into the required shapes. Creating a scaffold possessing these features is challenging since only one material alone cannot meet all the requirements of an ideal scaffold. For this reason, composite systems comprising the biodegradable polymer matrix combined with inorganic components are emerging as promising candidates. On the other hand, it is of high interest to develop a material with a release ability of therapeutic metallic ions for improving the biological performance of scaffolds. Among many therapeutically active ions, strontium has the ability to substitute calcium in the mineral phase of natural bone tissue, which is called “bone seeking behavior”. The ability of strontium to remodel bone can be attributed to its dual effect, which is promoting osteoblast-related bone formation while inhibiting osteoclast-related bone resorption. Meanwhile, copper has antibacterial activity, as well as enhancing angiogenesis. Within this respective, this study focuses on the fabrication and the characterization of strontium or copper substituted nanocomposite fiber mats made of gelatin (Gt), poly(ε-caprolactone) (PCL), and bioactive glass (BG). For this purpose, strontium or copper substituted BG powders were first obtained via classic quenching of melts method. Then the as-prepared BG powders were incorporated into a blend solution of two polymers (Gt and PCL). With the use of electrospinning technique, randomly oriented electrospun

fiber mats were collected on a grounded collector. After that, cross-linking treatment was carried out by glutaraldehyde vapor. The crosslinked fiber mats were used for characterization experiments. The surface morphology of the fiber mats was examined by the help of a scanning electron microscope. The crystalline structure of the fiber mats was analyzed by X-ray diffraction (XRD) measurements. In vitro degradation behavior of the fiber mats was determined by standard immersion test in simulated body fluid (SBF: pH 7.4 at 37oC). The formation of carbonated crystalline hydroxyapatite (HAp) on the surface of the fiber mats was also monitored through XRD measurements. Results indicated that the nanocomposite fiber mats may have a potential to be used in bone tissue engineering applications. This study provides an insight for the future researchers who aim to create multifunctional scaffolds with enhanced angiogenesis potential, osteostimulation, and antibacterial properties.

8814 | High Strain Rate Deformation of Nano-Enhanced Structural Composites

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Along with the out of plane and in-plane static performance, behavior of structural composites under high strain is intriguing, and especially important for their use against impact. Our previous studies demonstrated that P(St-co-GMA) nanofibrous interlayers with their chemically tuned epoxy compatibility were significantly effective for in-plane and out of plane toughening of structural composites with no weight penalty. Increasing the resistance to delamination and transverse matrix cracking, the performance of nano-enhanced structural composites under high strain rate deformation may further highlight their advantages. In this study, the mechanical behaviour of nano-enhanced structural composites under the extreme condition of very high strain rates will be explored. Carbon fiber reinforced composite laminates with (0/90)70s and (+45/-45)70s lay-up sequences are interlayered by P(St-co-GMA) nanofibers and are subjected to high strain deformation both through thickness and side-to-side directions. The change in the dissipation of energy with altered interlaminar microstructure will be monitored and reported along with the static performance of nano-enchanced composite laminates.

8817 | Selection of composite materials considering costs in the early phases of the design process

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The main purpose of this study is to create a material selection interface that leads the designer to select the most suitable composite material for aerospace applications based on the targets related to technical, economic, and environmental performance over a product's life cycle in a multi-disciplinary and multi-objective optimization scenario. This study aims to improve material selection decisions made during the conceptual phase of product design.
The first aim is to create the link between technical performance of the design and material selection interface in order to find a set of solutions (number of plies and their orientations) for the given mechanical requirements such as stiffness, weight, buckling, crashworthiness etc. by using a Finite Element Model (FEM). The second aim is to calculate the economic performance of the design and integrate it with the material selection interface. To determine the total manufacturing cost, the process-based cost modelling (PBCM) method[1] is used. The third aim is to calculate the environmental performance of the design by using Life Cycle Assessment (LCA)[2] and Life Cycle Cost (LCC) methodologies to identify the environmental impact and the cost by integrating an Eco-Indicator'99 module.
The material selection interface therefore analyzes, from a database of materials and processes, what are the solutions (material, process, ply thickness, and ply orientation) that are non-dominated with the Pareto front concept. Since it is a multi-objective decision-making (MODM) problem, Direct Multi Search (DMS)[3] optimization is chosen as the solver. DMS is a multi-objective derivative-free method, which works with the search/poll paradigm of direct-search methods of directional type and does not aggregate any of the objective functions. It uses Pareto dominance to preserve a list of non-dominated points. These points are also used to generate new iterations or choose new poll centers. This method generates as many points as needed in the Pareto front.
In this paper, the process based cost model is prepared to be tailor-made to a company's real conditions where the related product is manufactured. Knowing the manufacturing cost early in the design process allows companies to perform early trade-off analysis on the use of various materials and composites processes before manufacturing starts and prevents unplanned design change requests related to cost saving proposals when the manufacturing starts. This leads the designers to find out the most efficient way of manufacturing a product while meeting performance and functionality requirements. The same benefit is valid for environmental requirements evaluation as well. Making minor modifications during the post design phase to satisfy the noise and emission requirements of the airports or airlines always avoids achieving the overall optimum design considering technical, economic and environment factors. For that reason, the environmental trade-off analysis during the early phases of design process is also very essential.
The paper will present a worked example, developed in collaboration with a company, with real technical requirements and real manufacturing data. Results are discussed and compared with the traditional way of designing composite structures for aerospace applications.

Bibliography
[1] M. Johnson and R. Kirchain, "Quantifying the effects of parts consolidation and development costs on material selection decisions: A process-based costing approach," Int. J. Prod. Econ., vol. 119, no. 1, pp. 174–186, May 2009.
[2] P. Peças, I. Ribeiro, A. Silva, and E. Henriques, "Comprehensive approach for informed life cycle-based materials selection," Mater. Des., vol. 43, pp. 220–232, Jan. 2013.
[3] A. Custódio, J. Madeira, A. Vaz, and L. Vicente, "Direct multisearch for multiobjective optimization," SIAM J. Optim., vol. 21, no. 3, pp. 1109–1140, 2011.

8822 | Experimental and Numerical Analysis of Post-Filling Stage in Vacuum Infusion

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Post-filling stage of Vacuum Infusion (VI) was studied by numerically solving a coupled model of resin flow and fiber compaction, and by conducting

experiments for one-dimensional flow scenarios through random and woven fiber preforms. A recently developed finite element method solution of post-filling stage was modified to account for the compaction and permeability properties of the fabric types (random and woven) used. Two sets of post-filling scenarios (control actions) were compared experimentally and numerically: (1) resin bleeding after the complete mold filling by keeping the injection gate open and vacuuming from the ventilation port under ΔP≡P_in-P_out = 80, 40, and 10 kPa, and (2) by simultaneously closing the original ventilation port and converting the injection gate to a ventilation port under a set of vacuuming pressures of 80, 40, and 10 kPa. Usually these control actions are taken for two purposes: to ensure that macro and micro voids inside and between the fiber bundles can be impregnated with resin, and to equalize the pressure distribution and thus equalize the thickness distribution. As observed experimentally and verified by the model results, settling of pressure and thickness during the post-filling stage did not occur instantaneously, but took long times especially when compared with the mold filling time. Thickness monitoring was achieved by recording the part images at constant time intervals and doing an image analysis on these captured images. Numerical and experimental results agreed well for two types of fabrics in these traditional bleeding experiments with some scatter which is very common in composites manufacturing due to inherent variations in fiber structure and material preparation. The results of control action scenarios with a set of boundary pressures were compared to achieve short thickness settling time, low final variation in thickness, high fiber volume fraction, and low void content in the part.

8823 | Experimental study on the damping performance of a metal-composite hybrid wheel with a friction layer

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Carbon fiber reinforced composite materials have been used actively in automobile industry because of their light weight, and excellent mechanical properties, such as damping capacity, specific strength and stiffness. Therefore, core performances of passenger cars such as fuel efficiency, and NVH (Noise Vibration Harness) performance can be efficiently enhanced by using the composite materials. In this study, a metal-composite hybrid wheels which consists of aluminum and carbon fiber/epoxy composites were fabricated for aforementioned purposes. Furthermore, a friction damping layer was inserted between the composite part and the aluminum part of a metal-composite hybrid wheel to enhance the damping capacity of the structure. The hybrid wheel was fabricated with the same shape and dimension as a 17 inch conventional aluminum wheel and several performances were tested. To avoid mechanical degradation of structural integrity of the hybrid wheel due to the addition of damping layer we have used thermal residual stress (strain) during thermoforming inducing clamping force between the two materials. To investigate the variation of strain in composite part of the hybrid wheel with or without friction damping layer FBG sensors and a dielectrometry sensor were used for real time cure monitoring. Simulation of cure monitoring was also carried out and the results were compared with experimental one to check the precision of the simulation method. Damping capacity was measured by vibration test to evaluate mechanical performance of the hybrid wheel with a friction layer, and it was found that 325% higher damping ratio relative to the conventional aluminum wheel was achieved.

8824 | Mechanical Characterization of E-Glass /Epoxy & E-Glass /polyester Composites for Automotive body Application

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Experimental characterization of the mechanical properties of E-glass/Epoxy & Eglass/Polyester composite was conducted. The objectives of this paper is to present processing techniques of specimen preparation, conducting experiment to obtain mechanical properties and conduct experimental observation using Scanning Electron Microscopy (SEM) to know inhomogeneity, porosity and fracture behavior. The effect of strain rate on E-glass/epoxy and Eglass/polyester has been investigated & experimentation was performed to determine property data for material specifications. E-glass/polyester laminates were obtained by compression molding process and E-glass/epoxy laminate by hand lay-up vacuum assisted technique. The laminates were cut to obtain ASTM standards. This investigation deals with the testing of tensile, compression, shear and flexural strength on a universal testing machine. The graphs that are obtained from the tests were documented. This research indicates that the mechanical properties
are mainly dependent on the strain rate.

Key words: Composite, strain rate, ASTM, Mechanical tests, SEM

8835 | COMPOSITE SINGLE-LAP JOINT REPAIR ACCORDING TO VARIOUS PARAMETERS

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Laminated composite material can be produced to have high stiffness and strength. They are applied to aircraft structures and other cases that require high strength and light weight. Composite structures can satisfy various design requirements by selecting the composite's constituent materials (matrix, fibers, additives) and the ply angles and stacking sequence of the lamina plies. For these reasons, the use of composite materials is expanding. However, delamination or bonding separation (de-bonding) of neighboring plies can occur. Thermoset polymer composite materials have a brittle nature and can contain pores or voids formed during their production process. The problem of matrix cracking and degradation is a concern in areas of stress concentration. Structural repairs methods using mechanical fasteners, such as rivets and bolts, generate stress concentrations, and therefore will be affected by those degradation modes. In recent years, structural integrity of composite structures including repairs is being studied in terms of repair methods and work is done to establish regulations. Composite patching repair methodology is the subject of our study. The method of composite patching with secondary bonding, or hard patch, was used. We investigated the effect of laminate thickness on scarf length ratio (scarf angle), patch overlap length and overall patch length. These parameters were tested in terms of patched joint static and fatigue strength. The effect of the different parameters was

evaluated to determine the optimal patch configuration, in order to obtain maximum static strength and fatigue life.

8836 | INVESTIGATION ON STRENGTH RECOVERY OF SCARF PATCH REPAIRED COMPOSITE LAMINATES

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Recently the application of composite materials is expanding, due to its high specific stiffness and strength. However, unlike metal structures, the composite structure has a disadvantage which is its brittle fracture. In fact, a small damage can cause a significant difference in mechanical properties. Due to this aspect, ways to repair the damaged composite structures and extend their lives are under research. Therefore in this study, tensile tests with the use of a composite laminate after scarf repair were conducted. The damage and repair of the composite laminates were simulated by bonding a pre-cured scarf patch to a damaged laminate. A total of 50 specimens of 10 different types were tested with different taper ratios of the scarf, sizes of the damage and lengths of the patch overlap. Each of these variables was independently changed for the comparison of their effects on strength recovery. The strength recovery capability was investigated by comparing the strengths of non-defect specimens to repaired specimens.

8838 | Failure load prediction of scarf patched composite single- lap joints by FEM

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Accompanying the increased prevalence of composite structure maintenance in general practice is the increasing evidence that repair, rather than component replacement, is being considered as a treatment option for composite structures. When a defect is detected in a structure during maintenance inspection and thus requires repair, the repair process is important for restoring initial properties at low cost and within a short time period. A convenient technique for repairing composite defects is therefore desirable. According to literature reviews, the design of structural adhesively bonded joints is complicated by the presence of singularities (stress concentrations) and the lack of suitable failure criteria. In this work, a damage zone model based on a critical damage zone size and strain-based failure criteria is proposed to predict the failure load of adhesively bonded joints by FEM. Results from experimental load testing of laminate specimens with various defect sizes and scarf patch repaired single-lap joints have been obtained and compared with numerical analysis. A model case is first chosen as a reference by matching in FEM the experimental failure load and determining the number of failed elements in the model according to their failure index value. This reference number of failed elements, or equivalently failure area or failure volume, is then used as a failure criterion to determine the failure load of other laminate and single-lap joint specimens with different defect sizes.

