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Edited by:

A. Öchsner, L. Silva and H. Altenbach

ABSTRACT BOOK

ACE-X 2009 • ROME - ITALY

22-23 JUNE, 2009

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PREFACE

It is our great pleasure to welcome you to the **3rd International Conference on Advanced Computational Engineering and Experimenting, ACE-X 2009,** in the ancient Rome - Italy, from 22-23 June, 2009.

After its success as ACE-X 2008, ACE-X 2009 aimed at attracting a balanced portion of delegates from academia, industry and research institutions and laboratories involved with research and development work. In doing so, the conference provides a binding platform for academics and industrialists to network together, exchange ideas, provide new information and give new insights into overcoming the current challenges facing the academics and the industrialists relating to Computational Engineering of their application areas.

I would like to thank the Organising Committee members and members of the Local Committe for their help in contributing to the successful organisation of this meeting and special thanks to Prof. Luca Goglio for his support to help participants to get VISA's from the Italian Embassies.

I would like to thank the colleagues that lectured the Short Courses on 21 June, 2009 – a day before the conference. Thanks also for the organisers of the Special Sessions: Dr Lucas da Silva (Adhesive Bonding) and Prof. Saied Darwish (Biomechanics).

A special thanks to Dr. Lucas Da Silva and Professor H. Altenbach, co-chairs of ACE-2009, for the excellent work, significant inputs and support to this conference.

Concerns have been expressed about the influenza (H1N1FLU), travel to Rome etc... However, in the middle of all questions without answers delegates did the way till here and I would like personally to thank all delegates for the decision in attending ACE-X 2009 hope you will find the meeting very useful for your work, business and a useful forum for obtaining new knowledge.

Have fun learning and meeting new people!

Be helthy and keep yourself helthy!

See you again in 2010, in Paris!

Professor Andreas Öchsner
ACE-X CONFERENCES – Chairman

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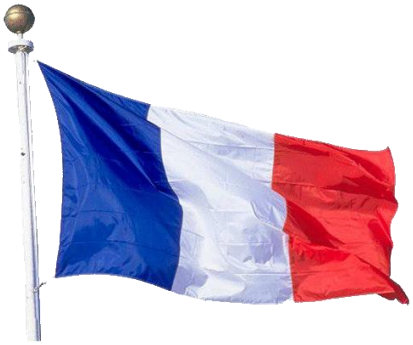

4TH INTERNATIONAL CONFERENCE ON ADVANCED COMPUTATIONAL ENGINEERING AND EXPERIMENTING, ACE-X 2010 / www.acex-2010.com

ACE-X 2010
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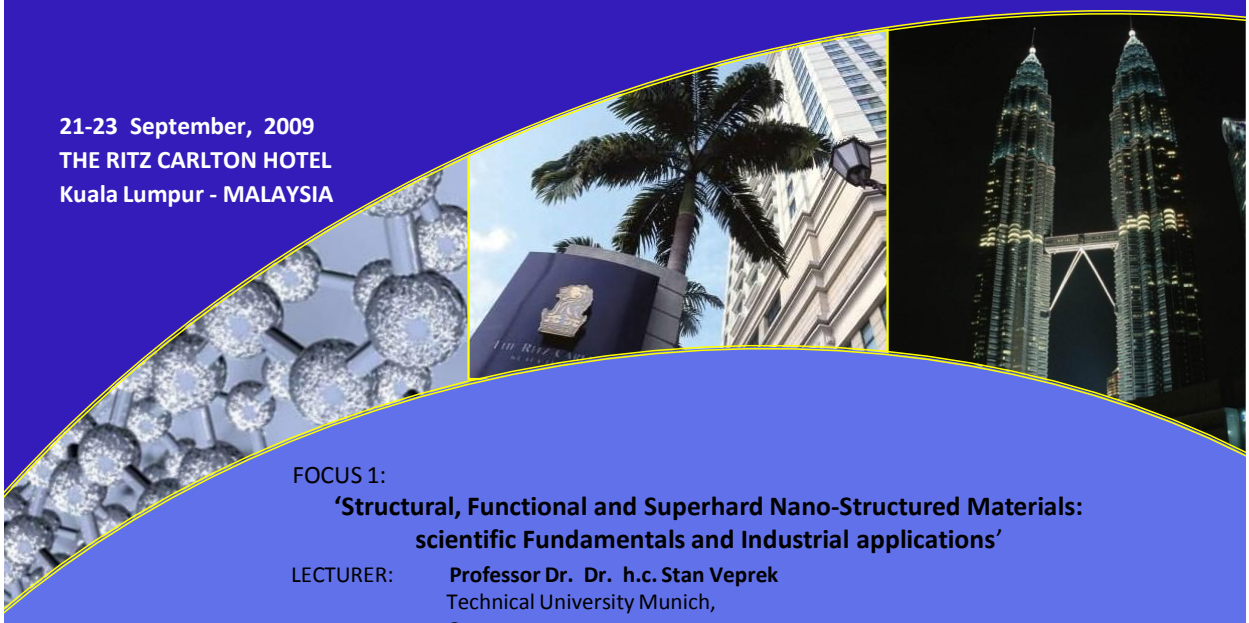
NANOSTRUCTURED MATERIALS

MANUFACTURING, CHARACTERISATION AND APPLICATIONS



21-23 September, 2009
THE RITZ CARLTON HOTEL
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FOCUS 1:

'Structural, Functional and Superhard Nano-Structured Materials: scientific Fundamentals and Industrial applications'

LECTURER: **Professor Dr. Dr. h.c. Stan Veprek**
Technical University Munich,
Germany

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FOCUS 2:

'Advanced Materials Characterization Techniques: surface and structural analysis'

LECTURER: **Professor Dr. Sam Zhang**
Nanyang Technological University,
Singapore

……

WHO SHOULD ATTEND?

Peoples from academia and industry working in the area of nanostructured materials are encouraged to attend this course to deepen and widen their knowledge. In addition, the course is designed for those who would like to start to work in the challenging area of nanotechnology.

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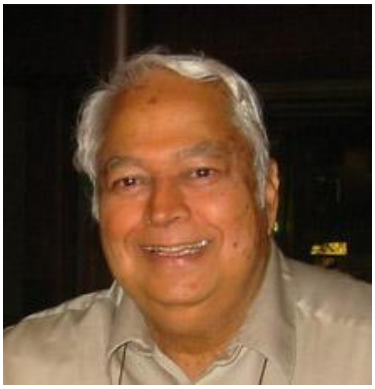
CONTENTS:

PLENARY LECTURE



AWARD FOR CAREER ARCHIEVEMENTS

VIP-ACEX001
PROF. DR. RUDRAPATNA V.RAMANTH
MASSACHUSETTS INSTITUTE OF TECHNOLOGY, MIT
USA

ACE-X 2009 HONORARY ACE-X CHAIRMAN

Bringing Engineering into Sports: Examples taken from Tennis and Golf

Professor Rudrapatna V. Ramnath,
Department of Aeronautics and Astronautics,
Massachusetts Institute of Technology, MIT-USA

Honorary ACE-X Chairman

This talk presents an overview of the physics and engineering concepts and methods in the technology and performance analysis of sports equipment. In particular, tennis and other racket sports are considered, along with the game of golf. Notions of attributes such as power, control, stability, maneuverability and comfort are discussed, along with the parameters contributing to each characteristic. Measurement of the relevant parameters is then described and discussed including the development of test procedure and set-up. Specifically, data analysis is presented illustrating the performance indicators such as what constitutes a sweetspot, power zone, etc., in the context of tennis and golf. The presentation draws heavily from the author's work over several years at The Massachusetts Institute of Technology, carried out for the men's professional tennis association (ATP Tour) and the magazines World Tennis and Tennis. The talk also includes a discussion of electronic line calling systems in tennis.

PLENARY LECTURE

VIP-ACEX005
PROF BOB ADAMS
UNIVERSITY OF BRISTOL
UK

Adhesive Bonding; from Ancient History to Current Challenges

Prof. Bob ADAMS
University of Bristol, UK

Adhesives have been in use for thousands of years, although there is, of course, no definite date we can establish since archaeologists are regularly making discoveries of the use of adhesives. Adhesives were probably first regarded as a nuisance before man used his natural inventiveness to turn the problem to his advantage. Tools and weapons for hunting and fighting were the main needs of early man. Later, adhesives were used for decorative purposes in jewellery and veneers, furniture, and construction.

During the last millennium, many inventions were made of techniques for preparing adhesives from natural products such as animal skins and bones, fish, and milk products [casein]. From the beginning of the 18th Century, industrial production increased until, by the end of the 19th Century, there were many glue factories in existence.

The 20th Century saw the invention of “plastics”, culminating in the modern, “man-made” adhesives such as epoxides, polyurethanes, polyesters, cyanoacrylates and the many variations on these themes. Most of the aeroplanes in the 1914-18 war were made of wood, using furniture adhesives for laminating the curved spars and the propellers. By the 1939-45 war, chemists were producing all sorts of interesting materials, but many of the aircraft were made from aluminium and joined by screws and rivetts. However, the shortage of aluminium led to a rethink on wooden aircraft, and in 1941 the de Havilland Mosquito was produced. This aircraft used casein and urea-formaldehyde adhesives.Modern aircraft make extensive use of structural adhesives, both with metallic and composite components. Today, most cars, buses, and trains use structral or semi-structural adhesives and to be without their use in the home and general day-to-day life is unthinkable. The future will be dependent on adhesives in various forms, particularly as we make efficient structures and components by joining dissimilar materials.