8841 | INVESTIGATION OF CONTROLLED ALIGNMENT EFFECT ON THE MECHANICAL PROPERTIES OF POLYMER NANOCOMPOSITES WITH DYNAMIC MECHANICAL ANALYSIS

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Carbon nanotubes (CNTs) have been utilized in many areas due to their extraordinary mechanical, thermal and electrical properties. No previous material has displayed the combination of superlative these properties attributed to them [1]. Most of studies related to polymer nanocomposite reinforced with randomly oriented carbon nanotubes (RCNT-PNC), the electrical properties were enhanced compacted to their strength improvement [2].These controlled morphology materials can be used to improve structural properties of polymer nanocomposite along the direction of CNTs such as fibres. As a CNT synthesis method, thermal CVD is significant technique.
CNTs have been used as reinforcement materials (filler or reinforcing) to fabricate advanced polymer nanocomposite and as well as hybrid composites for the last 10 years. One of the most important problems of these materials is dispersion of carbon nanotubes (CNT's) in polymer as bulk. In addition, (CNT) especially higher volume fractions of CNTs rate of carbon nanotube tend to agglomerate and form stress concentrators in polymer matrix and this condition reduces the capacity of strengthening of polymer nanocomposite (PNC). As the critical factors affect all properties of advanced composites, various methods are used to avoid agglomeration of carbon nanotubes such as mechanical mixing, ultrasonic mixing, homogenizer etc. [3]. Even though, randomly oriented carbon nanotubes polymer matrix nanocomposites (RCNT-PNC) enhance electrical properties of PNC, they can't show their full reinforcing capability for structural requirements in PNC. Therefore, synthesis of vertically aligned carbon nanotubes using with th-CVD method can give the ability to control the morphology of these nano-reinforcements. In recent studies, vertically aligned carbon nanotubes polymer nanocomposite (VACNT-PNC) has been fabricated with infiltration process in which the CNT's are immersed in a viscous polymer. The matrix infused into CNT forest via capillary induced wetting, at rates that depend on the properties of CNT forest (e.g. volume fraction, the space between CNT-CNT and viscosity of polymer). The aim of this study is to investigate effects of alignment of CNT's, volume fraction of CNT, type of polymer matrix and temperature on mechanical properties of polymer nanocomposite (PNC) using with dynamic mechanical analysis (DMA). Three different factors (alignment of CNT, CNT %Vf type of polymer and temperature) and their three levels has been performed using with experimental design.
According to experimental design 34= 81 different polymer nanocomposites will be fabricated depending on orientation of CNTs. Randomly aligned carbon nanotubes (RCNT) will be dispersed in polymers (RTM6, West System and PDMS) using with shear mixing. Vertically aligned carbon nanotubes (VACNT) will be embedded in polymers (RTM6, West System and PDMS) with infiltration process. Micro densification process will be utilized to change volume fraction of CNTs (up to 22%) [4]. Dynamic mechanical analysis will be performed in a suitable clamp over the entire strain range to investigate thermo mechanical properties of polymer nanocomposites. The results of storage modulus (E') of 81 different polymer nanocomposites will be compared with each other and prove the accuracy of the test results using with regression analysis method.

[1] Jonathan N. Coleman , U.K., Werner J. Blau , Yurii K. Gun'ko, Small but strong: A review of the mechanical properties of carbon nanotube–polymer composites. Carbon 44 2006. 1,[2] L. Ci, J.S., V. Pushparaj, X. Zhang, P.M. Ajayan. Continuous Carbon Nanotube Reinforced Composites. Nanoletters 2008 [cited Vol. 8. No.9 2762-2766. [3] Peng-Cheng Ma, N.A.S., Gad Marom, Jang-Kyo Kim, Dispersion and functionalization of carbon nanotubes for polymer-based nanocomposites: A review. Composites: Part A 41 (2010) 1345–1367, 2010.

8842 | STATIC AND FATIGUE STRENGTH OF REPAIRED COMPOSITE SINGLE-LAP JOINTS

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Composite materials have often been used in aircraft structures due to their excellent material properties, such as specific stiffness and strength. Aircraft composite structures can encounter a variety of damages, such as fatigue damage caused by local environmental conditions and operational condition of repeated loading. As a result, the longer an aircraft flies, the lower the structure strength gets, since it cannot maintain the integrity of the initial design stage. For this reason, ways to extend aircraft structure life through repair of damages have been studied. In this paper, we studied static and fatigue strength recovery of the repaired damaged portion of composite single-lap joints. Two different repair methods were used, composite patch and adhesive injection. Single-lap joint test specimens with three defect size were produced and repaired with the two methods, and then subjected to static and fatigue load tests. Specimens with no defect or repair were also tested for comparison. Thus, the influence on the strength recovery of the structure according to the repair method with the same defect size was evaluated. The changes of the tendency of static and fatigue strengths resulting from the changes of the defect size were also examined.

8846 | Progress in the Development of Self-Optimising Braiding Process of Technical Textile Structures

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Processes of net-shape preforms manufacturing become more and more popular nowadays. This interest is based on the reduction of production cycle time as well as cost reduction.

Each technology is based on strict following of processing parameters and production modes in combination with control operations. Development of automated production systems as well as development of smart control systems is the direction of any serial production development.

The system development process should be divided into several tasks to be performed in order to implement the system. First task is to develop and apply a method of process parameters automatic calculation. Then these values become references. Due to this, operation time of new part experimental production adjustment is reduced.

After processing parameters calculation methods are developed, there is a necessity to apply control and verification system to verify required parameters. There is a possibility to apply various control systems as well as their combinations.

Third task is implementation of cognitive process into the system that is being developed, i.e. a process of continuous comparison of actual and calculated parameters. This operation is a basic one in the process of automatic process control system.

ITA RWTH Aachen team is working on the project aiming at creation of such smart process control system for the process of radial braided reinforcement materials manufacturing. Process modes calculation algorithm for complex preforms production is developed. This method will be experimentally verified using braid angle video control system. Application of this control system will also allow analyzing process parameters. Basic diagram of cognitive process of controlled variables comparison is studied as well as creation of robot movements control algorithms based on data obtained.

Upon completion of the project a smart production system will be created. This will allow avoiding equipment adjustment procedures when part type is changed and additional operations of continuous production process control.

8849 | The structural analysis and strength evaluation of the rivet nut joint for composite repair

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Fiber reinforced polymer (FRP) composite laminates have become popular for aero-structures and mechanical parts as they are lighter, stronger and tougher. Damages of composite structures reduce the service life. For improved service life, the damages need to be repaired so that structural integrity is restored. The rivet nut joint is one of the prominent technique used for the composite repair which can access only to one side direction.
In this paper, we test and analyze the strengths of various specimens repaired by the rivet nut method. Single lap joint specimens with three different w/d (width to diameter) ratios and three e/d (edge to diameter) ratios were manufactured and tested. Tensile tests were performed on the rivet nut joints and their failure modes were evaluated. Also, the failure loads of the rivet nut joints were compared with those of mechanical bolted joints. Finite element analyses for the rivet nut joints were performed and the stresses around the hole were calculated. Finally, the experimental failure modes and loads were compared with the finite element analyses.

8851 | Effect of CaTiO3 addition on dielectric and ferroelectric properties of NBT based composites

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In the current work, the bulk (1-x) Na0.5Bi0.5TiO3-xCaTiO3 [NBCT] system was synthesized via solid state route. X-ray diffraction analysis revealed that CaTiO3 was produced as a secondary phase and rhombohedral and orthorhombic phases were observed in the pattern. Moreover, the addition of Ca promoted the segregation of Ca grains around NBT grains. CaTiO3 in Na0.5Bi0.5TiO3 was observed to decrease the dielectric constant at higher temperature and raise the dielectric constant at lower temperature. Frequency dispersion of dielectric constant was observed to decrease the dielectric properties. Polarization hysteresis measurements indicated that the ferroelectricity of Na0.5Bi0.5TiO3 was weakened with an addition of CaTiO3, resulted in the depression of depolarization temperature (Td) and transition temperatures (Tc). Furthermore, a small amount of Ca influenced the microstructure in the way to inhibit grain growth of NBT solution ceramics. The relative density and grain size considerably influenced the piezoelectric properties of the samples.

8855 | Synthesis of Fe based nanocomposites prepared by mechanical attrition

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The purpose of this work is to produce Fe based nanocomposites of different compositions by mechanical attrition and to investigate the high temperature grain growth and mechanical behavior of synthesized alloys. The oxide dispersion strengthened Fe based nanocomposites have a unique set of high strength and high thermal stability for high temperature applications. The oxide that is usually selected for reinforcement in Fe based nanocomposite is yttria (Y2O3), which has been shown to remain stable at high temperatures and hence will be investigated as the reinforcement in addition to SiC for the present study. XRD, SEM and optical microscope characterizations will be performed on mechanically alloyed and sintered samples. Microhardness changes along with grain sizes as a function of alloy compositions and annealing temperatures will be reported.

8861 | POLYMER/GLASS NANOCOMPOSITE FIBER AS AN INSULATING MATERIAL

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Nanotechnology is an area which is utilized in lots of applications such as filter media, fiber-reinforced plastics, solar and light sails and mirrors in space, application of pesticides to plants, biomedical applications (tissue engineering scaffolds, bandages, drug release systems), protective clothing aimed for biological and chemical protection and fibers loaded with catalysts and chemical indicator. The main idea of using nanofibers is increasing the surface to volume ratio by reducing to diameter into nanometer range. This supplies better mechanical properties such as wetting behavior and strength of fibers. Using nanofibers in insulation material is the unique idea. It provides better insulating facilities with compressing the air between the layers of nanofibers. Basically, glass wool is used for insulation materials. However, nanofiber glasses can be used for insulation purposes to be able to obtain insulation materials better then glass wool. From this point of view, glass nanofibers was produced with sol-gel method by using electrospinning technique. Firstly, sol-gel mixture (ethanol, tetraethoxysilane (TEOS), calcium nitrate tetrahydrate and hydrochloric acid) and polyvinylpyrrolidone (PVP)/ethanol solution was prepared, then they mixed together. The obtained mixture was then used to produce nanocomposite material by electrospinning method. After the heat treatment process, produced nanocomposite fibers showed specific insulating material characteristic specialties such as nonflammability, low thermal conduction coefficient. SEM, FTIR, and XRD, analyzes were also conducted to the produced composite materials. It was concluded that the nanocomposite fiber may be possible candidates for the industrial applications as an insulating material. To the best of knowledge of authors, this is the first study that polymer/glass nanocomposite fibers was produced as an insulating material.

Keywords: Nanocomposite, glass, polymer, insulating material

8865 | Response Bound Prediction of a T-shape Uncertain Composite Structure

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Products that are manufactured from the same production line and that have the same manufacturing processes can exhibit different vibro-acoustic response characteristics. This variability in vibro-acoustics is called as “uncertainty”. Uncertainty in structural systems makes vibration response unreliable especially at higher frequencies. For high frequencies, statistical approaches such as statistical energy analysis (SEA) are often used since they predict mean response level. In this study, response of a T-shape composite structure having uncertain mass is analysed via Finite Element Method (FEM) with Monte Carlo simulation. The results are evaluated by comparisons with SEA. Finally, an Extreme Value (EV) model which requires less Monte Carlo simulation data is constructed to predict the maximum bounds of frequency response considering random mass variability.

8866 | Scrolling CNTs Reinforced Nanowebs into Yarns

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Scrolling CNTs Reinforced Nanowebs into Yarns
Abstract
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Electrospinning is a versatile tool to produce nanofibrous webs. Carbon nanotubes (CNTs) are one of the most preferable fillers to reinforce polymer nanofibers due to their high strength, good thermally stability and electrical conductivity. However the use of CNTs reinforced nanowebs in multifunctional applications has been limited due to its delicate web form. To spin important materials into yarns such as the production of weavable neat CNT and CNTs

reinforced yarns is an emerging field in material science. In this study, twist-based spinning of CNTs reinforced nanowebs were conducted by a lab-design spinning equipment. This approach involves scrolling of 5-10 μm thick CNTs reinforced nanofibrous webs under constant load which is complicated than continuous spinning processes. The mechanical properties of these rectangular sheet strips enable weavability, knottability, and durability for scrolled yarns, which can result in applications for wearable electronic textiles and for strong woven electrodes of batteries. Optimum yarn diameter is investigated by varying turn speed and load. The morphologies and spiral angles and model are explored. In addition, proposed approach also offers wide range of functional materials and other types of nanotube yarns.

8869 | Film Formation from PS/Al2O3 Nanocomposites: A Fluorescence Study

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Steady state fluorescence (SSF) and UV-vis (UVV) techniques were used to study the film formation behavior of pyrene (P) labeled polystyrene (PS) latex and Al2O3 (PS/Al2O3) composites depending on PS particles size and Al2O3 content. Firstly, the close-packed arrays of PS spheres (SmPS: 203nm ; LgPS: 382nm) templates were assembled orderly on clean glass substrates by casting method. These films were then covered with various layers of Al2O3 by dip-coating method. Two different film series (SmPS/Al2O3 and LgPS/Al2O3) were prepared and seven different composite films were studied in various Al2O3 layer content for each series. The film formation behavior of these composites were studied by annealing them at a temperature range of 100 0C-250 0C and monitoring the scattered light intensity (Isc), fluorescence intensity (IP) from P and transmitted light intensity (Itr) through the films after each annealing step. The structural properties of composite films were characterized by scanning electron microscope (SEM). Optical results indicate that LgPS/Al2O3 films showed complete film formation independent of Al2O3 content while no film formation occurred above a certain Al2O3 content for SmPS/Al2O3 composite films. The surface morphology of the films was found to vary with the particle size of PS latex spheres and Al2O3 content. Extraction of PS template produced highly ordered porous structures for high Al2O3 content in both film series. SEM images showed that the pore size and porosity could be easily tailored by varying the PS particle size and the Al2O3 content.

8870 | Surface defect detection of the adhesive joint by measuring the normal and lateral impedances of adhesive joints with the carbon nanotubes

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Abstract.
The design of composite joints has become a very important research area because they are often the weakest elements in composite structures. Adhesive joints distribute a load over a larger area than mechanical joints, but they are very sensitive to surface treatment, service temperature, humidity and other environmental conditions. There are several non-destructive methods to evaluate the defects in adhesive joints but they can't detect the surface defects or contaminations effectively.
In this paper, the surface defects such as release film, release agent, or lubricating oil were evaluated by the impedance method, which measures the electrical impedance of the adhesive joint. To increase the electrical conductivity of single lap joint, 1-2 wt% carbon nanotubes were dispersed in the adhesive. The special probe which had multiple needles was made for uniform contact between test surface and probe. The normal and lateral impedances of adhesive joints were measured and the surface defects were evaluated by using the ratios of normal to lateral impedance.

8872 | Multiscale fiber reinforced composites with a carbon nanotube/epoxy nano-phased polymer matrix attached: Synthesis and interlaminar shear strength propertiy investigation

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Vertically aligned carbon nanotubes (A-CNTs) that are added into carbon fiber reinforced polymer matrix composite can significantly improve mechanical properties of composites and called as hybrid or hierarchical composite. Three common methods such as dispersion of CNTs into the polymer matrix, stitching them onto carbon fibers or synthesis CNTs onto fibers (fuzzy) are used to produce hybrid composites. In this study, A-CNTs which were synthesized using thermal chemical vapor deposition (CVD) are attached directly onto carbon fiber surface after the formation of custom made prepreg layers with carbon fibers. The custom made prepreg layers are made of nanotube reinforced epoxy matrix and carbon fibers. At the same time in this project, instead of performing too many experiments, experimental design which called Taguchi L8 orthogonal array would preferred and also only 8 experiments (each experiment was repeated 5 times, and number of total experiments were 40) were performed according to the design. At this design 7 different parameters which has 2 levels each one were examined and epoxy type, dispersion method, amount of CNT which dispersed and stitch types were selected as parameters which has two levels. For the mechanical properties interlaminar shear strength (ILSS) of the samples will be measured by short beam shear (SBS) test. In earler reports it is stated that carbon nanotube reinforced composites have showed an improvement of 8-30% interlaminar shear strength by short beam tests. The addition of A-CNTs onto the carbon nanotube reinforced matrix and fiber composite is expected to show higher interlaminar shear strength properties.