PLENARY LECTURE

VIP-ACEX006
PROF. J. N. REDDY
DEPARTMENT OF MECHANICAL ENGINEERING
TEXAS A & M UNIVERSITY,
USA

Numerical Modeling of Complex Structures: Shells and Cells

Prof. J. N. Reddy
Distinguished Professor and Oscar S. Wyatt Endowed Chair
Department of Mechanical Engineering
Texas A & M University, USA

This lecture presents an overview of two important research topics in the field of computational mechanics: computational methodologies for numerical simulations of complex shell structures and biological cells. The development of accurate shell finite elements has been one of the most important research activities for the last several decades. It is important to develop appropriate mathematical models together with efficient finite element formulations that can accurately represent the kinematics of deformation and stress fields in shell structures. A shell finite element based on a consistent shell theory for geometrically nonlinear analysis will be presented and its robustness will be illustrated through several benchmark problems.

Biological materials are complex hierarchical systems subjected to external stimuli in the form of mechanical forces, chemical potentials, and electrical signals. A deeper understanding of the behavior of biological systems is critically important for situations like diagnosis and treatment of serious diseases. Understanding the behavior of biomaterials requires extensive experimental studies; however, mathematical models and computational methodologies can provide an alternative to understanding these complex processes. The lecture will discuss computational framework, including multiscale, multiphysics models capturing processes at a sub-cellular scale, the microscopic scale, and also at the macroscopic scales. These computational tools are offer immense help in understanding and solving some of the significant medical problems facing biomedical research.

ACEX053
Dr Thomas Fiedler
Centre for Mass and Thermal Transport in Engineering Materials,
Priority Research Centre for Geotechnical and Materials Modelling,
The University of Newcastle, Callaghan, NSW 2308, Australia

Elastic Finite Element Analysis on Cross-Sections of Random Hollow Sphere Structures

T. Fiedler1,2, H. S. Kim2, I.V. Belova1,2, G. E. Murch1,2, A. Öchsner3,2
1Centre for Mass and Thermal Transport in Engineering Materials, Priority Research Centre for Geotechnical and Materials Modelling, The University of Newcastle, Callaghan, NSW 2308, Australia.
2 School of Engineering, The University of Newcastle, Callaghan, NSW 2308, Australia.
3Department of Applied Mechanics, Faculty of Mechanical Engineering, Technical University of Malaysia, 81310 UTM Skudai, Johor, Malaysia.

This work addresses the elastic analysis of two-dimensional models of random hollow sphere structures. Metallic hollow sphere structures are a new group of cellular metals that combine properties required for controlled deformation particularly under impact conditions, good structural and acoustic damping properties, high specific stiffness and strength, and low thermal conductivities. In contrast to conventional cellular metals such as metallic foams, metallic hollow sphere structures are designed with easily reproducible pore geometry and therefore controllable mechanical and physical properties. The current work aims to characterise the elastic properties of hollow sphere structures using 2D cross-sectional models. The influence of micro-porosity on the elastic behaviour of the sintered sphere wall material is investigated in the first part of work. This information is required to accurately simulate the behaviour of the sintered spherical shells in the second part of the analysis. Here, the elastic parameters, Young's modulus and Poisson's ratio, are determined using cross-sections of hollow sphere structures. These cross-sections are basically three-phase composites consisting of the adhesive matrix, sintered metallic shells and macro-porosity inside the hollow spheres. Within this analysis, the influence of different random sphere arrangements, sphere geometries and volume fractions is studied. Also, numerical results obtained were analyzed, and it was found that a good agreement between the results and the prediction based on the rule of mixtures equations is found.

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ACEX066
Dr. Dehi Pada Mondal
Advanced Materials and Processes Research Institute (CSIR),
Bhopal-462026, India

Effect of Thickening Agent and Foaming Agent on the Microrchtecture and Deformation Response of Closed Cell Aluminum Foam

D.P.Mondal and S. Das
Advanced Materials and Processes Research Institute (CSIR), Bhopal-462026, India

The present paper deals with the process development for making closed cell aluminum foam of varying densities (0.15 to 0.87 gm/cc) through variation of thickening agent and foaming agent in addition to the control of temperature and stirring speed for mixing. In this study, three different types of thickening agent namely calcium granules, fly ash particles and SiC particles are used. As foaming agent, CaH2 has been used in varying quantities (0.2 to 1.2 %). The thickening agent including fly ash and SiC was used in the range of 5 to 20%. Whereas Ca granules are used by 1 wt.%. Some of the trials were also carried out without any use of thickening agent. The closed cell aluminum foam was made using liquid metallurgy route. Foams are characterized in terms of chemistry, micro-constituents, micro-architectural characteristics, relative density and compressive deformation. The density of the foam is noted to be a strong function of foaming agent. The cell size and cell wall thickness varies relatively at greater extent with the foaming agent. But these are marginally influenced with the amount of thickening agent. These characteristics, are, however, influenced significantly with the type of foaming agent. Fly ash particle provides coarser cell size and thinner cell wall thickness as compared to silicon carbide particles. The foam without any thickening agent leads to considerably coarser cell size and thinner cell wall thickness. It was further noted that the relative density decreases considerably with increase in foaming agent and attaining almost to a stable value at around 0.6 wt.% CaH2. The relative density of fly ash-thickened aluminum foam is almost 2/3rd to that obtained through the use of SiC particles as thickening agent. The melt without any thickening agent, leads to the density as low as half of the density obtained from SiC thickened aluminum foam. Compressive deformation response of fly ash thickened foam provides comparable with that obtained in SiC thickened foam. The plateau stress increases with increase in SiC content up to 10 wt.%; beyond which the plateau stress decreases. The plateau stress and energy absorption follow power low relationship with relative density. The densification strain decreases with relative density following again power law relationship. But the foam without any thickening agent leads to have comparatively less energy absorbing capability.

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ACEX085
Dr. Branca F. Oliveira
Universidade Federal do Rio Grande do Sul,
Alegre, RS, Brazil

Computational Analysis of Loading-Unloading and Non-Homogeneity Effects in Metallic Hollow Sphere Structures

L.A.B. Cunda1, B.F. Oliveira2, A. Öchsner3, G.J. Creus 4
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2 Universidade Federal do Rio Grande do Sul, Av. Osvaldo Aranha, 99, sala 408, 90035-190, Porto Alegre, RS, Brazil - e-mail: branca@ufrgs.br
3 Universiti Teknologi Malaysia, 81310 UTM Skudai, Johor, Malaysia
e-mail: oechsner@fkm.utm.my
4 Universidade Federal do Rio Grande do Sul, Av. Osvaldo Aranha, 99, 3. andar, 90035-190, Porto Alegre, RS, Brazil - e-mail: creus@ufrgs.br

Cellular metals and metallic foams have been used since the 70's, as light and strong structural components. A metallic foam is a metallic matrix with air cells. Cells may be open or closed; each case shows different behaviour. Cellular metals can be applied in crash absorbers, heat exchangers and heat isolators, lightweight structures, acoustic and vibrations damping. Thinking in crash absorbers, that act in compression and can be severely deformed, finite deformations must be considered in the simulation. If severe deformation occurs, some level of ductile damage can be expected. To consider this damage effect, Gurson mod el is employed.

Most usual fabrication processes of metallic foams give rise to non-homogeneous microstructures and reduced reliability. One way of obtain a cellular metal with a more uniform microstructure [1,2] is to employ metallic hollow

spheres welded or bonded. Such materials are known as MHSS (Metallic Hollow Sphere Structures). Anyway, some level of non-homogeneity still can be expected between spheres.
In this work, the numerical simulation via finite elements is employed to study the mechanical behaviour of MHSS, focusing on two major aspects: first, the effect of reversal load and previous compression in voids nucleation, that still is an open task in Gurson model context; the second aspect, the consideration of variations in the material properties of the metallic spheres. Numerical results are compared with experimental data

[1] T. Fiedler, A. Öchsner, On the anisotropy of adhesively bonded metallic hollow sphere structures, Scripta Mater. Vol. 58, pp. 695-698, 2008..
[2] B.F. Oliveira, L.A.B. Cunda, A. Öchsner, G. J. Creus, Hollow Sphere Structures: a Study of Mechanical Behaviour using Numerical Simulation, Materialwissenschaft und Werkstofftechnik, in press, 2009.