A-CNTs are synthesized on a Si substrate using CVD of C2H4/H2 at atmospheric pressure. The length of A-CNTs which is used to fabricate hybrid composites are around 100 μm with Raman measurements of (D/G ratio) about 0,83. During the hybrid composite fabrication A-CNTs will be removed from the substrate without any damage with an easy delamination growth protocol and then will be placed between the unidirectional carbon fiber plies. Three most important steps of the study can be summarized as the removal of CNTs from substrate, distribution of A-CNTs into epoxy and application of the mixture into the system. Unmodified A-CNTs were dispersed using homogenizator and tip types ultrasonicators which was in IPA, after removed IPA all dispersed CNTs were mixed using mechanical mixer in a low viscosity thermosetting resins which were consisted two components and a high viscose thermosetting resin (has a component). This approach generally has the advantages of simplicity and compatibility with standard industrial techniques. A uniform distribution of CNTs during wetting is critical for composite properties. Samples will be produced using hand lay-up/vacuum, and vacuum assisted resin infusion molding (VARIM). Hand lay-up/vacuum and vacuum assisted resin infusion molding are a very attractive, cost effective and environmentally friendly method of processing composites. Experiments will be performed to compare fracture behavior of the hierarchical composite with and without A-CNT.

8873 | Fabrication of hBN/CNT Polymer Matrix Composites by Ball Milling and Injection Molding Methods

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In recent years, ceramic reinforced polymers are investigated extensively. Polymeric composite materials with high thermal conductivity and low coefficient of thermal expansion (CTE) are important to dissipate heat generated in electronic devices [1]. Even though current polymers such as polyamide (PA), polyethylene (PE), polypropylene (PP), and polystyrene (PS) provide some advantages (as low weight and cost), they have low thermal conductivity values. Most of researchers have focused on improving of thermal properties of these polymers by adding ceramic reinforcing agents such as boron nitride (BN), alumina (Al2O3), zinc oxide (Zn2O3), glass fiber and, aluminium nitride (AlN) [1,2]. In addition to these, also carbon nanotubes (CNT) are considered as a good reinforcing agents for structural properties of composites [3-5]. There are lots of techniques to disperse the fillers into the polymer matrix as calendaring, ultrasonicator, sonicator, extruder, and injection molding [5]. The aim of this study is producing proper homogeneous feedstock by ball milling, integrating this method into the injection molding fabrication technique, and also investigating the effects of hBN and CNT additions; hBN and CNT on polypropylene (PP) matrix.

Experimentally, hBN and CNT is pre-milled in ethanol medium and dried to obtain homogeneous mixture. After that, all samples (PP granules + hBN) and (PP granules + hBN/CNT) are mechanically dispersed by ball milling in proper ratio. Extrusion is applied to the mixed powder included granules for producing feedstock while increasing the homogeneity. Finally, PP - various wt. % hBN matrix composites and PP - various wt. % hBN/CNT matrix composites are fabricated by injection molding method. Morphological properties of composites carries out by scanning electron microscopy (SEM). Additionally, thermal properties and crystallinity of composites are investigated by differential scanning calorimetry (DSC). Dynamic mechanical analysis (DMA) are conducted using tension film clamp to examine the effects of the both hBN and hBN/CNT fillers on the mechanical properties of polymer matrix composites. Finally, thermal conductivity of composites are investigated by thermal flushing method. As a result, mechanical and thermal properties of the composites are compared with each other and the optimum amount of hBN and hBN/CNT fillers in the polymer matrix are discussed.

[1] Watthanaphon C., Daisuke F., Shuichi T., Hideyuki U., and Yoshiyuki I., Thermal and Mechanical Properties of Polypropylene/Boron Nitride Composites, Energy Procedia 34, (2013) 808 – 817.
[2] Wenying Zhou , Shuhua Qi, Qunli An, Hongzhen Zhao, Nailiang Liu, Thermal conductivity of boron nitride reinforced polyethylene composites, Materials Research Bulletin, 42 (2007) 1863–1873.
[3] Zhidong Han, Alberto Fina, Thermal conductivity of carbon nanotubes and their polymer nanocomposites: A review, Progress in Polymer Science, 36 (2011) 914–944
[4] Jonathan N. Coleman, Umar Khan, Werner J. Blau, Yurii K. Gun'ko, Small but strong: A review of the mechanical properties of carbon nanotube–polymer composites, Carbon, 44 (2006) 1624–1652.
[5] Peng-Cheng Ma, Naveed A. Siddiqu, Gad Marom, Jang-Kyo Kim, Dispersion and functionalization of carbon nanotubes for polymer-based nanocomposites: A review, Composites: Part A, 41 (2010) 1345–1367.

8874 | A Multiscale Approach for Investigation of CNT Waviness Effect on PNCs

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Using CNTs as carbon fibers for light weight and hybrid materials provides advantages for multi functionality and mechanical improvements. Vertical aligned carbon nanotubes (A-CNTs), used as similar to carbon fibers in polymer matrix, have waviness as a complex structure and waviness causes significant changes on the effective mechanical properties of Polymer Nano Composites (PNCs)[1, 2]. In addition to waviness property, interphase effects have been studied for their effect on composite properties for many decades, and it is well documented that an interphase exists in polymer composites comprised of nanofibers[3, 4] with a changing region as 1-10 nm as well. In this project, a wavy CNT embedded in a polymer matrix with considering the interphase region is modeled by finite element method to investigate the waviness effects and interphase region on the elastic properties of representative volume element. Along this study specific CNT structures such as single walled (SW-), double walled (DW-) and multi walled (4-wall) CNTs were also considered to show that using solid structure for modeling the CNTs does not give appropriate results. In towards of these results, hollow structure to model the CNTs is used. The interphase region effects on the RVE are considered by using molecular dynamic (MD) simulations of this region in the presence of CNTs in a polymer matrix. The MD results were incorporated into the FE model for further investigation.

A commercial finite element analysis (FEA) software, from ANSYS, is utilized to investigate effective elastic properties of wavy A-CNT PNCs. A representative volume element (RVE) with a single wavy CNT embedded in a polymer has been created. CNT waviness is characterized by waviness ratio w=A/L, where A is the amplitude and L is the wavelength of CNT. The wavy CNT is defined by a sinusoidal shape function. Analytical reduction performed to define the variables of FE wavy model when DWCNT reinforced RVE is analyzed. For the loading conditions, the model is symmetric on xz (y=0) and z=nL/2 plane and a displacement, Δ in axial (z) direction applied to cross sectional area of RVE.

Mechnical properties of interphase region defined using molecular dynamics (MD) simulations of a thermoset polymer. The interlayer thickness of ~1nm is found to be independent of crosslink density and contain regions of both higher and lower mass density than the bulk polymer, and a methodology developed that provides an estimated average isotropic of ~90% of the bulk modulus. Finite element analyses of wavy A-CNT PNCs incorporating this interlayer have been defined and the effective constitutive relation based on a representative volume element is being extracted.

[1] F. T. Fisher, R. D. Bradshaw, and L. C. Brinson, "Fiber waviness in nanotube-reinforced polymer composites-1: Modulus predictions using effective

nanotube properties," Composites Science and Technology, vol. 63, pp. 1689-1703, Aug 2003.
[2] H. Cebeci, R. Guzman de Villoria, R. Jones, K. Schulte, H. Turkmen, and B. Wardle, "Effective Stiffness of Wavy Aligned Carbon Nanotubes for Modeling of Controlled-Morphology Polymer Nanocomposites," 2012.
[3] C. M. Hadden, B. D. Jensen, A. Bandyopadhyay, G. M. Odegard, A. Koo, and R. Liang, "Molecular modeling of EPON-862/graphite composites: Interfacial characteristics for multiple crosslink densities," Composites Science and Technology, vol. 76, pp. 92-99, Mar 4 2013.
[4] L. T. Drzal and M. Madhukar, "FIBER MATRIX ADHESION AND ITS RELATIONSHIP TO COMPOSITE MECHANICAL-PROPERTIES," Journal of Materials Science, vol. 28, pp. 569-610, Feb 1 1993.

8875 | Numerical Evaluation of Stiffness Degradation in Cross-ply Laminates due to Matrix cracking and Fiber splitting

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Composite laminates are extensively used in different load carrying structure due to their high strength and stiffness to weight ratio. Laminates such as off-axis plies are used to obtain high stiffness. Matrix cracking and delamination are the main initial forms of damage in advanced laminated composites. Sometimes this kind of damage is catastrophic for the structure, for example, it may cause leakage in pressure vessels. To design the structure properly it is necessary to understand the damage process and to predict the level of mechanical properties degradation. In this paper, transverse cracking initiation on a fiber/matrix level is investigated, and fiber/matrix interface strength that influences this process is explained under bi-axial loading for cross-ply laminates. The finite element software ABAQUS is used for the analysis. Based on experimental observations, equally spaced cracks have been considered in the model. Therefore, transverse cracking and fiber splitting are modeled by inserting equi-spaced cohesive elements in the transverse and longitudinal ply, respectively. Stress based damage failure criteria are implemented for the cohesive element. Stiffness properties degradation is evaluated for CFRP and GFRP laminates. Results are compared with existing theoretical and experimental predictions which show reasonable agreement.

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8876 | THE EFFECT OF CALCITE (CACO3) FILLER ON E-GLASS WOVEN FABRIC REINFORCED EPOXY COMPOSITES

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Polymers are reinforced with some fillers or fibers to obtain better physical and mechanical properties. Polymer composites ,which have high modulus, high thoughness, the resistance against corosion, easy-processable, low cost and good tribological properties, are used very effectively in a very large area ranged from aviation and space to automotive industry.
To enhance the general properties of polymers, different fibers are applied, whereas glass fiber, aramid fiber and carbon fibers represent the common high performance fiber. All fibers have advantages and disadvantages regarding price, performance and mechanical properties. Regarding specific mechanical properties, a big difference between fibers occurs.
Focusing on these specific mechanical properties, glass fibers show a good potential in fiber reinforced plastics with its low cost and easy-processability. In this study the epoxy resin was used as matrix. Epoxy resin stands out due to their good thermal behaviour and high mechanical values. Also, fibers can easily adhere to epoxy. Another advantage is the low shrinkage of the epoxy. During the curing cycle the resin and the hardener react within a polyaddition reaction.
The main target of this experimental study is manufacturing and characterization of a new composite material, therefore E-glass woven fabric reinforced epoxy resin based composites with calcite (CaCO3, particle size 5 μm) as a filler were fabricated. While the production with mats and chopped glass fiber reinforced epoxy composites with calcite (CaCO3) filler is already studied, E-glass woven fabric as reinforcement in epoxy resin composites with calcite (CaCO3) filler are not studied yet. Therefore, in this experimental study, the effect of calcite(CaCO3) on E-glass woven fabric reinforced epoxy resin composites was studied. The target of using calcite (CaCO3) filler in this study is to reduce production cost. E-glass woven fabric also increases mechanical properties. Thus the production of more economical new material groups were aimed for without changing production processes. However change of physical and chemical properties is inevitable with the addition of third component (calcite) into the composite. It effects mechanical properties negatively. At the end of the study, the change of properties of this hybrid construction was analysed.
In experimental study, E-glass woven fabric reinforced epoxy composites without filler were compared with the composite materials which is produced with new components. Epoxy/calcite composites without fiber and epoxy/E-glass fiber/calcite composites were produced with addition of different weight proportions of calcite(5 wt% ,10 wt% and 15 wt%). Eight composite plates were fabricated; one plate is neat epoxy composite, one plate is E-glass woven fabric reinforced epoxy composite, three plates are the composites of epoxy resin with calcite(5 wt% ,10 wt% and 15 wt%) and three plates are the composites of E-glass woven fabric reinforced epoxy with calcite (5 wt% ,10 wt% and 15 wt%). Epoxy/calcite composites without fiber were produced in a mold which has 4mm thickness at room temperature (25°C), and 1 atm. The epoxy/E-glass fiber/calcite composites were produced by using vacuum bagging technique. Four layers woven fabrics were used. The composites stayed one day under vacuum at room temperature, then placed in drying-oven at 60°C, 1 atm for post-curing. After preparation of test specimens, their mechanical and physical properties were characterized. Tensile test, three point bending test and impact test were carried out for determination of mechanical properties of composites. The obtained samples were also characterized by calcination test for determination of fiber volume fraction. The properties of composites were compared after characterization of samples.
In conclusion, the result shows that increasing of calcite decreases the mechanical properties.

8877 | DEVELOPING BLAST RESISTIVE FOAM FILLED SANDWICH PANELS BY USING EVOLUTIONARY OPTIMIZATION

ALGORITHMS

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In recent years, a large number of studies have been undertaken to develop novel composite materials for blast protection. Sandwich structures provide high strength/weight and rigidity/weight ratios as well as protect the structure behind it through damping high speed shock loads. Therefore, sandwich structures are used in critical public buildings, military establishments, ground/air/space vehicles and vessels. The goal of the present study is to develop a novel composite material which has high strength/weight and rigidity/weight ratios. To obtain these properties, advanced design optimization techniques were used in the design stage of the material. In the optimization process, the optimum parameters of cell geometry in the sandwich panel were investigated. The main objectives of this study are; to develop blast resistive foam filled sandwich panels using evolutionary optimization algorithms and to contribute to the scientific literature on the novel composite materials. The structures developed in this study will be of use to the defense, automotive and other industries. A shock tube apparatus was used in the experiments to simulate the blast effect and a simulation-based design approach integrated with the experimental results was prepared and used for supporting the designs of the new shock absorption sandwich structures. After correlating the simulations, the new optimization approach, based on a method that uses the best vectors in the population as differential vectors in mutation strategy, was applied and very good results were obtained for three different boundary conditions. The final results of the optimized sandwich panels included 37% improvement of shock absorption with respect to the original sandwich panel for the simple supported case, 25% improvement for the fixed case, and 14% improvement for the rigid base case.