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ACEX085
Dr. Branca F. Oliveira
Universidade Federal do Rio Grande do Sul,
Alegre, RS, Brazil

Study of the Use of Metallic Foam in a Vehicle for an Energy-Economy Racing Circuit

E. Cardoso1, B.F. Oliveira2
Universidade Federal do Rio Grande do Sul, 90035-190, Porto Alegre, RS, Brazil
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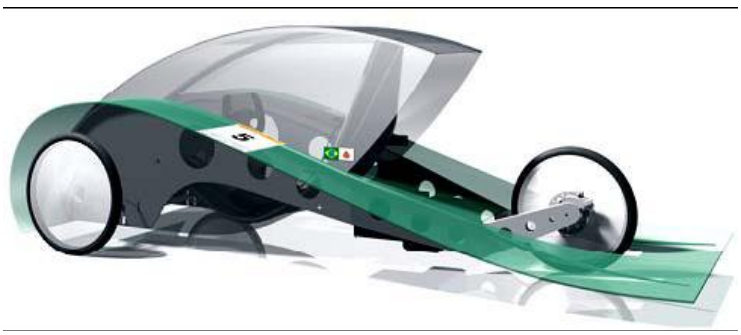
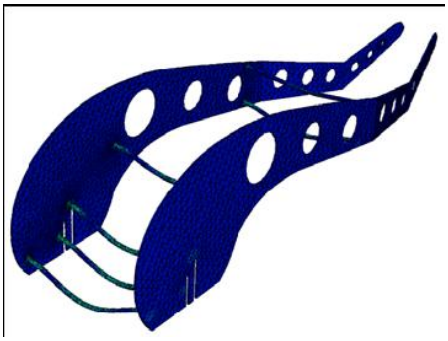
2 branca@ufrgs.br

The study of metal foams has become attractive to researchers, from both the academic scientific and the industrial fields, due to their properties. Metal foams have low density andpeculiar physical, mechanical and acoustic properties, offering great advantages in terms ofweight and strength. They also present an interesting combination of these properties, such ashigh stiffness with light specific weight and high compressive strength with good energy absorption [1].
The emphasis of this work is on the use of metal foams in automotive design for weight reduction with the purpose of studying the mechanical behaviour and possible projectalternatives, through the modelling and subsequent computer simulation according to the casestudy – chassis of the “Sabiá 5” vehicle (Fig. 1). The “Sabiás” are hyper-economic vehicles created to compete in an energy-economy racing circuit (Shell Eco-marathon).
For the structural analysis, the finite element software Abaqus/CAE is used. Many cellularmaterials have high capacity of energy absorption under impact conditions, presenting great energy absorption at constant stress levels. According to the results of the computational testsperformed, metal foams demonstrated to be a good choice for the studied application, presenting the necessary weight reduction with the expected structural performance.



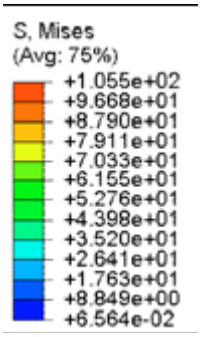
a)



b)

Figure 1 - a) “Sabiá 5” vehicle b) von-Mises stresses (MPa) in the chassis of the vehicle

[1] M.F. ASHBY et al. Metal Foams: A Design Guide. Butterworth-Heinemann, Oxford, 2000.



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ACEX200
Mr. Marco Speich
University of Applied Sciences Aalen,
Department of Mechanical Engineering, Aalen,
Germany

Impact Behaviour and Large Deformation of Core Materials for Sandwich Panels

M. Speich1, M. Merkel1, A. Oechsner2
1University of Applied Sciences, Aalen, Beethovenstr. 1, 73430, Germany.
2Technical University of Malaysia, 81310 UTM Skudai, Johor, Malaysia.

Sandwich panels represent a basic design unit for light weight structures. Sandwich panels typically consist of at least two different materials for the core and the skin. Within the scope of this paper, the impact behaviour of different core materials for sandwich panels is investigated.

Metallic hollow sphere structures (MHSS) form a new group of advanced composite materials characterised by high geometry reproduction leading to stable mechanical and physical properties. The MHSS combine the well-known advantages of cellular metals in terms of their high ability for energy absorption, good damping behaviour, excellent heat insulation and high specific stiffness without major scattering of their material parameters. Various joining technologies such as sintering, soldering and adhering can be used to assemble single metallic hollow spheres to interdependent structures and allow adjusting different macroscopic properties.

The impact behaviour for different core materials is analysed experimentally by drop tests. We investigate MHSS and foams like synthetic polyvinyl chloride foams.

In addition appropriate computational models are presented to account for the deformation mechanisms and to compare computational to experimental results.

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ACEX201
Mr. Rolf Winkler

University of Applied Sciences Aalen,
Department of Mechanical Engineering, Aalen,
Germany

Finite Element Vibration Analysis of Metallic Hollow Sphere Structures based on 3D Computer Tomography Image Processing

R. Winkler1, J. Schulz2, T. Bernthaler1, M. Merkel1, A. Öchsner3
1University of Applied Sciences Aalen, Department of Mechanical Engineering, Aalen, Germany
2Albert-Ludwigs-University Freiburg, Faculty of Engineering, Chair of Pattern Recognition and Image Processing, Freiburg, Germany
3Technical University of Malaysia, Faculty of Mechanical Engineering, Johor, Malaysia

Well-known advantages of cellular metals are their high ability for energy adsorption, good damping behaviour, sound absorption and a high specific stiffness. Metallic hollow sphere structures (MHSS) feature a new group of advanced composite materials characterised by high geometrical reproducibility leading to stable properties in comparison to foams.
This paper presents a Finite Element (FE) model for vibration analysis of Metallic Hollow Spheres Structures (MHSS). Due to the fact that an extraordinary detailed model would exceed available resources we developed a proper FE model with special description for hollow spheres and interconnections. A standard approach uses model structures such as cubic centred, face centred or hexagonal closest packing structures. We perform vibration analysis using the real geometry gained by Computer Tomography (CT) images. The location, centre point and radius of each sphere have to be determined for a CT based simulation, therefore an image processing method will be represented in detail. The numerical results for different structures are compared.

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INVITED TALK

VIP-ACEX007
Prof. Dr.-Ing. M. Merkel
University of Applied Sciences Aalen,
Germany

On the Sound Transmission Through Porous Media: A Comparative Experimental Study

R. Winkler1a, W. Pannert1b, M. Merkel1c,*, A. Öchsner2d
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2Technical University of Malaysia, Faculty of Mechanical Engineering, Department of Applied Mechanics, 81310 UTM Skudai, Johor - Malaysia
Keywords: Cellular Metals, Hollow Sphere Structures (HSS), Acoustical Properties

Metal hollow sphere structures (HSS) represent a new material group. Well-known advantages of cellular metals are their high ability for energy adsorption, good damping behaviour, sound absorption and a high specific stiffness. This wide portfolio of properties cannot be found in classical materials. HSS represent an optimal material group for engineering applications with multifunctional use.

This paper has a focus on the acoustical properties. The essential parameters are the absorption and transmission coefficient. For the experimental part Kundt's tubes are standard analysing tools to determine the absorption coefficient. We use a modified Kundt's tube to analyse the transmission coefficient. The frequencies under investigation range from 200 Hz to 4.000 Hz.
A standard theoretical model to describe the sound propagation in porous absorbers consists of an assembly of cylindrical tubes serving as pores. Viscous and thermal effects are taken into account.
Our experiments verify that this model is useful to predict the transmission behaviour. Results for hollow sphere structures are compared with other cellular materials, e.g. foams. The macroscopic thickness of the specimen varies from 10mm to 60mm. The diameter of the spheres in HSS structures range from 1.5mm to 2.8mm and represent a closed cell structure.

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VIP-ACEX007
Prof. Dr.-Ing. M. Merkel
AalenUniversity–Germany

On the Sound Transmission Through Porous Media: A Comparative Experimental Study

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ACEX031
Dr. Geum-Su Yeom
Korea Institute of Machinery and Materials
104 Sinseongno, Yuseong-Gu,
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South Korea

Numerical and Experimental Study on Spray Freeze-Drying Process for Estimating Optimum Drying Conditions

C.S. Song, G.S. Yeom
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104 Sinseongno, Yuseong-Gu, Daejeon, 305-343, South Korea

Spray freeze-drying is considered a promising technology for producing high-quality porous particles for pharmaceutical uses such as pulmonary drug delivery, micro-encapsulation of drug, and processing of low-water-soluble drugs. In the present work, we experimentally investigated the freeze-drying behavior of spray-frozen particles by using a batch-type spray freeze-dryer which was developed in our lab. We measured the size distribution of the spray freeze-dried particles by means of a scanning electron microscopy and analysis software. We numerically simulated the spray freeze-drying process by using a mathematical model based on the finite volume method in a fixed grid system and compared with the experimental results. The simulation results showed that the dried layer near the bottom surface was observed resulting in a long drying time. Parametric studies were conducted experimentally as well as numerically so that the effects of operation parameters such as product thickness, heating temperature, and cell porosity were discussed.

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ACEX037
Mr. Md Ashique Hassan
Hindustan Institute of Technology,
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Numerical Solution of Natural Convective Heat Transfer Across an Inclined Rectangular Enclosure

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In this work natural convective heat transfer in buoyancy driven vertical inclined enclosure has been studied using numerical technique. Heat transfer by natural convection across an enclosed space called an enclosure or sometimes, a cavity, occurs in many real situations, for example, the heat transfer between panes of glass in a double pane window. Heat transfer between collector plate and glass cover in a solar collector and in cooling of many electronic and electrical

devices. One wall of the enclosure is at uniform high temperature and the opposite wall is at uniform low temperature. The remaining two walls are considered as perfectly insulated one.