8878 | High precise cutting of carbon- and glass fiber using laser technology

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Introduction:
Highly efficient connection elements for the assembling of component groups are the basis for an integration of high performance composite parts into existing structures. Economical and technical advantageous processes for an integration of force transmission elements in Fiber Reinforced Plastics (FRP) are important for a large scale application of these high performance materials.
State of the art is the integration of functional elements by a complex reworking of the consolidated parts. The consequences are high process times. An integration of functional elements in the preforms is recently not possible because of insufficient processes to realize the provided highly precise notches in carbon- or glass-textiles for a sufficient connection to inserts. State of the art cutting technologies are causing frazzling's and shifting at the cutting edges. Pull-out-forces and -torques are too low for an industrial application of dry integrated inserts. Furthermore the geometrical complexity of notches is strictly limited.
Aim:
The aim is the production of highly precise notches in textile preforms for inserts. These cut outs are effecting a perfect fitting connection to the inserts, in order to increase required pull-out-forces and -torques. Furthermore complex cut-out geometries for tailored and innovative insert-geometries should be realized.
Approach:
For the optimization of connections from textiles to inserts, to increase required pull-out-forces and -torques, and to increase the quality of the cutting edges and tolerances, an ultra-short pulsed laser is used.
In the context of the "Laserinsert" project companies and departments of several areas are cooperating. The required highly precise notches are cut out with aid of an ultra-short pulsed laser source from AMPHOS. The Laser experiments are conducted at Fraunhofer Institute for Laser Technology (ILT) and Chair for Laser Technology (LLT), RWTH Aachen University, Germany. The Laser offers the opportunity to generate highly precise and complex geometries with minimum distortion of the textile and with potential of time savings in the production process.
The Institute for Textile Technology (ITA) RWTH Aachen, Germany, is determining the optimal carbon- and glass-textile structures for a laser cutting process.
Objective of the first tests is the investigation of the cutting characteristics of woven and non-crimped carbon textiles, including:
• Determination of suitable parameters for a textile cutting with the ultra-short pulsed laser in general,
• Finding of sufficient parameters to cut different thicknesses of the textiles
• Investigation of an optimum cutting strategy by the variation of different cutting parameters.
Methodology:
In a first step samples with circular cut outs, with diameters of 10 mm, are produced. Samples of woven and non-crimp fiber carbon textiles are made. Furthermore, different cutting geometries with increasing complexities are cut out.
For an investigation of the cutting edge quality an optical image analysis system for a measurement of the fiber orientation and defect detection, is used. The system offers the opportunity of the investigation of the cutting edges of the different textile structures regarding a detailed picture of cut outs. In a second step, the cut outs are evaluated with image evaluation software, by measuring the uniformity of the round cut out.
Results:
Highly precise cut out of woven and non-crimp fiber carbon textiles is possible by using the ultra-short pulsed laser. It has been shown that the quality of cutting edges is strictly linked to the thickness of the carbon textiles. Main influencing parameters for ultra-short pulse laser processing are pulse energy per area (fluence), repetition rate, scanning velocity and the scanning path strategy.

8879 | Effect of starch source on the biodegradability of LDPE/Thermoplastic Starch Blends

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Starch, which was one of the most abundant biopolymers in the environment, comprised of two main carbohydrates, amylose and amylopectin. Amylose had a typical molecular weight of several thousands and comprised the amorphous segment of starch whereas amylopectin comprised the crystalline structure of starch with higher molecular weight. Depending on the ratio of amylose/amylopectin, physical, thermal and mechanical properties of starch could be varied according to starch source. However, starch could not be processed as a thermoplastic in its natural form because of the ordered

crystalline parts in its structure. In order to avoid these problem, starch should be plasticized with a plasticizer, which had the ability to make -H bonds with -OH groups in starch. In plastification process, starch granules disrupted, ordered crystalline structure deterioted and melt processable thermoplastic starch (TPS) had been formed. By the synthesis of thermoplastic starch, starch could be processed with commercial thermoplastics like low density polyethylene(LDPE), polypropylene, etc. to gain biodegradability behaviour to synthetic, petroleum based polyolefins. Moreover, the cost of material would be diminished and waste management of polyolefins would be performed by the addition of thermoplastic starch to polyolefins [1,2].
In this study, low density polyethylene had been blended with potato, rice and corn starch, which were plasticized with 30 % (w/w) glycerol before extrusion processs, to investigate the effect of starch type on the biodegradability of thermoplastic matrix. LDPE/TPS blends were synthesized in the range of 90:10, 80:20 and 70:30 in a co-rotating twin screw extruder having screw diameter of 16 mm, with a screw ratio (L/D) of 24. Structure of potato, rice and corn starch was investigated by X-ray diffraction analysis and biodegradability behaviour of LDPE/TPS blends was determined by soil burial, bacterial strength and water absorption tests. Soil burial tests were performed in a truffle soil for six months and weight loss of films were calculated after particular periods and results were supported by visual observations. Bacterial strength of blend films were investigated in the presence of Aspergillus Niger for 28 and 56 days incubation period. Water absorptivity of blend films was determined at 4 oC, 25 oC and 40 oC in 100mL distilled water. At 7th,14th, 21th and 28th days of storage, blend films were weighed and water absorption ratio was calculated. According to biodegradability tests, LDPE/TPS blends comprised of rice starch as a biodegradable reinforcement had been found to be readily degraded in all biological environments. Moreover, LDPE/TPS blends having 30% (w/w) starch had showed biodegradability behaviour in the presence of Aspergillus Niger bacteria.

References
[1] R. Chandra, R. Rustgı, Biodegradable polymers, Prog. Polym. Sci., Vol. 23, 1273–1335, 1998
[2] E. Rudnik, Compostable Polymer Materials, Elsevier Science, 2008.

8880 | Composite Structure of a Solar Electric Vehicle

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This study was carried out to investigate ITU's new four seated solar electric vehicle's, while in design process and after design process determining the composite structure, the methods will be used to produce the vehicle's shells and chassis also the test will be made in order to produce reliable, light-weight vehicle structure.

The most significant property of solar vehicles is that they can go long distances with small amount of renewable energy. During the design phase of these vehicles energy efficiency is considered of upmost importance. Additionally different design problems than normal passenger and commercial vehicles are encountered and dealt with.Reducing energy consumption depends on three parameters of design.First parameter is the efficiency of the system, as the vehicle is going to have in wheel hub motor the efficiency of the system is very high and could reach about 95 percent.Second parameter is aerodynamic design which is effected by the shape, geometry and quality of the surface quality.Eventually, third and major role which vehicle structure and production could take is weight.The designs which are the team has before were one seated solar electric vehicles and at this point weight had the 25 percent of the energy consumption.After the team decided to challenge in a two or more seated "challenger" class, weight has the 30-40 percentage of the energy consumption at cruising speeds.In order to make the vehicle lightweight and produce high quality of surface some tests like tensile and bending will be made.

In the study, vehicle fundamental calculations, done by using of commercial software's like Solidworks, MS/Excel, ANSYS were taken firstly into consideration. A series of methods was developed to optimize the construction, endurance, production and test process and basic know-how is collected for the design of chassis and shell structure of such an environmentally friendly vehicle.

By using of solid modelling and other CAD techniques together with ANSYS software, different constructions were modelled and analysed, aiming to obtain the optimum vehicle structure that provides both reliability, endurance, stability and energy consumption.

8883 | Effect of Nafion content in carbon black layer on catalytic activity of Pt/C composite electrode prepared by pulsed electrophoresis deposition for PEMFC

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Polymer electrolyte membrane fuel cells (PEMFCs) can be used as energy converters in all kinds of systems, from portable electronics and automotive applications to stationary power plants. The catalyst layer is a critical component of the membrane electrode assembly (MEA) and the whole cell performance is dependent on them. Platinum (Pt), which is typically used as catalyst in PEMFC electrodes, is one of the major factors for cell costs. Therefore, the main goal in PEMFC development is to reduce Pt loading of the electrodes without sacrificing fuel cell performance. Most of fuel cell electrodes are fabricated by a decal method or air-brushing catalyst ink onto a carbon paper or a cloth gas diffusion layer. In this case, inactive catalyst sites exist in the catalyst layer because the electrochemical reaction of fuel and oxidant occurs mainly at the interface of the membrane and the electrode. This problem decreases the activity of the Pt catalyst in fuel cell reactions. Therefore, that three-phase reaction zone is very important for Pt utilization since the catalyst sites need to be easily accessible for the hydrogen oxidation and oxygen reduction reactions.
A new approach to prepare MEA with ultra-thin Pt catalyst layers at the polymer electrolyte/carbon black electrode interface based on pulsed electrophoresis deposition (PED) was reported in our previous work. In order to localize Pt at the interface between the membrane and electrode, it is critical to prepare carbon black electrode with an optimum amount of Nafion, hydrophilicity, and thickness. In this study, the effect of the carbon black loadings and the weight ratio of Nafion to carbon black on the electrocatalytic activity was investigated. To prepare a Pt/C electrode using this electrophoresis deposition, carbon paper coated with carbon black ink (without platinum) and ionomer (5 % of Nafion solution) was used as the working electrode, and Pt colloidal solution was applied as a plating bath. The amount of solid Nafion in the carbon black electrode was varied from 5 to 35 wt%. Electrochemical experiments were conducted on Potentiostat/Galvanostat (Model 263A, Princeton Applied Research) in three-electrode cell. In each experimental case, pH level of Pt colloidal solution, pulse current density, cycle time, and duty cycle held constant at 2, 30 mA cm-2, 1 s, and 25%, respectively. The deposition time used in this experiment varied from 1 min to 10 min. The effects of the Nafion amount and carbon black loadings on the

electrocatalytic activity of the electrophoretically deposited Pt/C electrodes were evaluated by cyclic voltammetry (CV) technique in the electrolytes with 0.5 M H2SO4 and 0.5 M H2SO4/ 1 M CH3OH, respectively. Transmission electron microscopic (TEM) image of Pt colloidal nanoparticles was obtained using Hitachi H8100-IV electron microscopic operated at 200 kV. The morphology of Pt/C electrodes was examined by field emission scanning electron microscopy (FESEM; Hitachi, S-4800). The XRD test was carried out on Rigaku DMax diffractometer using Cu kα1 radiation at 40 kV and 30 mA

8893 | Retrofitting of Damaged Masonry Walls Using 3D Spacer Fabrics

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It is a common fact that unreinforced masonry walls are very brittle structural elements and prone to severe damage under seismic events. Such walls especially in old and historical structures need to be retrofitted and strengthened. Several methods and techniques for this aim were developed so far; however, applications using technique textiles were gained significant popularity in last decades. Near surface mounting of FRP using epoxy is considered an excellent option for damaged quite old or historical masonry structures. On the other hand, durability concern for interaction between epoxy and mortar, poor behavior of epoxy under moist and wet environment and relatively high cost of such polymers can be declared as disadvantages of FRP retrofitting/strengthening methods.

In this innovative study, 3D spacer fabrics manufactured with polyester were used to retrofit of damaged masonry walls. It was investigated that 3D fabric polymers could be a reasonable, cheap and also a durable solution of retrofitting of masonry walls. Two masonry walls having 190x1190x1390 mm dimensions were built using about 70 year-old clay bricks and tested under constant axial load and monotonic lateral load to a certain amount of damage level. Subsequently, both walls were repaired by hydraulic-lime grout injection. One of the walls was retrofitted by embedding of 3D fabric strips to near surface of bed joints using hydraulic-lime grout in addition to grout injection. The retrofitted walls were tested under same loading scheme with initial tests. Load-displacement results and failure behavior of the walls were presented in the research paper. Promising results and strength recovery were achieved with 3D fabrics with respect to initially undamaged and retrofitted by only grout injection counterparts.

8918 | Improved Core-Skin Adhesion Through Electrospun Nanofibers for Honeycomb Structures

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This work investigates the effect of electrospun P(St-co-GMA) nanofibers to the adhesive properties of core-skin interface region for honeycomb structures. Honeycomb sandwich panels are manufactured by using (0)8 carbon fiber/epoxy prepregs as upper and lower skin layers. Two different types of honeycombs are considered for the core. Specifically, 8 mm thick Nomex and 12 mm thick Aluminum honeycomb cores are utilized. Electrospun nano fiber addition is only considered to the core-skin interface region. Two separate manufacturing techniques that is widely applied in industry are followed for the sandwich manufacturing. First, the construction of the sandwich (core, nanofibers and skins) is made while the skin prepreg and additinal epoxy film layers at the core-skin nanofibrous interface are co-cured. Second is the manufacturing of the sandwich by bonding the core and the pre-cured skins by incorporating nanofibers and the epoxy film as nanofibrous interface. Sandwich manufacturing is done via vacuum bagging technique. Cured structures are cut into test specimens by a diamond cutter and holes are introduced to structures by diamond drills. Sandwich specimens are tested under three point bending, four point bending and open hole four point bending test conditions. The fracture analysis through mechanical testing is supported by cross-sectional and fracture surface SEM analysis as well as acoustic emission to carefully detect local core-skin debondings and face delaminations. Preliminary results suggested that the addition of nearly weightless electrospun interlayers to core-skin interface delayed the local debondings occurring during 3 point bending test and resulted an increase in flexural strength by `10%.

8922 | Hybrid use of carbon and halloysite nanotubes for toughening of epoxy composites

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Carbon nanotubes have proven to be effective fillers to increase mechanical properties such as tensile strength and fracture toughness in epoxy matrix composites. However, the toughening of conventional carbon fiber/epoxy composites with different nanotubes than carbon nanotubes appears to be a promising research field. The naturally occurring halloysite nanotubes (HNT) are potential candidates in this area due to their lower cost and non-toxicity. Recent research efforts proved that HNT/epoxy nanocomposites showed superior mechanical performance when compared to neat ones [1]. However, the problem of particle agglomeration during nanocomposite preparation is a factor that limits the mechanical performance of these nanocomposites. This research aims to prove that the hybrid use of CNTs and HNTs in epoxy matrix composites will result in a significant increase in mechanical properties of epoxy matrix composites due to lower interaction between HNT and CNT nanotubes when compared with self-same interactions. In the scope of this work, the toughening effects of HNT/CNTs are first studied in neat epoxy. The dispersion in epoxy is evaluated using scanning electron microscopy, transmission electron microscopy and dynamic light scattering analysis. The samples are then subjected to three point bending tests. The overall comparison between mechanical behavior is made between HNT/Epoxy, CNT/Epoxy and HNT/CNT/Epoxy specimens. Optimum HNT/CNT ratio that results in best bending performance is applied to conventional carbon fiber/epoxy laminates manufactured by vacuum infusion. Composite laminates having (0/90)6s lay-up sequence are then tested under three point bending. Flexural strength and flexural modulus of toughened and neat composites are compared. The fracture mechanisms are revealed with the aid of cross sectional and fracture surface SEM analysis.