The basic governing equations of mass, momentum and energy balance have been transformed in terms of stream function and vorticity to obtain the solution. These equations were non-dimensionalized. An iterative finite difference method has been adopted, which were applied at different nodal points. Finally set of non-linear dimensionless finite difference equations with their associated boundary conditions are solved iteratively starting with guessed values of the variables at all points.

Results in the form of streamlines, isotherms and plot between Nusselt number and Rayleigh number has been drawn for different angle of inclinations, aspect ratio=1 and Prandtl number 0.7 and discussed.

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ACEX226
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Effect of the Wavy Permeable Interface on Double Diffusive Natural Convection in a Partially Porous Cavity

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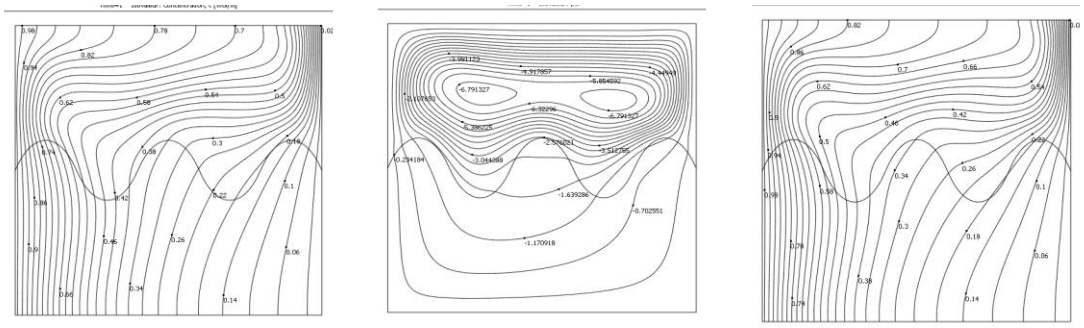
The convective flows due to double-diffusion in a partially porous cavity saturated by a binary fluid have many applications, such as, soil pollution, thermal insulation, grain storage, dispersion of chemical contaminations through water saturated soil, storage of nuclear waste, fuel cells, heat removal from nuclear fuel debris in nuclear reactors, thermal energy storage system, solar collectors with a porous absorber. Another interesting application can be found in the accurate modelling of the boundary conditions at a fluid porous interface. Therefore, an understanding of the transport phenomena from a porous layer to a clear fluid layer and vice versa, and of the corresponding interface boundary conditions has become even more important. Most of the published studies on the natural convection in composite systems deal with cases in which the buoyancy forces are due to the variations of temperature only. However, the studies of double diffusive convection in composite enclosures are very important in numerous scientific and industrial problems. A numerical study has been made of the double-diffusive natural convection in a rectangular fluid-saturated vertical porous enclosure by Mamou et al. they showed that the effects of the buoyancy ratio to be rather significant on the flow pattern and heat and mass transfer. Double diffusive convection in a differentially heated cavity has been studied by Singh et al. They used the Brinkman– Forcheimer–extended Darcy model for the momentum equations in the porous region. Bennacer et al. performed a numerical analysis on the double diffusive, natural convection in a closed, vertical enclosure fitted with two symmetrical porous layers confining a fluid layer. Costa et al. have used a control volume finite element method for simulating flows through a coupled fluid saturated porous and open domain. Gobin et al. studied the simulation of double diffusive convection flows in a binary fluid, confined in a vertical enclosure, divided into two vertical layers, one porous and the other a pure fluid. Their investigation showed the dependence of the average heat transfer on the double diffusive parameters. Generally, the interface between the porous and fluid may not be flat or smooth everywhere. The shape of this interface may be from wavy form. For example, substrate of an agricultural greenhouse, thermal insulation. On the other hand, the bibliographical study shows that no work was found on the double-diffusive natural convection in partially porous cavity with a wavy interface. The main object of the present study is to consider the effect of wavy shape horizontal interface on the double diffusive

natural convection in a cavity. The equations which describe the fluid flow and heat and mass transfer are described by the Navier-Stokes equations (fluid region), Darcy- Brinkman equation (porous region) and energy and mass equations. The finite element method was applied to solve the governing equations. The fluid flow and heat and mass transfer has been investigated for different values of the amplitude and the wave number of the interface and the buoyancy ratio. The results obtained in the form of isotherms, stream lines, isoconcentrations and the Nusselt and Sherwood numbers; show that the wavy interface has a significant effect on the flow and heat and mass transfer.



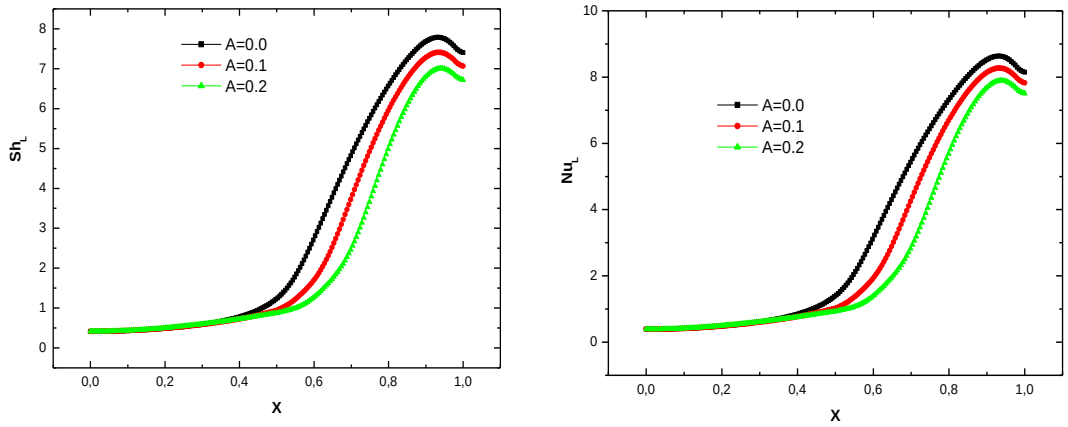


Fig. 1. Isoconcentration lines, Streamlines and isotherms for Ra=10^5, N=1, Da=10^{-4}, Le = 0, 84, A=0,1, Pr=0,71, ε=0,5

Fig. 2. Local Nusselt number, and local Sherwood number for Ra = 10^5, N=1, Da = 10^{-4}, Le = 0.84 at X = 1.

References

M. Mamou, P. Vasseur, E. Bilgen, Multiple solutions for double-diffusive convection in a vertical porous enclosure, Int. J. Heat Mass Transfer 38 (1995) 1787–1798.

A.K. Singh, T. Paul, G.R. Thorpe, Natural convection due to heat and mass transfer in a composite system, Heat and Mass Transfer 35 (1999) 39–48.

V.A.F. Costa, Double diffusive natural convection in a square enclosure with heat and mass diffusive walls, International Journal of Heat Mass Transfer 40 (1997) 4061–4071.

A. Bahloul, L. Kalla, R. Bennacer, H. Beji, P. Vasseur, Natural convection in a vertical porous slot heated from below and with horizontal concentration gradients, International Journal of Thermal Sciences 43 (2004) 653–663.

D. Gobin, B. Goyeau, A.A. Neculae, Convective heat and solute transfer in partially porous cavities, International Journal of Heat and Mass Transfer 48 (2005) 1898–1908.

Z.M. Saghir, R.M. Islam, Double diffusive convection in dual permeability, dual-porous media, International Journal of Heat and Mass Transfer 42 (1999) 437–454.

L.B. Younis a, A.A. Mohamad, A.K. Mojtabi, Double diffusive convection in a vertical rectangular cavity, International Journal of Thermal Sciences 46 (2007) 112–117.

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ACEX039
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Dependence of Monovacancy Formation Energy on Ashcroft's Potential, Exchange and Correlations

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Recently in some papers defect structures in a-Fe [1-3] using different types of density functional theory were discussed. Here pseudopotential approach [4] is used to study the vacancy formation energy for some group I and group II fcc metals, viz. Cu, Ag, Au and g-Fe. In pseudopotential approach, total energy of any crystal contains structure independent and dependent energy. Any defect in the crystal lattice changes it and an algebraic difference between the energy after defect creation and that before will yield the defect formation energy when considered for the whole lattice.
In the first step, variation of with parameter of Ashcroft's empty core model potential (AECMP) is plotted for different exchange and correlation functions (ECF) for Cu, Ag, Au and g-Fe. The nature of graphs is almost similar for all ECFs with two positive peaks from 0 to 5 AU due to term of AECMP. It is observed that experimental value of lies near the nodal point corresponding to the condition rather than that to the maxima. Value of has been chosen corresponding to the condition, where is the Bohr radius and the Fermi wave number.

[1] C. Domain and C. S. Becquart, Phys. Rev. B, 71, 214109 (2005)
[2] Stewart M. J. Gordon, S. D. Kenny and Roger Smith, Phys. Rev. B, 72, 214104 (2005)
[3] Par Olsson, Christophe Domain, and Janne Wallenius, Phys. Rev. B, 75, 014110 (2007)
[4] A. Ghorai, Defect and Diffusion Forum, 278, 25 (2008)

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Surface Tension Driven Flow in a Closed-End Capillary

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Capillary flow which utilizes surface tension as an effective driver in microscale has a wide spectrum of applications. Specifically in microfluidics technology where there is a large surface to volume ratio, surface tension is used as a transport mechanism to deliver buffer solutions [1].

In this study, we employed pneumatic pressure of air as a means to control liquid column in capillary flow [2]. Extensive experiments were carried out in closed-end capillaries of diameters from 200 to 700 μm and aqueous glycerol solutions with viscosities ranging 8 to 80 mPa.s. A 1D model is developed to predict the liquid displacement. This is compared with experimental data. Specifically, the molecular kinetic theory (MKT) based on Blake and De Coninck's model [3] is implemented in the model to account for the dependence of dynamic contact angle on wetting velocity. MKT relates this dynamic behavior to a conceptual frictional dissipation at the liquid wetting front. This model gives a good trend in agreement with our experimental results. Our experimental results showed that the liquid viscosity does not affect the maximum displacement, but a more viscous liquid has a lower average velocity and takes a longer time to reach the maximum displacement. In addition, the total distance travelled by the liquid in a smaller radius capillary is longer. This is because the built-up pneumatic back pressure due to trapped air is smaller with decreasing capillary diameter. Additional experiments were performed with attachment of syringes to one end of the capillary in order to provide more enclosed air volume. It was also observed that for a larger attached volume, the total displacement is longer.

[1] J. Ralston, M. Popescu and R.V. Sedev, Annu. Rev. Mater. Res., 38, p. 23, (2008).
[2] C.P. Steinert et al., Proc. IEEE International Conference MEMS, p. 224, (2004).
[3] T.D. Blake and J. De Coninck, Adv. Colloid Interface Sci., 96, p. 21, (2002).

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ACEX071
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Effect of Non-Uniform Inlet Flow on the Performance of a Solid Oxide Fuel Cell at High Fuel Utilization

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This study investigates the effect of non-uniform inlet flow on the electrical performance of a SOFC unit. This work employed a software package to solve the simultaneous mass equations, energy equations, and electrochemistry equations. With considering three flow patterns and different fuel molar flow rates, this research analyzed the current density distributions at different conditions. The results show that the fuel utilization and average current density increases and decreases with a decrease in the fuel molar flow rate, respectively. In addition, non-uniform Pattern A will induce a severe happening of non-reaction area in the corner of the fuel exit and the air inlet comparing to Pattern B did. This non-reaction area deteriorates the average current density and deteriorates the electrical performance to –7% when the fuel molar flow rate is 0.003375 mol/s and fuel utilization is 83.3%. This study suggests that the fuel inlet manifold should be located far from the inlet of air, which will decrease the deterioration due to non-uniform profile below -3%.

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ACEX076
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Developing an Optimal Dispatching System for Natural Gas pipeline Network

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This paper consists of three main parts which aim at developing an optimal dispatching system for natural gas pipeline network. First of all, a model is proposed to determine the pressure level and the energy needed to pressurize the gas in the pipeline network. The proficient system that determines the pressure level of the network, constructs input-output mapping in the form of fuzzy if-then rules, based on both human knowledge and input-output data pairs [1]; in addition, the Takagi-Sugeno Kang (TSK) fuzzy model that is used to evaluate the energy requirement of the network is proved to have unlimited approximation power to match any given data set by applying the Stone-Weierstrass theorem. Moreover, the problem of minimizing the cost of the fuel consumed by the compressor stations in a specified pipeline network is addressed [1]. Solving the problem by means of fuzzy linear programming (FLP) method [2], optimum operational commands can be made in the compressor stations in order to turn on/off or change the speed of the compressors. Last but not the least, this paper focuses on dynamic modeling of the gas distribution pipeline network [3]; after deriving a simplified model from the set of the Partial Differential Equations (PDE's) governing the pressure and flow dynamics of the network, an analytical scheme is proposed in order to solve the system dynamics using the method of separation of variables.

[1] C. K. Suna, V. Uraikula, C. W. Chanb, P. Tontiwachwuthikul, Engineering Application of Artificial Intelligence, 13, 465 (2000).
[2] L. Wang, A Course in Fuzzy Systems and Control, p.381 (Prentice-Hall, 1997).
[3] A. Herran-Gonzalez , J.M. De La Cruz, B. De Andres-Toro, J.L. Risco-Martın, Applied Mathematical Modeling, 33, 1584 (2008).

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ACEX117
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Numerical Simulation of the Non-Isothermal Three-Phase Flow of Petroleum, Gas and Water in T and Y Junctions

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The occurrence of multiphase flow in the petroleum industry is very common in the transport, production and processing facilities of hydrocarbon from oil and gas fields. In the transport facilities, occur multiphase flow when the produced fluids are transferred for other areas through pipelines. In the production systems, the multiphase flow happens, for example, when the fluids inside the reservoirs in deepwater moves until the surfaces through wells, pipelines and risers.

Studies about multiphase flow majority are limited to two-phase flows such as: liquid-liquid, liquid-solid, liquid-gas, gas-solid, thus involving only two phase. Few are the research related to three-phase flow especially in "T" and "Y" junctions[1-4]. These junctions when properly used can contribute significantly in the process of phase separation of produce fluids. In this sense, the objective of this work is to study the three-phase flow (water-gas-oil) in T and Y junctions including heat transfer. Simulations were realized using the software CFX-3D. Numerical results of the velocity, pressure, void fraction and temperature distributions of the phases, and effect of the oil viscosity in the phase separations are presented and analyzed.

[1] L. Yang and B.J. Azzopardi, Int. J. Multiphase Flow. 33, 6, 207-216 (2007).
[2] A. Wegmann, J. Melke and P.R. Rohr, Int. J. Multiphase Flow. 33, 5, 484-497 (2007)
[3] J.R. Buell, H.M. Soliman and G.E. Sims, Int. J. Multiphase Flow, 20,819–836 (1994).
[4] D. Qian and A. Lawal, Chem. Eng. Science, 61, 7609 – 7625 (2006).

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ACEX120
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Water Adsorption on the Alpha-Al2O3(0001) Surface

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The interaction of water with solid surfaces is fundamental to research in various fields ranging from atmospheric chemistry to corrosion and heterogenous catalysis. Despite substantial research efforts, however, precise information on the water geometry at the atomic level often seems elusive, for the ubiquitous liquid phase as well as for many cases of substrate-supported thin water films and clusters prepared in the laboratory.
Here we present a comprehensive comparison of the adsorption energetics of both molecularly and dissociatively adsorbed water for various coverages based on density functional theory (DFT). In addition, potential energy surfaces for surface adsorbed water molecules, hydrogen and hydroxyl groups are presented to address the controversial issue of surface mobility. Finally, the adsorption energetics is also addressed experimentally, by temperature programmed desorption (TPD) spectroscopy.

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ACEX159
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Optimization of the Soil Hydraulic Functions Parameters Using the Inverse Approach

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In this work we propose to optimize the parameters of the soil hydraulic functions k(h) and θ(h) of the Mualem-Van Genuchten model, while being based on the results of the multi-step outflow experiments (J. Chen et al [4]) combined with the inverse method.
The main objective of this paper is to simultaneously estimate the parameters (θ_r, α, n and K_s) appearing in the formulation of the water retention θ(h), and the hydraulic conductivity k(h), by using cumulative outflow volume Q and soil water pressure head h measurements taken inside the medium. The inverse problem is solved by using the Levenberg–Marquardt minimizing method of the least-squares norm.
The results show that the model describes the process of drainage reasonably. The comparison of the measured and optimized cumulative outflow volume and soil water pressure head shows an agreement between measured and optimized values. An analysis of sensitivity has been done in the goal to value the influence of the initial parameters values on the results of parameter estimation.

Key words: unsaturated porous media, multi-step outflow, parameter estimation, inverse problem, inverse approach.

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ACEX193
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The Effect of Droplet Diameter on the Separation of the Heavy-Oil from Water using Hydrocyclone – CFD Simulation

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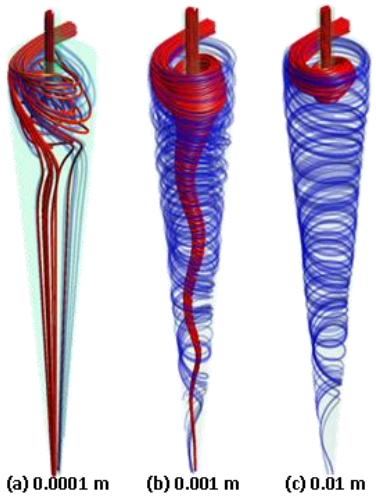
The hydrocyclone is an alternative for produced water treatment in the petroleum industries, especially at offshore fields. Produced water is water co-produced with oil and gas from hydrocarbon reservoirs.
According several authors the hydocyclones may experience efficiency problems often attributed to unfavourable properties of the produced water or sub-optimal hydrocyclone design [1]. The oil droplet diameter has a considerable influence on the rate of separation of droplet from the water [2]. In this sense, this paper describes the effect of oily droplet diameter on the performance of a hydrocyclone to remove dispersed heavy-oil from a water continuous stream. A numerical solution of the governing equations using the Eulerian-Eulerian model was obtained by the CFX commercial code. The Figure displays the streamlines of water and heavy-oil into the hydrocyclone. A comparative study between

these figures permits to observe an outer vortex moving in the underflow direction and an inner, reversed vortex, moving in the overflow direction. Oil migrates to the centre of the hydrocyclone as the heavier water is forced towards the wall. These results show that the droplet diameter can influence on the hydrocyclone performance.