References
[1] Deng S, Zhang J, Ye L, Wu J. Toughening epoxies with halloysite nanotubes. Polymer 2008;49(23):5119-27.

8936 | Flexural Analysis of Symmetric Laminated Composite Timoshenko Beams under Harmonic Forces – I. Analytical Solution

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The flexural dynamic response of symmetric laminated composite beams subjected to general transverse harmonic forces is investigated. The dynamic equations of motion and associated boundary conditions based on the first order shear deformation are derived through the use of Hamilton's principle. The influences of shear deformation, rotary inertia, Poisson's ratio and fibre orientation are incorporated in the present formulation. The resulting governing flexural equations for symmetric composite Timoshenko beams are exactly solved and the closed form solutions for steady state flexural response are then obtained for cantilever and simply supported boundary conditions. The applicability of the analytical closed-form solution is demonstrated via several examples with various transverse harmonic loads and symmetric cross-ply and angle-ply laminates. Results based on the present solution are assessed and validated against other well established finite element solutions and exact solutions available in the literature.

8937 | Flexural Analysis of Symmetric Laminated Composite Timoshenko Beams under Harmonic Forces – II. Finite Element Formulation

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A super-convergent finite element is formulated for the dynamic flexural response of symmetric laminated composite beams subjected to transverse harmonic forces. Based on the assumptions of Timoshenko beam theory, a one-dimensional finite beam element with two-nodes and four degrees of freedom per element is developed. The new beam element is applicable to symmetric laminated composite beams and accounts for the effects of shear deformation, rotary inertia, and Poison's ratio. The analytical closed-form solution for flexural displacement functions developed in a companion paper [1] is employed to develop exact shape functions. The present formulation can be used for quasi-static, steady state flexural analysis of symmetric laminated composite beams. It is also used to extract the natural frequencies and mode shapes for flexural response. The accuracy and efficiency of the present finite element are shown through comparisons with other established exact and Abaqus finite element solutions. The new element is demonstrated to be free from shear locking and discretization errors occurring in conventional finite element solutions and illustrates an excellent agreement with those based on finite element solutions at a fraction of the computational and modeling cost.

8938 | Coupled Flexural-Lateral-Torsional of Shear Deformable Thin-Walled Beams with Asymmetric Cross-Section – Closed Form Exact Solution

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This paper develops the exact solutions for coupled flexural-lateral-torsional static response of thin-walled asymmetric open members subjected to general loading. Using the principle of stationary total potential energy, the governing differential equations of equilibrium are formulated as well as the associated boundary conditions. The formulation is based on a generalized Timoshenko-Vlasov beam theory and accounts for the effects of shear deformation due to bending and warping, and captures the effects of flexural–torsional coupling due to cross-section asymmetry. Closed-form solutions are developed for cantilever and simply supported beams under various forces. In order to demonstrate the validity and the accuracy of this solution, numerical examples are presented and compared with well-established ABAQUS finite element solutions and other numerical results available in the literature. In addition, the results are compared against non-shear deformable beam theories in order to demonstrate the shear deformation effects.

8968 | DYNAMIC BEHAVIOR OF COMPOSITE DEEP CURVED TIMOSHENKO BEAMS UNDER BLAST LOAD WITH NUMERICAL METHODS

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This study focuses on linear dynamic behaviour of composite deep curved Timoshenko beams under the blast loading. Deep curved beams exposed to high stresses and impact loads are studied in depth. Equations of motion of the Timoshenko deep curved beam is obtained by using the virtual work principle and by taking into account the effects of rotational inertia and the transverse shear. Dynamic equations are solved by using the finite difference and the finite element method. Deep curved beam results are presented and compared with the finite element counterparts. Effects of the different boundary conditions, radius of curvature and laminate lay-up order on dynamic responses are analysed. In addition, analyses are repeated for various beam structures for the same material for different radius of curvatures. Finally, dynamic responses of these structures in similar loading circumstances are compared.

8973 | Comparison between three fatigue damage models and experimental results for composite materials submitted to spectrum loading

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- The theme that we have treated here is about phenomenon of random fatigue of composite structures.
- The failure mode on which we focused in our work is that of inter-laminar fracture delamination.
- Next to experimental results, we have presented three models for predicting damage of structures in order to compare them to test results.
- The effect of the standard deviation of the predictions of the life of composites is also highlighted in the last part of the paper.

Thanks to their excellent fatigue resistance and low weight ratio, today; composite materials are of great importance in humanity life, either in civil or military fields such as aerospace, automotive, marine … and as is usual, each material reaches failure towards the end of his life which is manifested by

the occurrence of fractures. Until now, researchers put their efforts into service in order to achieve accurate and general models for predicting damage of this mysterious material. On our side, we compared three fatigue damage models in order to see the most accurate and consistent with our experimental results. Throughout the work, we adopted a stationary ergodic Gaussian random loading.
First, we conducted a thorough study of the interlaminar fracture of composite laminates subjected to stochastic loads. The choice of this failure mode was inspired by the fact that this failure mode is most predominant among others; moreover, it is more dangerous because it's invisible and undetectable and occurs suddenly between the layers of material. The results of the experiments carried out with graphite epoxy composite laminates [± 45/0/90]3s, were compared to the predictions of three models namely:
- Linear damage model based on the law of Miner,
- Damage mathematical expectancy E (t),
- Stiffness degradation model,
Second time, following an analysis of the results, we found that the three models mentioned above are close to the experimental results. We see that the correlation is the best for the stiffness degradation model. On the other hand, the effects of load sequence and interaction are not taken into account in linear damage model, which can lead to some difference between the model predictions and experimental results.
Finally, we had to study the effect of standard deviation on the life of composite laminates. For this we calculated the lifetime for various values of sigma and various average amplitudes of the applied load. Interpolating the data obtained led us to an equation linking lifetime of structures to standard deviation.

9001 | Mechanical behaviour of laminate (Glass fiber fabric/Epoxy resin) at the saturation and ageing

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This paper considers the analysis of the mechanical behaviour of a laminate constituted of 12 layers of glass fiber fabric/epoxy resin conditioned at different relative humidities of 0, 60 and 96% at 60 °C. The analysing of the experimental results obtained of hygrothermal ageing on the mechanical response has permited to show that the influence of the moisture concentration on the ultimate mechanical properties becomes significant and important for the composite conditioned at relative humidity of 96% to the periods I and II (state of saturation and ageing).

9007 | Fabrication of diamond particles dispersed Zr-alloyed Cu matrix composites and their thermal conductivity

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Abstract: Highly powered electronic devices like laser diodes and microprocessors are demanding packaging materials with high thermal conductivity to dissipate the heat generated. As a promising candidate, diamond particles dispersed Cu matrix (diamond/Cu) composites are attracting much attention in recent years. In this paper, diamond/Cu composites were produced at 1150 °C for 30 min under a pressure of 1.0 MPa by a gas pressure infiltration method. In order to overcome the inherently poor interfacial bonding between diamond and Cu, before infiltration, 0.3-1.0 wt.% Zr were added to Cu matrix to modify the interfacial bonding. The scanning electron microscopy (SEM) observations showed that the diamond particles were uniformly dispersed in the Cu matrix. The X-ray diffraction (XRD) results demonstrated the existence of ZrC in the produced diamond/Cu-Zr composites. The Auger electron spectrometer (AES) and transmission electron microscopy (TEM) characterizations further confirmed that a thin layer of ZrC was formed at interface of diamond/Cu. This layer is believed to connect diamond reinforcements and Cu matrix closely. As a result, the diamond/Cu composites with Zr-alloyed Cu matrix exhibited much higher thermal conductivity than the unmodified diamond/Cu composite. In the compositional range of 0.3-1.0 wt.% Zr, the thermal conductivity first increased and then decreased with increasing Zr content, and a maximum thermal conductivity of 930 W/mK was obtained at 0.5 wt.% Zr, which is reportedly high in literature. The thermal conductivity values were also compared with theoretical values predicted by the differential effective medium (DEM) model. The results manifest the role of Zr alloying to Cu matrix in enhancing the thermal conducting properties of diamond/Cu composites.

Keywords: Metal matrix composites (MMCs); Diamond; Thermal conductivity; Infiltration; Interface

9010 | Moment distributions around elliptic holes in anisotropic plates subjected to remote uniform bending or twisting moments

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The problem of an elastic plate containing a hole subjected to a remote loading is important in engineering applications because of the stress concentrations at the edge of the hole. The loading may include in-plane forces and out-of-plane moments. However, most of the studies on the hole problem are for in-plane forces and relatively fewer results are available for bending or twisting moments. The present work is concerned with the latter. Specifically, an elliptic hole in a homogeneous anisotropic plate is considered. The size of the hole is assumed to be small compared with the over-all dimensions of the plate so that the plate may be regrade as infinitely large. Moreover, the Kirchhoff plate theory is adopted.
In contrast with the previous works on the problem, the requirement that the deflection be a single-valued function is satisfied by introducing a correction constant. An exact solution for general anisotropic materials under arbitrary uniform loading conditions is derived. Explicit expressions for the moments on the edge of an elliptic hole in an orthotropic plate subjected to bending or twisting moments are obtained. The moment intensity factors as the elliptic hole degenerates into a crack are also given.

9014 | Fabrication of P(AN-co-BuA)/PPy core/shell nanoparticles, their thin-films and spectroscopic and morphological characterization

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Poly(Acrylonitrile-co-Butyl acrylate) [P(AN-co-BuA)] nanoparticles were synthesized from its monomers via micro-emulsion polymerization. Without any additives in the same batch, but just as divided into the equal volumes of containers from the total volume of main emulsion, different amounts of Pyrrole (Py) monomer were polymerized onto the synthesized polymer nanoparticles, thus, P(AN-co-BuA)/PPy core/shell nanoparticles (CSNPs) were obtained by single-batch micro-emulsion polymerization method. In each container, respectively the homogeneous colors changing from gray to bluish-black were observed as an indication of PPy formation on copolymer nanoparticles. Samples were taken from the composite emulsions to analyze particle size in particle-size-analyzer instrument by light-scattering method. Precipitated, insulated and dried nanoparticles were taken as sample to analyze their composition on ATR-FTIR spectrometer and to estimate their particle-size distribution also on UV-Vis spectrophotometer. Morphological analysis was achieved by images taken on Scanning Electron Microscope (SEM). As last stage, thin films (1-3 microns of thickness) were produced from the synthesized core-shell nanoparticles, and also their morphological (Atomic Force Microscopy - AFM), electrical (Electrochemical Impedance Spectroscopy - EIS), and spectroscopic (ATR-FTIR) analyses were achieved to indicate the changes of electrical performances of CSNPs via increase in PPy formation with increasing initial Py content and resultant particle diameter. The correlation between average particle-size, spectroscopic and morphological analyses proved the success at producing core-shell nanoparticles with different shell-thicknesses via such a cost-effective process.

Keywords: Acrylonitrile; Butyl acrylate; Pyrrole; Micro-Emulsion polymerization; Core/Shell nanoparticles.

9020 | A Study on Acoustic Behavior of the Combined Structure from Nanofibrous Membrane and Nonwoven Fabric

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White goods can cause many noise problems in domestic properties such as vibration and airborne noise which can be very intrusive. Washing machines, fridges, dishwashers and other electrical goods can give off vibration and airborne noise, which can be intrusive both within your own property and to others. Nonwoven fabrics, in general, are ideal acoustical insulator due to their high volume-to-mass ratio, and as a result of that they are preferred to use in acoustic applications including white goods. Electrospun nanofibrous membranes, on the other hand, are a novel topic to analyze their acoustic characteristic for similar applications. There are relatively few reports on the acoustic properties of nanofibrous membranes. Sound absorbents based on nanofibers can have a higher absorption factor compared to traditional absorbents especially in lower frequencies. The combination of the nanofibrous membranes and porous materials is expected to provide great efficiency across a larger frequency bandwidth. The purpose of this study is to develop a combined structure of the nanofibrous membranes and nonwoven fabric and to analyze the acoustic behavior of this very structure. The water solution of polyvinyl alcohol PVA (Mw = 80,000 -100,000 g/mol) was used for preparing the solution for the production of the nanofibrous membrane. The concentration of prepared PVA solution was 12.8% v/v. The mass per unit area of the produced nanofibrous membrane was 25g/m2. The average fiber diameter of PVA nanofibrous membrane was found to be 230±100 nm. The surface and structure of the membrane and the diameter of the electrospun PVA fibers were determined using a Carl Zeiss Ultra Plus Field Emission scanning electron microscopy (SEM). Needle punched nonwoven fabric (felt) having a thickness of 20mm was used as substrate. Two-microphone Impedance Measurement Tube Type 4206 was used to measure the absorption coefficient in the frequency ranges 50Hz to 6.4kHz.The results showed that the combination of the nanofibrous membranes with a nonwoven fabric significantly improved the sound absorption coefficients. The sound absorption curves of the combined structures suggested that these structures could better absorb sound at larger frequency bandwidth. Furthermore, the sound absorption coefficients of the structure increased with increasing air gap between the structure and rigid wall especially in low and medium frequencies. In the low frequency range, the resonance frequency of resonant system appeared to decrease for higher air gaps. It may be concluded that the nanofibrous membranes, together with nonwovens, would offer more efficient solutions to the noise problems in white goods.

9025 | The heat release rate of hardened Epidian 5 resin unmodified and modified by fire retardants ZS and ZHS

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A description was presented of the impact of selected flame retardants on the flammability of the Epidian 5 (Ep 5) epoxy resin. The applied combustion inhibitors comprised of: zinc stannate (ZS), zinc hydroxystanate (ZSH) in various mass concentrations. The fire retardancy of selected materials was determined on the basis of measurements of the heat release rate in cone calorimeter. Both for the measurement of the oxygen index and the combustion heat, the addition of 5% or 10%of mass of ZS at external heat flux 50kW/m2 proved to be the most effective fire retardant.
Experimental test was made using a cone calorimeter at heat flux 50 kW/m2, and comprised the determination of such parameters, as: rate of heat (HRR) and smoke release rate, materials inflammability and the toxicity of volatile phase of modified and unmodified epoxide samples under decomposition conditions. Studies have shown that introduced flame retardants favourably influenced the flame retardancy of epoxy material as evidenced by lower values of the heat and smoke release rate as compared to unmodified resin Epidian 5.