(a) 0.0001 m (b) 0.001 m (c) 0.01 m

Figure 1 – Streamlines of water (blue) and heavy-oil (red) for different oil droplets diameters (a, b and c).

[1] T. Husveg, O. Rambeau, T. Drengstig, T. Bilstad, Minerals Eng. 20, 368–379, (2007).
[2] K. Gaaseidness, J. Turbeville, Pure Appl. Chem., 71, 1, 95–101, (1999).

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Contribution to Heat Transfer Modelling of Interaction Problems between an External Flow and a Finned Surface

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Hot gases, confined by engine walls can induce disturbances in functioning sets (determined by mechanical and tribological considerations) and other complicated problems like fissuration in the cylinder- head. Then, it is necessary (for the correct functioning of this device) that mechanical structures must be maintained at moderated temperatures. It is well known that heat transfer problems in the various components of the engine (cylinder head, cylinder, piston and valve) are of conductive types. The boundary conditions with the interfaces are of convective and radiative types and, the nature of the flows in the combustion chambers is in general rather complex (two and multiphase reactive flows).

The cylinder, object of our study, can be appeared in the form of a boring in the driving block or as a cylindrical barrel. Its dimensions are imposed by the couple and the power which the engine has to provide.
The aim of the work presented in this study consists to an interaction effect analysis between an external flow and a cylinder with finned surfaces of an internal combustion engine, by using a numerical simulation. We were interested in a first study to a purely conductive heat transfer problem taking place in the cylinder of the engine, by using convective heat transfer coefficients derived from the literature. In a second one, we were interested to a fluid structure interaction problem were the mathematical modelling of the flow analysis, on the external side, is established by using a laminar free convective heat transfer modelling around finned surfaces. The hydrodynamic as well as the thermal aspect of the flow problem are also analysed in this study by solving the fluid dynamics equations with the adequate boundary conditions by using the finite volume method.

We must underline that the originally of the present work consists on the mathematical and the numerical modelling of flows around solid structures by taking into account the effects of interaction between an external flow and a structure consisting of a finned surface cylinder were the heat transfer problem is purely conductive. The results presented are related to the temperature distributions in the cylinder, the velocity and the isothermal lines around the finned surfaces of the cylinder and the evolution against space and time of the convective heat transfer coefficient between the flow and the structure.

Keywords: Heat transfer, Flow modelling, Numerical simulation, Interaction effects.

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Study of Capillary Effects from a Pendant Droplet

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Capillarity is a ubiquitous transport phenomenon in nature and engineering. Specifically in microfluidics technology, studying flow behaviour in capillary channels is of great importance [1]. The first rigorous analysis of the dynamics of capillary penetration is attributed to Washburn (1921) [2]. His theoretical model assumes steady state low Reynolds number flow of a Newtonian liquid with a constant contact angle at the liquid front. These assumptions have always been points of contention by many researches [1]. One of Washburn's assumptions which has not received much attention is the size of liquid reservoir [3]. While many practical applications such as spray coating, ink-jet printing and wicking in textile yarn systems involve transport of a liquid from a finite reservoir into capillary structures, almost all previous experimental studies are related to capillary flows from an infinite reservoir. Thus, studying the effect of reservoir size in the process of capillary penetration is of practical importance [3]. In this study, we report experimental and theoretical investigations on capillary flow from a liquid pendant droplet as a finite reservoir. Extensive experiments were carried out with aqueous glycerol solutions of viscosities ranging 80 to 934 mPa.s. in borosilicate glass capillaries of diameters ranging 300 to 700 μm. The results are compared with capillary flow from an infinite reservoir. In theoretical analysis, we apply the concept of Gibb's free energy of surface to derive the contribution of the finite reservoir in the total surface tension force. Moreover, an egg-shaped model is proposed to describe the pendant droplet shape. The

molecular kinetic theory (MKT) based on Blake and De Coninck's model [4] is also implemented in the model to account for the dependence of dynamic contact angle on liquid column velocity. This model gives a good trend in agreement with our experimental results. It is shown that the finite reservoir size has significant effects on the dynamics of capillary flow, resulting in a faster transport of the liquid.

[1] J. Ralston, M. Popescu and R.V. Sedev, Annu. Rev. Mater. Res., 38, p. 23, (2008).
[2] E.W. Washburn, Physical Rev., 17, p. 273, (1921).
[3] A. Marmur, J. Colloid Interface Sci., 122, p. 209, (1988).
[4] T.D. Blake and J. De Coninck, Adv. Colloid Interface Sci., 96, p. 21, (2002).

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Numerical and Experimental Study of the Flow inside the Industrial Electrical Breaker

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This paper explores the effect of the magnetic field on quenching the arc plasma in the electrical breaker. An environment is considered wherein the electromagnetic field is generated by permanent magnetized material and two coils around the plasma runner. A three dimensional transient computational model of the flow inside the electrical breaker is theoretically derived by solving the momentum and Maxwell equations considering the variation of the flow properties with the temperature. The CFX program is used to simulate and study the plasma flow and heat transfer inside the electrical breaker. Moreover, P1 radiation models are considered to simulate the radiation intensity in the arc chamber and to investigate the temperature distribution. In the experimental part, optical sensors (or diodes) embedded in different parts of the electrical breaker are used to measure the degree of light emission, which allows studying the behaviour of the plasma motion .

References:

[1] F. Karetta, M. Lindmayer. IEEE Trans. CPMT-21 Part A (1998), pp. 96.
[2] L.Z.Schlitz, S V.Garimella and S H. Chan , Journal of Applied Physics, 2540 (1999). P 85,
[3] S.R. Marandi , IEEE Canadian Conference on Electrical and Computer Engineering (1996) , P 1.
[4] P.G. Slade , Electrical Contact Principles and application, 1999 , Marcel Dekker, Inc, P 629.
[5] M.Lindmayer , M.Springstubbe , IEEE Holem Conference on Electrical Contacts, (2001).
[6] Boulos M. I., Fauchais P., Pfender E. Thermal plasmas. Fundamentals and applications. Volume 1. Plenum Press, New York. (1994).

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Diffusion Considerations Regarding Flexible Solar Cell Substrates

Water vapour condensation on - and diffusive transport in - thin polymer based flexible films can give rise to several physical-chemical failure modes, such as swelling stresses on interfaces, reduced impact resistance, blister formation driven by osmotic pressure or chemical degradation of another laminate component.

In this research the properties of transparent polyimide substrates are discussed. Among others, the high glass transition temperature, low free volume and excellent UV resistance, make it an attractive concept material for flexible thin film solar cells. However, in real life circumstances, water and oxygen mass diffusion must be evaluated rigorously for sake of solar cell lifetime predictions and proper design of accelerated laboratory tests.

SPECIAL SESSION ON 'ADHESIVE BONDING'

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ACEX027
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The Interaction between Parameters of the Single Lap Joint and the Strength of Adhesive Joint Structure

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Nowadays, adhesive joint become one of the most famous joining method among welding, mechanical fastener and others. This joining method offered a lot of advantages to use in industrial areas, marine environment, aircraft structure, etc. Single lap joint is the simplest design selected in this project to determine the strength of the adhesive joint, which the specimens have been exposed into two kinds condition, which are dry and wet environment. The chosen adhesive was polyester resin whereas for substrates were aluminum and stainless steel. For improvement purpose, the stainless steel specimen prepared with fibre reinforcement embedded in polyester resin and this result in stronger joint than the aluminum specimen. Those specimens prepared differently based on chosen parameters, which are the adhesive thickness, everlap length, substrate thickness and substrate width. In order to obtain better result and validate the data properly, the experiment that is conducted in shear mode analysis was done repetitively by using same dimensions of the specimens. The test result then depicted in graphical and table forms for detail discussion. Ultimately, for better future work in this filed, som recommendations had discussed in detail at final chapter of this report.

[1] B. Ross, Investigating Mechanical Failures; the Metallurgist's Approach, Chapman & Hall (1995).
[2] H. W. So, N. N. S. Chen & P. I. F. Niem, Fatigue Performance of Adhesive Joints Immersed in Different Solutions, Vol. 44, p. 245 – 256, Journal of Adhesion (1994).
[3] N. J. Brown, K. G. Swift & J. D. Booker, Joining Process Selection in Support of a Proactive Design for Assembly, Vol. 216, p. 1311 – 1324, Journal of Engineering Manufacturer: Part B (2002).

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INVITED TALK

VIP-ACEX035

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Optimum Configuration of Adhesively Bonded Thick Adherend Lap Shear Specimen

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Adhesive characterization is an important issue from the viewpoint of both adhesive manufacturers and end users. In most engineering applications, it is desirable to employ adhesives to transfer shear stress, rather than normal or peel stress, between two substrates. Thus it is imperative to accurately measure shear behavior of an adhesive. Amongst the available standard test methods for measuring adhesive shear behavior, ASTM D5656 is one of the simplest and most widely used standard test methods, in which thick adherends are employed in conjunction with the well-known KGR-1 device. This report presents a preliminary investigation into minimizing the non-uniformity in shear stress distribution and the localized-bending induced peak peel stress through optimizing the geometrical configuration of ADTM D5656 standard specimen.

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INVITED TALK

ACEX035

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Investigation of the Thermo-Viscoelastic Material Behaviour of Adhesive Bonds Close to the Glass Transition Temperature

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Polymers are widely used as adhesives in industrial applications, e. g. in automotive and aeronautical engineering. The appropriate description of the mechanical behaviour of such adhesive joints still poses a variety of problems, i. e. very often the mechanical properties of the viscoelastic polymer are not known with necessary precision. In a current research project we experimentally observe and model size effects in polymer joints beside the bulk behaviour under isothermal conditions at ambient temperature [1, 2, 3].
Since application is not restricted to ambient temperature, there is the need to examine the mechanical material behaviour of the used polyurethane over a range of different but constant temperatures. Due to the fact that the used material has a glass transition temperature of about 2 °C it is very interesting and of essential importance to capture the mechanical behaviour from the glassy to the viscoelastic state.

On the one hand uniaxial tension tests are performed on dogbone specimens in order to describe the polymer bulk behaviour. On the other hand adhesive bonds of different thicknesses are investigated in shear tests. Both experiments are performed isothermally at different temperature thus capturing the finite viscoelastic material behaviour over the range of the glass transition temperature. In this manner a pool of experimental data is provided, cf. Figure.

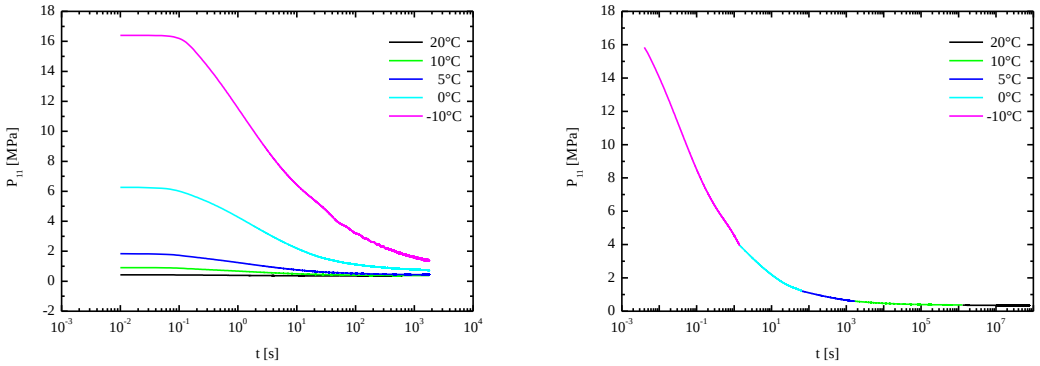

Figure: Relaxation behaviour at different constant temperatures (left) and constructed master-curve (right)

On the theoretical side we present a finite, thermo-mechanically coupled, viscoelastic material model which is able to display the experimentally observed material behaviour. For this we adopt temperature dependent moduli and relaxation times.

Optionally observed size effects can be covered by the introduction of scalar-valued structure parameters and their related balance equations as shown in [2, 3].

All these model parameters are identified strategically via a parameter identification tool based on biologic evolution strategies.

[1] M. Johlitz, H. Steeb, S. Diebels, J. Batal, W. Possart, Technische Mechanik, 28(1), 3, 2008.

[2] M. Johlitz, S. Diebels, J. Batal, H. Steeb, W. Possart, J. Mat. Sci., 43, 4768, 2008.

[3] M. Johlitz, Experimentelle Untersuchung und theoretische Modellierung von Maßstabseffekten in Klebungen, Saarbrücker Reihe, Band 12, Materialwissenschaft und Werkstofftechnik (Shaker Verlag, Aachen, 2009).

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ACEX036
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The Synthesis and Characterization of Acrylic Polymer/Montmorillonite Clay Nanocomposite Pressure Sensitive Adhesives

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Acrylic polymer/montmorillonite (MMT) clay nanocomposite pressure sensitive adhesives (PSA) were synthesized using different types and amounts of modified and unmodified MMT clays. The clays were dispersed in ethyl acrylate/2-ethylhexyl acrylate monomer mixture, which was then polymerized using a suspension polymerization technique. By the

use of in-line attenuated total reflectance-fourier transform infrared spectroscopy it was observed that the kinetics of suspension polymerization was independent of the addition of MMT clays. However, the adhesive properties of adhesives were strongly influenced by the type and the amount of MMT clay added. The adhesion properties were determined using standard measurements of tack, peel and shear strength. While peel strength and tack gradually decreased with higher amount of modified MMT clay, a substantial increase in shear strength was determined with a maximal value at 1 wt. % of added MMT clay. Moderate influence on tack, peel and shear strength was observed when the unmodified MMT clay was used. Dynamic mechanical analysis showed an increase in storage modulus for adhesives synthesized with MMT clay addition, but no significant differences were determined between particular types of MMT clays. A decrease in tan δ values for adhesives with 1 wt. % of added MMT clay was observed, which also concurs with higher shear strength and implies to the improved cohesion of adhesive.

[1] J. Kajtna, M. Krajnc and J. Golob, Macromol. symp., 243, 132 (2006).
[2] J. Kajtna, U. Šebenik, J. Golob and M. Krajnc, Dry. technol., 26, 323 (2008).
[3] J. Kajtna, B. Likozar, M. Krajnc and J. Golob, Int. j. adhes. adhes., 28, 382 (2008).
[4] J. Kajtna, M. Krajnc and J. Golob, Int. j. adhes. adhes., 29, 186 (2009).
[5] J. Kajtna and U. Šebenik, Int. j. adhes. adhes., (2009), doi:10,1016/j.ijadhadh.2009.01.001

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ACEX044
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Modeling Adhesively Bonded Joints in Explicit Finite Element Simulations

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To evaluate the potential impact of variability of the adhesive bond strength on crashworthiness performance of vehicles, one needs to model the adhesive fracture and/or adhesive bonded joint separation in explicit finite element analysis (FEA) of full vehicle models. In standard adhesive joint modeling, the adhesive can be modeled, in detail, with a fine mesh. Such an approach is unfeasible in full vehicle crashworthiness simulations. The objective of this work is to develop a modeling method to simulate adhesive joint failure in explicit FEA that can be used in large scale simulations. Our previous work [1] showed that a simple shell/solid FE representation was sufficient to describe the stiffness response of the adhesively bonded joints. This modeling method is computational efficient for large scale simulations. At the time, the available material models could not represent the fracture behavior of adhesives under different stress conditions and hence failure modeling was not attempted. Recently, advance has beenmade in adhesive material models. Cohesive zone models (CZM) also become availablein explicit FE code LS-DYNA. This paper examines the use of cohesive zone models(CZM) and an adhesive material model. Investigations were conducted onaluminum/epoxy joints including single lap shear, scarf and double cantilever joints.

1. Xiao X, Foss PH, Schroeder JA, Stiffness Prediction of the Double Lap Shear Joint,
Part2: Finite Element Modeling, Int. J. Adhesion and Adhesives, 24, 239-246, 2004.

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ACEX047
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Experimental and Numerical Study of Composite T-Joints for Marine Applications

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In a common ship structure multiple watertight bulkheads are used to divide the hull into many compartments. These sections are the primary structures in maintaining the ship stiffness under various loading conditions. A typical joint (i.e. T-joint) is used to bond bulkheads and hull in order both to transfer loads and to maintain watertight integrity. Then, the reliability of the ship depends heavily on this one as the connection between the sub-structures [1].
The aim of this work was to study the behaviour of composite T-joints realised in a Sicilian shipbuilding. Three configurations were investigated; i.e. with structural adhesive and with two different over-laminations (i.e. stratification layers made of 0/90 and +45/-45 bidirectional glass fabrics). Moreover the joined sections were made with different materials. Particularly two cases were taken into account. In the first one two glass-reinforced plastic (GRP) sandwiches were bonded. In the second one a GRP sandwich was bonded to a wood based sandwich (i.e. with balsa core).
These joints were subjected to a tensile load in the plane of the sheet [2]. To quantify the effect of the different designs on the strength a variance analysis was performed. Finally a numerical model was developed using a commercial code (Ansys). Such model should be suitable for designing and/or verifying the mechanical performances of the joints.