9041 | Controlling the flow of heat with layered composite structures

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The design of invisibility cloak or concentrating devices has received substantial attention since the pioneering papers in 2006 on electromagnetic wave based on coordinate transformations. The method of coordinate transformation often exploits stretching, or compressing of one region in one (virtual) coordinate into another region in a different (physical) coordinate. Often this will lead to a transformed domain, with anisotropic and non-homogeneous material properties. In practice this will cause some difficulty in practical fabrication. Here based on a concept of neutral inclusion, we present an inverse method to design a device to concentrate the heat flow with constant anisotropic conductivity. We demonstrate that the device can be simulated by a layered structure made of two homogeneous materials. To validate our formulation, in addition to the theoretical formulation, we also demonstrate our

results based on finite element calculations. This study may find potential applications in controlling the intensity of thermal energy.

9046 | New Qualitative Method to investigate the vibration of composite rectangular plates under the effect of Dimension and Rigidities ratio of both perpendicular sides

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In this work we propose a qualitative method that allows rapid expertise of the composite vibration behavior of rectangular plates taking into account the dimensions ratio (a/b), and the effect of the rigidity ratio (Dx/Dy) along the two axes of the plate (x, y). The comparative analysis of two or more composite rectangular plates which differ in their boundary conditions (ex: SSCC / SCSC) is intended to systematically verify the frequency curves and ensure their relative proper positions with regards to their modal progression. From previous work the qualitative method applied to the isotropic rectangular plates with the support conditions (SSCC/ SCSC) and based only on the effect of the dimensions ratio (a/b) showed a good concordance with the results obtained from the FE method.
In our previous works, we proposed a study based on a dimension ratio (a/b>1) and on varying the rigidity ratios (Dx/Dy) = (2, 1, (2:3), (1:2), (1:3), (1:4)). In this work we propose to globalize and validate the qualitative method by
studying the case where we have a dimension ratio (a/b<1) and by taking into account the effect of the rigidity ratio (Dx/Dy) = (2, 1, (2:3), (1:2), (1:3), (1:4)).
The comparative and qualitative analysis of frequency responses allowed the justification of the position and the threshold of the respective modal frequencies of the two plates (SSCC/ SCSC) in accordance with the results obtained from the numerical and analytical methods in use. The first six frequency modes are obtained from the results achieved by developing a MATLAB program that checks these results against those obtained by the FEM using the code of calculation ANSYS.

Keywords: Free Vibration, Thin Plates, composite, Rigidity Ratio, Equivalent Method, Rayleigh's Method, Finite Element Method.

9050 | Mechanical Properties of Woven Jute-Glass Hybrid Composites

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Textile reinforced composites have an increasing significance in various sectors such as automotive, aerospace, marine transport and sport equipments. In this study, while jute and glass woven fabrics were used as reinforcement material, polyester was used as resin for hybrid composite laminate production. Four different composite plates, each of which has four layers, were produced with different stacking sequences (JJJJ, GGGG, JGGJ, GJJG; J: Jute G: Glass) by vacuum infusion technique. Finally, the effect of stacking sequence of the fabric layers on the mechanical properties (Charpy impact and three point bending tests) of hybrid composite materials were estimated and also mechanical performance of hybrid composites was compared with pure jute and glass composites. All test specimen preparation and testing were carried out as per ASTM standards.

9051 | The Effect of Acid Solvents on Morphology of Electrospun Polycaprolactone Webs

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Chloroform is one of the solvent that is mostly preferred for electrospinning of polycaprolactone (PCL) due to its less hazardous properties [1,2]. Although continuous and bead-free fibres can be achieved from PCL/chloroform solution, the fibers are mostly in microscale [1-3]. For nanofibrous PCL webs, alternative solvent systems are required. In this study, PCL (45000Mn, Sigma Aldrich) was dissolved in chloroform:ethanol (9:1; Sigma Aldrich) solvent system) at a concentration of 18 w/v %. 1 and 2 drops acid solvents as acetic acid and formic acid were added separately to the prepared 10ml PCL-chloroform:ethanol solutions. Fibrous webs were produced by a basic electrospinning unit (Inovenso, TR) working on horizontal production principle. Distance between needle tip and collector was fixed to 20 cm while needle diameter was choosen as 0.8mm. Voltage, flowrate and spinning time were varied based on used solvent systems. Fibrous webs were investigated by using scanning electron microscopy (SEM) while fiber diameters were measured by Image J Software System. Results indicate that, electrospun webs including microfibers were produced from PCL/chloroform:ethanol solution while the addition of 2 drops acid solvents to PCL/chloroform:ethanol solution caused a notable drop in fiber diameters.

Keywords: polycaprolactone, acetic acid, formic acid, chloroform, electrospinning

References:

[1] Lowery JL, Datta N, Rutledge GC. Effect of fiber diameter, pore size and seeding method on growth of human dermal fibroblasts in electrospun poly(epsilon-caprolactone) fibrous mats, Biomaterials, (2010) 31(3):491–504.

[2] Del Gaudio C, Grigioni M, Bianco A, De Angelis G. Electrospun bioresorbable heart valve scaffold for tissue engineering. Int J Artif Organs, (2008) 31(1):68–75.

[3] Yalcin, I., Harakova, J., Mikes, P., Gok Sadikoglu, T., Domın, R., Lukas, D., “Design of Polycaprolactone Vascular Grafts” Journal of Industial Textiles, (online published in June 2014, Available at http://jit.sagepub.com/content/early/2014/06/23/1528083714540701)

9069 | FLEXURE STRENGTHENING OF GLULAM BEAMS USING CARBON FIBER FABRIC

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As a natural product, wood has a number of advantages and disadvantages using from building point of view. Wood products have natural and organic defects which are an important source for big variations of mechanical properties. To minimize these disadvantages due to defects, a new wood product was developed: the glue laminated timber (GLULAM).
The use of composite systems for strengthening the timber structural elements, especially in restoration, is now a frequently issue. Because the GLULAM shows many advantages over solid wood, this paper presents an experimental study on large scale GLULAM beams subjected to flexure. The experimental items were originally tested to failure and after that were strengthened and tested again. Strengthening solutions are based on carbon fiber reinforced polymers (C-FRP) fabric, without anchoring systems and anchored. In the study it is aimed to achieve technology-related parameters, the quantity of fabric, the anchoring methods and how to tie their influence on elements resistance and elasticity.
In conclusion, GLULAM beams strengthening using CFRP fabric aims, primarily, two important purposes, namely: repair of elements that have suffered degradation and increasing the bearing capacity of some elements or load-bearing capabilities of the corresponding cross section reduction. After strengthening, most degraded elements that were not injected reached 80% to 100% of reference elements load-bearing capacity. The other strengthened beams, that were injected, led to increased load-bearing capacity up to 20% and reduction of deformation up to 50%.

9070 | FLEXURE STRENGTHENING OF GLULAM BEAMS USING CARBON FIBER SHEET

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Wood, as a natural product, has a number of advantages and disadvantages using it for buildings structural elements. The disadvantages are related to natural and organic defects which are an important source for big variations of mechanical properties. To minimize these disadvantages due to defects, a new wood product was developed: the glue laminated timber (GLULAM).
Using composite systems for strengthening timber structural elements, especially in restoration, is now a frequently issue. This paper presents an experimental study on large scale GLULAM beams subjected to flexure because the GLULAM shows many advantages over solid wood. The experimental items were originally tested to failure and after that were strengthened and tested again. Strengthening solutions are based on carbon fiber reinforced polymers (C-FRP) sheet (lamella). Two methods were used: without anchoring systems and with anchoring systems. In the study it is aimed to achieve technology-related parameters, the quantity of lamella, the anchoring methods and how to tie their influence on elements resistance and elasticity.
In conclusion, GLULAM beams strengthening using CFRP sheet aims, primarily, two important purposes, namely: repair of elements that have suffered degradation and increasing the bearing capacity of some elements or load-bearing capabilities of the corresponding cross section reduction. After strengthening, most degraded elements that were not injected reached 80% to 100% of reference elements load-bearing capacity. The other strengthened beams, that were injected, led to increased load-bearing capacity up to 20% and reduction of deformation up to 50%.

9073 | RC BEAMS FLEXURAL STRENGTHENING USING CARBON COMPOSITE MATERIALS WITH DIFFERENT ANCHORING METHODS

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Flexural rehabilitation/strengthening of reinforced concrete beams using polymeric composite materials was first considered and studied in the 80's. Throughout time, a series of technological solutions, theoretical models and guidelines have been developed. The target of the experimental program conducted at the Laboratory for Reinforced Concrete of the Department of Civil Engineering at "Politehnica" University of Timisoara, was to develop viable anchoring systems and to study their behavior once there are mounted on strengthened RC beams.
Since there is a real bond issue between the support layer (concrete) and the epoxy resin used to bond the CFRP composite materials (fabric or lamella), in most situations the failure of the strengthened element occurs due to debonding mechanism, long before is reached the capacity of the composite. This phenomenon usually arises because of the lack of attention paid to the preparation of the support layer by neglecting the concrete's quality, by poor knowledge of technological requirements or by poor qualification of the workers who apply this strengthening technique. In order to overcome this bond issue that could lead to important faults and reduced effect of strengthening intervention, a series of anchoring solutions (mechanisms) were proposed and already experimentally tested in the laboratory. The first proposal involves the anchoring of the pultruded lamella and the second solution suggests the anchoring of the CFRP fabric.
The length of the entire beam was 4200 mm, leading to an effective span of 4000 mm. The cross section of the beam was rectangular, of 200x400 mm. The beams were cast using Class C32/40 concrete. The stirrups were overdesigned to resist for the increased shear forces (using steel stirrups of 8 mm placed at every 15 cm) because the purpose of the tests was to studied efficiency of flexural strengthening. The experimental elements were subjected to a monotonic increasing vertical force, applied in two points, in steps of 10 kN, by a hydraulic jack.
Tests started with two reference elements that were loaded up to failure without being strengthened. The first beam (RB) was reinforced with three bars made of steel reinforcement of 16 mm diameter (ft,med=781 N/mm2), while the second one (RB2) had only two bars of steel reinforcement of 16 mm diameter, simulating time degradation. The other tested beams had the same characteristics as beam RB2, the strengthening systems being design so that these beams reach the capacity of RB reference beam.
Strengthened RC beams are:
- R-2W - strengthened beam with 2 CFRP fabric layers, not anchored
- R-1C-0 - strengthened beam with 1 CFRP strip
- R-2W-A - strengthened beam with 2 anchored CFRP fabric layers, using anchor spikes
- R-2W-MA - strengthened beam with 2 anchored CFRP fabric layers, using recycled metal grinding discs with heavy duty bolts
- RL-2W-A - lateral strengthened beam with 2 anchored CFRP fabric layers, using anchor spikes
- R-2S-W - strengthened beam with 1 anchored CFRP strip, using transversal CFRP fabric
- R-2NSMS - strengthened beam with 2 CFRP strip, using Near Surface Mounted Strengthening system
- R-1S - anchoring the lamella at both ends using steel plates connected to the concrete elements by bolts
- R-1S-AS - strengthened beam with 1 anchored CFRP strip, using anchor spikes
- R-1S-SP - strengthened beam with 1 anchored CFRP strip, using metal plates with heavy duty bolts

- R-1S-CA - anchoring the lamella on its entire length using steel bolts that are chemically anchored in the concrete
The solutions proposed in this paper try to achieve an optimum balance between structural effectiveness and cost efficiency, taking into account also the reversibility of each solution.

9075 | ELABORATION AND MECHANICAL CHARACTERIZATION OF BIO-COMPOSITES MATERIALS (LUFFA/POLYESTER)

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Renewable materials or bioproducts are strongly desired as solution of mechanical, civil, aeronautical, and in many others fields of engineering. In recent years extensive work has been made to develop competences and knowledge in the characterization of biomass. The main purpose is to integrate the variability of these resources desired as an alternative solution mainly for their environmental impact besides the optimization factor effect which combines both the economic side and the strength of mechanical material.

This work considers the economic and mechanical contexts of regional and local bio products “luffa fibers” which can be used as a reinforcing phase in the extrusion of biocomposites with multi-directional fiber’s orientation. Moreover, this study includes the extrusion method of luffa biofibers with their geometric measurements and performs the analysis of their mechanical behavior as well as their environmental tensile strength. Three-point-bending tests were performed using specimen manufactured with polyester and luffa’s reinforced bio-fibers taking into consideration their evaluated density, water absorption and thermal stability.
We achieved this work by studying the possibility of changing several traditional local materials so that they may be used in industries of clothing, entertainment, aerospace and automotive.

Keywords: biofibers, bioproducts, luffa, mechanical behavior, composite structural analysis

9081 | Elaboration and structural characterisation of some nanocomposites

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Topic: THEME D: Materials (Nanocomposites)

Nanocomposites of metal nanoparticles dispersed by oxide nanoparticles are of a great interest due to their unusual properties and application potentials. Among various methods, mechanical alloying (MA) technique is well known for synthesis of compounds and nanocomposites using the mechanochemical reactions.
In this study, the mixtures of α-Fe2O3 and (Cr / Si) powders have been milled for various times up to 15 h, in a planetary ball mill (P7) in air atmosphere. The as-milled powders were structurally and magnetically characterized by X-ray diffraction (using the MAUD program based on the Rietveld method) and magnetic measurements in dc magnetic fields up to 10T at room temperature.
The refinement of the X-ray diffraction patterns (α-Fe2O3/Cr) shows that the reduction of hematite by chromium is gradual with the formation of nanoparticles of α-Fe. The final phases α-Fe and Cr2O3 are formed, with a nanometric grain size at 15 h respectively. The saturation magnetization (Ms) of Fe-Cr2O3 nanocomposites jumps from 6 Am2/kg at 1h to 76 Am2/kg at 15h. This value of Ms is in relationship with the change in the computed fraction of iron nanoparticles. The value of coercive field (Hc) is about 0.02 T.
In the milled mixture of (Fe2O3/Si), there is no change up to 5 h of milling. After 15h of milling, α-Fe nanoparticles are formed in an amorphous SiO2 phase. All phases have nanometric size. The calculated lattice parameter of the iron nanoparticles is a0 = 2.8687 Å. The magnetic measurements of Fe-SiO2 nanocomposites show that the (Ms) reaches 70.6 Am2/kg at 15h. The increase of Ms is expected since this parameter depends on the total mass of material embedded into silica matrix. The values of coercive field (Hc) decreases first then increase reaching a stationary value above 10 h of milling time (about 0.03 T at 15 h).
Mechanisms governing the formation of the nanocomposites are discussed. Magnetic properties of the powders are dependent on the structural and microstructural state after each milling time.

9084 | Properties and behaviour of resin-treated plybamboo exposed to weathering

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Bamboo is regarded as eco friendly and can be used as an alternative to timber. The world is losing its timber resources due to high demand and long recovery period taking about 15 to 20 years. Bamboo, due to its faster maturity has potential to be used as an alternative material for wood. Bamboo is naturally hygroscopic in which they shrink and swell when subjected to different environmental conditions. The hygroscopicity increases due to the removal of epidermis and inner layer of the bamboo strips. One of the methods to enhance the properties of bamboo when converted into plybamboo is by impregnation modification using phenolic resin.

The objective of this study is to evaluate the mechanical properties of resin-treated plybamboo from bamboo strips (Gigantochloa scortechinii). These plybamboos were made from low molecular weight phenol formaldehyde (LMwPF) treated bamboo strips. They were exposed to outdoor condition ranging from one to 12 months. Modulus of elasticity (MOE), modulus of rupture (MOR) and compression strength of resin-treated playbamboo with plywood (as control) were periodically evaluated. Resin impregnated plybamboo had the highest bending and compression strength properties compare to exterior grade plywood. The overall properties of treated plybamboo showed higher values than those of plywood samples. It appears that resin impregnation could be considered as an alternative method to enhance the properties of plybamboo exposed to environmental conditions as can be observed from the results of this study.

9085 | PIONEER TIMBER SPECIES FOR CROSS LAMINATED TIMBER IN MALAYSIA

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Changes in forest landscape and control of commercial timber felling from natural forest for provides opportunity to explore for other timber resources. Native pioneer species such as mahang (Macaranga spp.), sesendok (Endospermum malaccense), ludai (Sapium baccatum) and batai (Paraserianthes falcataria) are among the 11 pioneer species identified in Peninsular Malaysia. The advances attained in wood processing and timber technology has witness the manufacturing potential of products from these timber species for various end usage including cross laminated timber (CLT). Cross laminated timber (CLT) is an engineered wood produced by laminating timber perpendicular to the grain direction with odd number of layers. This technology that has been developed in European countries is a breakthrough in using timber as structural component in building. As cross laminated timber is arranged in such a way, the strength of the product is expected to match the strength of solid timber. This enables timber with low mechanical strength properties such as the pioneer to be used in structural applications.

The study involves determination of the wood properties, bonding and mechanical performance of CLT panel. Result shows that the wood properties i.e., sesendok are almost similar to temperate softwood such as spruce, pine, or fir that is also used for CLT. Three layer panels with length ranging from 1.8 to 3m were produced from sesendok and laminated using phenol resorcinol formaldehyde (PRF) adhesive. The bonding properties and delamination test for CLT meets the requirement set by international standard as an outdoor structural application. While, the mechanical properties of full size CLT members were also carried out and will be reported. This study thus advocates the use of ecofriendly product with many construction advantages, is expected to be introduced into the Malaysian timber and construction industry.

9112 | Mechanics of thin ply laminates

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The mechanics of a nw generation of composite materials based on ultra-thin plies will be discussed. Analysis methods developed at different length scales, from micromechanical models to finite fracture mechanics, will be used to predict the response of thin ply laminates. Experimental results based on smooth specimens, open hole tension and compression specimens will be used to compare the strength of thin-ply laminates to that of conventional laminates.

9114 | Characterization of the damage propagation under cyclic loading for GFRP composites used in wind turbine blade

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Various types of damage in wind turbine blades have been known to be developed during operation and those may have a significant influence upon the integrity and life of the blade. In this study, initiation and propagation of the damage for GFRP(Glass Fibre-Reinforced Plastic) composites, which are usually used in wind turbine blades, were characterized. The damage was initiated from a circular notch in 4 ply GFRP composite plates 3.5 mm thick under cyclic loads with a load ration of 0.1. The initiation and propagation of the damage were measured with optical and 3-dimensional DIC(Digital Image Correlation) system. The damage for the unidirectional composite was initiated and propagated along the fiber direction of the specimen, while that for the tri-directional composite was widely developed near the notch tip. The damage propagation rate was evaluated with measuring the damage zone sizes. The damage development mechanisms for these two composites were investigated by considering characterization of the strain fields in the vicinity of the damage tip which were determined with the DIC measurements. Furthermore, the damage surfaces corresponding to their initiation and propagation were observed by SEM.

9120 | Calorimetric Studies of the Crystallization Growth Process in Al-Mg alloys

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Precipitation in Al- 12 % Mg is investigated by differential scanning calorimetry (DSC) performed at different heating rates under non-isothermal conditions to study the crystallization kinetics. The interest of this study is justified by the existence of a significant number of methods of isoconversionnelle analysis, more or less sophisticated like that of (KAS), (OFW) and that of Boswell, which makes difficult the choice of a method particular. The goal of the use of these models of analysis would be to find a description proportioned of the development of the reaction according to time and temperature. In this work we have interested by the influence of the heating rates on the non isothermal transformations in Al-12%Mg. For this the samples of this alloys have heated with different rates from room temperature until 530°C using the differential scanning calorimetry (DSC) and we will calculate the energy activation of the precipitated phases □ and □' by various isoconversionelles methods.

9130 | EXPERIMENTAL INVESTIGATION ON THE WEAR BEHAVIOR OF NATURAL FIBER REINFORCED POLYMER COMPOSITES

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Natural fibers are become attractive to the researchers, engineers and scientists as an alternative reinforcement in the preparation of fiber reinforced

polymer composites. It is due to their low cost, mechanical properties they possess, high specific strength, non abrasive, eco friendly and bio-degradability characteristics. Further, they are exploited as a replacement for the conventional fibers such as glass, aramid and carbon.

This study contributes to a better understanding of the wear behavior of the composite prepared using different natural fibers. To properly understand the wear behavior of materials, the connection between surface loading, work hardening, and material removal has first to be determined. Here, the experiments are carried out with different parameters load, time and distance with different levels. The results obtained showed the optimum setting of parameters that could offer a good tribological performance of composite material. A systematic study of the friction and wear behavior of the natural fiber reinforced composites was carried out using a pin-on-disk tribometer under dry sliding conditions against a counter with nominal surface roughness and a suitable hardness.

To fulfill the study, scanning electron microscope (SEM) was used to study wear particles with different magnification. The micro structural change on the wear surface of the composite enables us to trace the evolution of chemical elements and to study the formation of tribo layers.

9179 | Vibroacoustics fatigue material parameters characterization of the composite materials with different short vegetal fiber reinforcement under low-velocity impacts

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This work concerns the characterization of the vibroacoustics behavior of composite materials with different short vegetal fiber reinforcement under the fatigue load. A preliminary experimental mechanical characterization of materials is conducted. The study is devoted to the elastic shock of Hertz-Boussinesq extended to viscoelastic bodies by direct convolution of Riemann-Stielges. The shock excitation method includes a deduced force in the load and disload phases. The spectral response of the specified shock allows calculation of the damping. The viscoelastic shock parameters, acoustic waves, their sound levels, pressure, intensity, power and energy density are determined.

9195 | Damage growth characteristics in composite glass-epoxy plate by Vibration analysis

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The aim of this paper was to presents a identification of dynamic behavior and response analysis of a glass-epoxy plate.
The numerical simulation were carried out on model plate made of glass-epoxy, and the corresponding frequency response functions have been calculate. An initial study into the dynamic loads of this method has been considered, the use of the finite element method makes it possible to develop the model of the plate, the model is used to evaluate the maximal (displacement, strain and stress) and the natural frequencies , mode shapes of plate in composite glass-epoxy under damage condition.
The stress should be increased to improve the strength of the plate. The experimental results can provide a reference for analysts and designers of composite material in aeronautical systems.

9274 | Comparison of fatigue crack growth behavior of Al 2024-T3 and Al-7075-T6 repaired with composite patch

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Abstract

In this work, we experimentally studied the fatigue crack growth behavior in thin 2024-T3 and 7075-T6 aluminum panels repaired with single sided adhesively bonded composite patch. Experiments involved fatigue tests at constant amplitude loading on v-notched thin aluminum plates. The composite patches were manufactured using 8 unidirectional plies. The patches were bonded to plate at different initial crack lengths for different stress ratios. The obtained results showed that fatigue life of repaired specimen improved at least 3 times compared to the unrepaired ones and that the fatigue crack growth behavior of 2024-T3 is different than that 7075-T6 specimens. The results also showed that 2024-T3 specimen have higher fatigue strength than that of 7075-T6 but the crack growth rate of 7075-T6 is slower than 2024-T3.

Keywords: Al 2024-T3; Al 7075-T6; Composite patch repair; Constant amplitude loading; Stress ratio;

9276 | Investigation of cracked aluminum panel repaired with composite patch: An experimental study on effect of patch length

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Investigation of cracked aluminum panel repaired with composite patch: An experimental study on effect of patch length

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Abstract

The advanced Bonded Composite Repair Technology (BCRT) is widely used to reinforce weakened cracked components and damaged metallic structures in various applications, especially in aerospace. This technology offers significant advantages over conventional repair methods. In this work, the fatigue crack behavior of V- notched thin aluminum 2024-T3 plates, bonded with single side carbon composite patch configuration was experimentally investigated. This covers the study of the repair efficiency and fatigue life of cracked samples patched with three different patch lengths along the loading direction. Furthermore, a complete set of similar tests on unrepaired configurations to compare and calculate the efficiency of bonding, were studied. Repairs were found to increase the fatigue life up to four times compared to unrepaired ones. The results show that with the increase in patch length more than 50% of the sample has no beneficial effect on fatigue life. This is due to the fact that the patch extra stiffness in thin sheets and decreases the radius of curvature causing detrimental effect on fatigue life.

Key words: Bonded composite repair, Fatigue life, 2024-T3, Patch length

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9290 | A FEM-based model to study the behaviour of corroded RC beams shear repaired by NSM CFRP rods technique

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This paper presents the main features of finite element FE numerical model developed using the computer code FEMIX to predict the near-surface mounted NSM carbon-fiber-reinforced polymer CFRP rods shear repair contribution to corroded reinforced concrete RC beams. In the RC beams shear repaired with NSM technique, the Carbon Fibre Reinforced Polymer (CFRP) rods are placed inside pre-cut grooves onto the concrete cover of the RC beam's lateral faces and are bonded to the concrete with high epoxy adhesive. Experimental and 3D numerical modelling results are presented in this paper in terms of load-deflection curves, and failure modes for 4 short corroded beams: two corroded beams (A1CL3-B and A1CL3-SB) and two control beams (A1T-B and A1T-SB), the beams noted with B were let repaired in bending only with NSM CFRP rods while the ones noted with SB were repaired in both bending and shear with NSM technique. The corrosion of the tensile steel bars and its effect on the shear capacity of the RC beams was discussed. Results showed that the FE model was able to capture the main aspects of the experimental load-deflection curves of the RC beams, moreover it has presented the experimental failure modes and FE numerical modelling crack patterns and both gave similar results for non-shear repaired beams which failed in diagonal tension mode of failure and for shear-repaired beams which failed due to large flexural crack at the middle of the beams along with the concrete crushing, three dimensional crack patterns were produced for shear-repaired beams in order to investigate the splitting cracks occurred at the middle of the beams and near the support.

9291 | Fullerene-Metal Composites produced by mechanical milling and sintering

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Metal (Fe, Al) and fullerenes (C60) are used to synthesize composites by powder milling and sintering. Powders are milled in high energy mills (Spex) to produce mixtures that are subsequently sintered by means of SPS (Spark Plasma Sintering). The fullerenes are used with high purity (C60) and in mixtures involving several fullerene forms (C60, C70 and sooth). The fullerenes can be completely mixed during milling without affecting their structures, however the selection of milling means affects the physical size and stability of the C60. The fcc structural arrangement for C60 can no longer be identified by X ray diffraction when milling is performed with sufficiently large balls (energy involved in milling increases). Smaller milling means produces a fine dispersion of fullerenes in only 2 h of milling. Sintering by SPS allows retention of the nanostructure developed during milling and production of solid composites with relatively low porosity. During sintering the C phases transform partially into carbides and other hard phases including diamonds. When sooth is used in the initial fullerene mix, a phase transformation into fullerenes is also observed. The mechanical properties of these composites show a considerable hardening when compared to pure materials. Conventional and HREM TEM, X ray Diffraction are used for characterization.

9292 | Mechanical properties of polypropylene matrix reinforced with short natural Alfa fibers: extraction fibers & chemical treatment

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This paper presents an experimental study of mechanical characterization of composite materials reinforced with short Alfa fibers, obtained by extraction of stems raw Alfa. An alkaline chemical treatment under different duration applied to the fibers and a mechanical behavior analysis was studied of PP/Alfa samples with different volume fiber fractions. An SEM observation affected to the fracture surface samples PP/Alfa to improve the interfacial adhesion morphology of the material. There're important increases of the Young module of PP/Alfa with deferent volume fraction compared to Neat PP.
Key words: Alfa fibers, chemical treatment, composite material, mechanical properties, SEM

9294 | Utilization of Palm Oil Clinker (POC) as Aggregates for Sustainable Lightweight Concrete

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Utilizing waste material in the construction industry is recognized as an effective way to improve the green environment and minimize construction cost. In this research, palm oil clinker (POC) aggregates are considered to be used as coarse and fine aggregates replacement in the production of lightweight concrete. This study focused mainly on investigating the effect of both partial and full replacement of aggregate with palm oil clinker on the mechanical and physical properties of concrete. DOE method is adopted for the mix design and the approach used in the mix design involved POC replacement of 0%, 10%, 20%, 40%, 60%, 80% and 100% by volume of fine and coarse aggregates respectively. Parameters will be investigated in this study included slump and density for the fresh properties, as well as compressive strength, UPV, Flexural Test, Splitting tensile, and Water Absorption for the hardened properties.

9300 | Clickhouse project – an all-composite emergency housing system

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The Clickhouse project, developed in cooperation between Instituto Superior Técnico, Minho University and composites manufacturer ALTO – Perfis Pultrudidos, aims at developing an emergency housing system made of composite materials.

The Clickhouse is made of glass fibre reinforced polymer (GFRP) pultruded profiles and composite sandwich panels, comprising GFRP skins and polyurethane foam core. Its lightweight and modularity and the simple connections proposed facilitate the (i) packing, transportation and shipping, as well as the (ii) assembly and (iii) disassembly operations. In addition, the thermal insulation properties of those materials allow complying with thermal comfort requirements, while their durability allows for multiple reutilizations.

The emergency housing system developed comprises 3.00 × 3.00 m2 modules, with a 3.30 m height, which can be installed isolated or combined. The frame structure comprises square tubular (section 120×120(×10) mm2) GFRP pultruded beams and columns (4 columns and 8 beams per module), supporting one elevated ground floor and a roof, made of composite sandwich panels. The external and partition walls are also made of composite sandwich panels. From an architectural point of view, the isolated modules can be used as dormitories or bathroom installations. In addition, the combination of two or more modules allows creating single family houses, including a living room with kitchenette, sleeping rooms and a bathroom. The Clickhouse also includes water supply and sewage piping systems, as well as electrical installations, all built-in the wall panels and frame elements.

In order to enhance the ease of assembly, allowing the construction to be performed by unskilled workers, all connections between structural elements are bolted and all drilling operations in the GFRP profiles are made in the shop. Due to the tubular geometry of the profiles, the beam-to-column connections developed in this project include small-length stainless steel parts, installed in the interior of the columns. These parts have threaded holes that allow fastening stainless steel bolts without nuts. The sandwich panels, on the other hand, are connected to the profiles (beams or columns) by means of an auxiliary square-section (50×50(×5) mm2) pultruded profile. The extremities of the sandwich panels comprise sockets to fit these auxiliary profiles. The panel-to-panel connections feature a similar constructive detail that facilitates construction and disassembly operations.

This paper presents an overview of the Clickhouse project, detailing the main objectives and requirements defined for this all-composite prototype of emergency house. Subsequently, the main developments of the architectural design are presented, as well as the structural design and the development of the other building facilities. Finally, an overview of the experimental programme developed within this project is presented, including (i) material characterization tests, (ii) tests on isolated GFRP members (beams and columns), (iii) static tests (monotonic and cyclic) on beam-to-column joints, (iv) static tests on two-dimensional frames (monotonic and cyclic) and (v) dynamic tests on three-dimensional frames using a shaking table.

9301 | Matrix selection for polycarbonateurethanes/modified nanosilica composites with natural oil polyols for implants of the intervertebral disc

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The aim of this study was to propose an elastomer, which would be the matrix for the composite polyurethane / modified nanosilica intended for use as part of the intervertebral disc implant. In order to select recepis with vegetable poliols to produce materials for biomedical applications, used the composition developed in previous studies replacing standard polyols, chain extenders based on different vegetable oils. Chosen materials are prepared based on oligocarbonatediol having a molecular weight of about 2000 g / mol, HDI was used as isocyanates, while 2 types of soy based, rapeseed and palm polyol served as a chain extender. Synthesis was performed via a prepolymer method with molar ratio of the used reactants 2:1:1 (isocyanate : polyol : extender) and isocyanate index of 1.01. From materials were cast prototypes flexible part of intervertebral disc implant in the shape as described in the patent application P.401816. After modifying the the assumed concept of a mold and casting method was able to receive disks of a desired shape having no defects. The resulting material were tested for the required characteristics for this application such as high wear resistance, mechanical properties similar to those of a natural disk and low plastic strain. The properties and structure of the manufactured polycarbonate urethanes (PCU) were characterised using the following techniques: Fourier transform infrared spectroscopy (FT-IR), differential scanning calorimetry (DSC), dynamic mechanical thermal analysis (DMA), thermogravimetric analysis (TGA) and electron scanning microscopy (SEM). Also evaluated were the strength properties, wear resistance, hardness, resilience, density, contact angle and surface energy. Preliminary cellular studies were also carried out to prevent toxicity of the performed materials. Toxicity evaluation in vitro was performed by determining the percentage of cells with low mitochondrial potential (J) using JC-1 assay and in neutral red test (C- cell viability).

Examined features of polyurethanes showed no toxicity in vitro. Produced materials characterized by a high wear resistance, suitable mechanical properties and surface features. Produced from oligocarbonate diols polyurethane elastomeric materials extended vegetable polyols, can be considered as promising for application to of intervertebral disc implants. From all four materials were cast fully formed disks prototypes containing no defects. The materials were homogeneous with no air bubbles and other disorders. Casting ideal shapes allows on their examination on the motion simulator in. Disks will undergo fatigue tests and friction – wear tests on the simulator enables the implementation of research in conditions similar to the load carried by the spine of a natural load. The materials were tested on the simulator for fatigue tests, and all passed the test of 500 000 load cycles.
After analyzing all the results, to perform composite polyurethane/nanosilica chosen material extended by soy polyol. Planned that as a filler will be used nanosilica modified silver and copper particles.

9305 | Preparation and properties of HDPE/SBS-g-MA/organoclays nanocomposites with different clays content

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Polymer/nanoclays nanocomposites and nanoblends present unique properties that are not observed in conventional composites. The achievement of compatibilization, even by addition a compatibilizer or by in situ chemical reaction between blends components (reactive blending), has played an important role in the development of polymer blends and provides a good solution for needs of industry [1]. The aims of the incorporation of small amounts of nanoclay (<10wt.%) into polymer matrices may improve dimension stability, mechanical, thermal, optical, electrical, gas barrier properties, and decrease the flammability of polymer-polymer blends [1,2, 3]. This work is focuses on the study of thermoplastic nanocomposites based on Polyethylene/Polystyrene blends compatibilized with SBS-g-MA and modified with nanoclay. All PEhd/PS formulations modified with untreated nanoclay were prepared by using internal mixer and single screw extruder followed by injection molding. Maleic anhydride styrene-butadiene-styrene (SBS-g-MA) was used as the compatibilizer and the nanoclay content was varied between 0 - 5 wt percent. The mechanical and thermal properties of PEhd/PS nanocomposites were examined. Also the structure of PEhd/PS nanocomposites has been characterized by the Scanning electron microscopy (SEM), X-Ray diffraction and DMA.

9331 | Damage Detection of the Carbon Fibers in Filament Winding Process by Electrical Resistance Measurements

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The aim of the study is to assign fiber damage which occurs during the pretensioning of the carbon fiber during Filament Winding manufacturing process. The electrical property of the carbon fiber was used to define the level of the damage of the fiber since it is an electrical conducting material. An experimental system has been proposed to simulate the pretension system of a FW machine and measure the electrical change of broken fiber during the winding process. TORAY T 1000G 12 K type of carbon fiber were used in the experimental part of the study. Carbon fiber were forced to follow a certain route through the rollers which mainly causes damage in the fiber. The damaged fiber then were used to obtain tension tests pieces to evaluate the amount of the damage which was caused by pretensioning unit. The tension test has been done according to ASTM 4018-99. The results showed that electrical properties of the carbon fiber can be effectively used to evaluate the damage which occurred during the pretensioning in FW process.

9333 | THE PERFORMANCE OF EMBEDDED FIBER BRAGG GRATING SENSORS FOR MONITORING FACING INDENTATION OF FOAM CORED SANDWICH STRUCTURES UNDER FLEXURAL LOADS

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THE PERFORMANCE OF EMBEDDED FIBER BRAGG GRATING SENSORS FOR MONITORING FACING INDENTATION OF FOAM CORED SANDWICH STRUCTURES UNDER FLEXURAL LOADS

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Keywords: Sandwich composites, three-point bending, facing indentation, fiber Bragg grating sensors; structural health monitoring.

Abstract. In this work, facing indentation of foam cored sandwich composites are investigated using embedded Fiber Bragg Grating (FBG) sensors. Sandwich specimens with FBG sensors embedded inside their composite facing were manufactured using vacuum infusion and later, subjected to static and cyclic loading conditions under 3-point bending mode. Formation of damage is tracked utilizing the wavelength shift and spectrum information acquired from the sensors in order to understand the sensor behavior and material response. By exploiting the sensor response, failure detection strategy is developed for damage characterization to achieve reliable structural health monitoring of sandwich structures.

9528 | Multi-objective optimal design of hybrid viscoelastic/composite sandwich beams by using generalized differential quadrature method (GDQM) and non-dominated sorting genetic algorithm II (NSGA II)

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In this study, the optimal design of hybrid viscoelastic/composite sandwich beams for minimum weight and minimum vibration response is aimed. The

equation of motion for a multi-layer beam is derived by using the principle of virtual work, in the most general form. The equations are discretized by the generalized differential quadrature method in the frequency domain for the first time. Also, the time and temperature dependent properties of the viscoelastic materials are modeled by the newly proposed 10 parameter fractional model to realistically capture the response of these materials. The material variability is taken into account by letting the optimization algorithm to create the most appropriate stacking sequence out of four fiber-reinforced composite materials and five viscoelastic damping polymers. The design parameters such as the orientation angles of the composites, layer thicknesses and number of layers that give the set of optimal solutions, namely the Pareto optimal front, is obtained for the clamped-free sandwich beams.

7587 | The Applications of the Composite Wall on Construction in Heilongjiang Province

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The Applications of the Composite Wall on Construction in Heilongjiang Province
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Keywords: building energy efficiency, building industrialization, composite wall and panel，
“Four savings and Environment protection”

Abstract
This paper firstly analyzed the results and the status of China's building energy efficiency, explored the new areas of building energy in future: the industrialized composite wall on construction. As China is engaging a process of rapid urbanization, it is believed that the need to build a lot of construction will continue for 25-30 years, and all of our new buildings must be strictly in accordance with the standards of energy-saving by 50% or 65% in the processes of design and construction. Chinese construction industry is currently implementing the “Four Savings and Environment Protection” policy, that requires to realize energy, land, water and materials saving and environmental protection in every building project.
In Heilongjiang Province, as other areas in China, the requirements of energy-efficient design have been comprehensively and strictly implemented on the new buildings since 2000. By 2010, energy-efficient design has been completely popularized in all kinds of new buildings by 50% energy saving compared with the same type of buildings built in 1980s. According to the requirements of the Ministry of Construction, in the future the further energy efficiency targets should be increased from 50% to 65%, meanwhile the main field of building energy efficiency will been changed from the initial entry points such as the thermal insulation of external wall, roof, doors and windows to further wide areas, such as the Optimization of building material, component manufacturing, construction quality and method, all of which could be realized by the industrialized composite panels and walls completely. Building industrialized composite panels and walls bring thoroughgoing innovations on wall materials and construction, the improvement of the construction accuracy, so that the wall thermal insulation performance is much higher than traditional buildings. Due to the production concentrated in the factory and the batch processing, the energy consumption of building industrialization is much lower than the traditional human construction at the construction site. The industrialized composite panel and wall of buildings can reduce the loss of the main materials of construction, the assembling construction reduce the loss of Secondary building materials.
Compared with traditional construction methods, building industrialization of the composite panel realizes the field fabricated construction, which greatly minimizes the generation of construction waste, building waste water emissions, construction noise interference, harmful gases and dust emissions, and so on. The Building industrialization could maximize the improvement of the quality of components and assembly precision, and effectively reduce the roof leaks, wall cracks, quality defects of wall and window such as cold air infiltration, so the architectural quality and accuracy can be improved significantly. Factory production and on-site assembling of prefabricated components can reduce the workers of construction site and management, saving a lot of labor costs. Building industrialization transfer most of the operation to production line, saving construction cost and schedule greatly. It is particularly important to the construction in cold areas.
Moreover, three types of building composite walls and panel are introduced. In this paper, composite walls and panel includes composite material, composite structure or both of them applied in the wall and panel.
The first kind o

8602 | LAYERWISE APPROACH TO ANALYSIS OF A FUNCTIONALLY GRADED CYLINDRICAL SHELL VIBRATION AND DYNAMIC BEHAVIOUR

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Summary:
A layer-wise finite element approach is developed to the analysis of thick functionally graded material (FGM) cylindrical shell with finite length under dynamic load. For this purpose, FGM cylinder is divided into many sub-layers and then the general layer-wise laminate theory is formulated by introducing piecewise continuous approximations through the thickness. The radial displacement field is approximated both linearly and in quadratic form, through each "mathematical" layer. The FGM shell properties are controlled by volume fraction as an exponential function of radius. The virtual work statement yields the 3-D governing equations which are then reduced to 2-D differential equations and the resulting equations are solved by finite element in the axial direction. Results are obtained in terms of the time history of the displacement and stress components with different exponents of functionally graded material. The results for static loading and the first natural frequencies are also compared with the solutions of previous problems in the literature. In addition, the natural frequency and mean velocity of the radial stress wave propagation for different exponents of functionally graded material (FGM) are studied and compared to similar ones obtained for FGM cylindrical shell of infinite length.

8942 | DEVELOPMENT OF COMPOSITE POLYACRYLONITRILE FILAMENTS FOR USE AS MULTI-FUNCTIONAL TEXTILES

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Recently there is a growing interest in producing composite fibers with different functionalities. There are many studies showing the successful incorporation of carbon nanotubes, nanoclays, metals, metal oxides, and conductive polymers into the structure of fibers in order to be able to develop/improve functionalities of the textile materials. Composite fibers containing nanoparticles of metals and metal oxides are reported to show photo

catalytic ability, electrical conductivity, and UV shielding. Good electrical conductivity, fire retardancy, UV protection, high stiffness and high strength can be achieved by using low content of CNTs in polymeric nanocomposites. Composites with silver nanoparticles are reported to acquire catalytic, optical, and especially antibacterial properties. Conductive polymers form another class of materials which are also used in polymeric composites to improve electrical properties. Polyaniline is a promising conductive polymer and increasingly used in production of composites. In this study, composite polyacrylonitrile filaments with the addition of amine-functionalized carbon nanotubes, silver nanoparticles, polyaniline and their combinations for multi-functionalization purpose were produced by wetspinning method. Conductivity, mechanical properties and thermal properties of the composite filaments were measured and compared to each other. The conductivity was improved to around 10-9 S/cm which provides antistatic properties to insulator PAN. The addition of silver nanoparticles which can provide antimicrobial and antistatic properties into composite structure resulted in an increase in breaking stress, while decrease was observed with the addition of carbon nanotubes and polyaniline. The breaking elongation values of the composite filaments were higher than the pure polyacrylonitrile filaments.

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9008 | The limits of nanocomposites

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This article has for objective to analyze the generation of constraints in a unidirectional multilayer laminated by using a finite element method. However, composite structures can be weakened by the introduction of geometrical singularities, such as notches, this analysis allows obtaining an intuitive representation of the stress field to provide a physical explanation to the development and variation of constraints and more specifically the evolution of stresses in directions other than that of the fibers. The study that we conducted, through different cases tests, showed that constraints deducted in multilayered under uniaxial traction depends on many parameters (thickness, width, etc.). The analysis predicts an increase of intensity of constraints with thickness and the width of the laminate increasing.