[1] H.C.H. Li, F. Dharmawan, I. Herszberg and S. John, Compos. Struct., 75, 339 (2006). [2] L. F.M. da Silva and R.D. Adams, Int. J. Adhes. Adhes., 22, 311 (2002).

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ACEX056
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A Computational Model for Nanoscale Adhesion Between Deformable Solids and its Application to Gecko Adhesion

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A computational contact formulation is presented that is suitable for simulating contact- interaction problems at very small length scales. The contact model is based on the coarse- graining of the intermolecular forces between neighboring bodies, like van der Waals attrac- tion, into an e ective continuum contact description. The model is cast into a nonlinear 3D nite element implementation which allows for the description of large deformations and general contact geometries [1].

The contact model is then applied to the modeling and simulation of the adhesion and deformation of a gecko seta based on a 3D multiscale approach [2]. The approach spans six orders of magnitude and combines three distinct modeling levels that describe the e ective adhesion behavior of the seta scale, the spatula scale (at the seta tips) and at the molecular scale. The model is successful in capturing the adhesion behavior that has been observed experimentally, e.g. [3, 4].

References

[1] R. A. Sauer and S. Li. An atomic interaction-based continuum model for adhesive contact mechanics. Finite Elem. Anal. Des., 43(5):384{396, 2007.

[2] R. A. Sauer. Multiscale modeling and simulation of the deformation and adhesion of a single gecko seta. Comp. Meth. Biomech. Biomed. Engng., in press, 2009.

[3] G. Huber, H. Mantz, R. Spolenak, K. Mecke, K. Jacobs, S. N. Gorb, and E. Arzt. Evidence for capillarity contributions to gecko adhesion from single spatula nanomechanical measurements. Proc. Natl. Acad. Sci. USA, 102(45):16293{16296, 2005.

[4] W. Sun, P. Neuzil, T. S. Kustandi, S. Oh, and D. Samper. The nature of the gecko lizard adhesive force. Biophys. J., 89(2):L14{L17, 2005.

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ACEX059
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Static and Dynamic Behaviour of Interference fit and Adhesively Bonded Cylindrical Joints

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The present work aims at defining the anaerobic adhesive residual strength in press-fit and adhesively bonded cylindrical joints, loaded with a tension tension fatigue cycle. The final purpose is to evaluate the possibility to reduce the interference level by taking advantage of the adhesive strength. The tested specimens are some shaft hub cylindrical joints made of different materials in contact: the hubs are always made of steel alloy while the shafts are made both of steel alloy and of aluminium alloy. Firstly some coupling and decoupling tests have been performed to evaluate the static strength of the joints, calculated as the addition of the interference contribution and the adhesive contribution. Then the fatigue tests have been performed to evaluate the adhesive residual strength after 106 tension tension fatigue cycles. The fatigue cycles have been differentiated and related to the static strength of the joint.

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ACEX067
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Plasma Surface Modification of Fibre Reinforced Polyester Enhanced by Ultrasound Irradiation

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Atmospheric pressure plasma treatment can be highly enhanced by simultaneous highpower gas-borne ultrasonic irradiation onto the treating surface [1]. It is because powerful ultrasonic waves (sound power level (SPL) above approximately 140 dB) can reduce the thickness of a boundary gas layer between the plasma and the material surface, and thus many reactive species generated in the plasma can reach the surface before inactivated,and be efficiently utilized for surface modification.

In the present work glass fibre reinforced polyester plates are treated using an atmospheric pressure dielectric barrier discharge in helium with ultrasonic irradiation (frequency diapason 20 to 40 kHz, SPL ≈ 150 dB) onto the surfaces. The powered electrode has a perforated hole covered with a steel mesh, above which a cylindrical waveguide is attached for the introduction of ultrasound. The plasma gas and ambient air are separated using a polyethylene film clamped in the waveguide. The water contact angle of the plate dropped markedly after 5-s plasma treatment with no ultrasonic irradiation, and tended to decrease furthermore after longer treatments. Ultrasonic irradiation during the plasma treatment consistently improved the wettability. The polar component of the surface energy changed from 12 mJ m-2 to approximately 60 mJ m-2 after plasma treatment, increased furthermore with ultrasonic irradiation, but remained almost unchanged after longer treatment. It is therefore indicated that polar functional groups could be introduced on the surfaces in a short time, and that further improvement of the wettability after longer treatment is due to enhanced roughness.

[1] N. Krebs, A. Bardenshtein, Y. Kusano, H. Bindslev and H.J. Mortensen, Int. Patent
WO2008-138901 A1, (2008).

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ACEX075
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Mechanisms for Adhesive Grip-and-Release Using Material with Variable Elastic Modulus

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New grip-and-release mechanisms are proposed, considering adhesion phenomena between an elastic body and a rigid object with a surface roughness. They are demonstrated using a polymer, which has a temperature dependent elastic modulus. In our model, the polymer is assumed to be a semi-infinite elastic body and the surface roughness is assumed to be sinusoidal. Since the contact width between the body and the object is explained as a function of an external normal pressure and the elastic modulus [1], the gripping stress can be obtained as a function of the elastic modulus. This is the first mechanism. The relation between the gripping stress and the elastic modules is investigated experimentally. Using the first mechanism, separation occurs at a partial contact. The theory [1] suggests that no more separation occurs if the complete contact is achieved by sufficiently large pressure. However, separation can occurs near the complete contact, if the interface is modified so that the work of adhesion can be negligible partially in the interface. This is the second mechanism. Using the second mechanism, separation occurs at the larger contact width than the case of the first mechanism. Therefore, larger gripping stress can be designed using the second mechanism. In the present study, the second mechanism is investigated theoretically. It is found that the second mechanism exhibit the large dependence of the elastic modulus on the gripping stress and increases the feasibility of the design for grip-and-release devises.

[1] K. Takahashi, P. Hemthavy, R.R.A. Sriwijaya, L. Lei, K. Jatmiko and S. Saito, Quarterly Journal of the Japan Welding Society, 26, 292 (2008)

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ACEX077

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Comparison of Tack of Pressure Sensitive Adhesives (PSA) at Different Temperatures

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Pressure sensitive adhesives (PSA) have several applications in the field of packaging, joining, wound care and personal care. Depending on the application of the PSA, different performance tests are carried out whilst new products are developed or the quality of the existing products are checked. Tack is the property of an adhesive that enables it to form instant bond on the surface under light pressure. The tack properties of PSA strongly depend on the way the bonding is created. Parameters such as the bonded area, contact time and tack materials will affect the tack force measured. In the development of all the PSAs, it is desirable to find the correlation of the performance related properties such as tack and peel to the rheological behaviour. Finding these correlations would make it possible to make evaluation on the performance of the PSA using its rheological characteristics. In this investigation we study the influence of rheological behaviour of three different PSAs on the adhesive tackiness. The three different PSAs in this study are a low molecular weight rosin, high molecular weight rosin and dicyclopentadiene. Various rheological properties such as viscosity, phase angle, storage and loss modulus are measured versus the frequency and temperature. Also the tack properties at various removing speeds and temperature are evaluated. Analysis of the results indicates different performances of the three adhesive could be related to their rheological properties especially the phase angle at different frequencies and temperatures. Adhesive with high molecular weight rosin are more sensitive to temperature change and showed drastic

change in tackiness from high temperature to low temperature. On the other hand, rosin with low molecular weight is less sensitive to temperature change. These were proved by both rheology and tack tests.

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ACEX078
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Increasing Single Lap Joint Strength by Adherend Curvature-Induced Residual Stresses

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Single lap geometry is the most widely used type of adhesive joint geometry. In this joint, peel stresses occur at the overlap ends due to load eccentricity and the presence of shear-free adhesive termination surfaces. These peel stresses, along with the transverse tensile stresses which occur along the overlap longitudinal axes, and adhesive shear stresses, ultimately cause joint failure. Obviously, reductions in these stresses should result in higher joint strength and increased load capacity. To this end, we exploited elastic spring-back capability of (steel) metal adherends by initially forming curved segments of varying arc length and radii at overlap ends. These adherends with curved-end sections were then bonded in single lap configuration, simply by applying sufficient bonding pressure to elastically flatten the curved segments to result in typically flat overlap sections subsequent to adhesive cure and the removal of bonding pressure. Since the elastic adherend overlap ends tend to revert back to their initial curved form, they exert compressive residual stresses on the adhesive layer at the overlap end regions. We modeled this novel method of strength enhancement using finite element method (FEM). This was accomplished by applying bending moments to overlap ends. The FEM provided us information on the effects of residual stresses, which are created by these “effective bending moments” and their effects on load capacity of the single lap joint geometry. We determined that the compressive residual stresses induced in this fashion, considerably increased the load capacity of single lap joints subjected to tension.

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ACEX080
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Experimental Analysis of Different Adhesives in Steel Rods Glued-in Hardwood

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The utilization of adhesives for the materialization of effective unions of steel rods gluedin hardwood constitutes a field of great future in the world of the rehabilitation of existing structures, as in the design of new structures.
Up to the moment, the studies realized on this type of unions have been centred fundamentally in case of laminated timber of softwood. Nevertheless, its application to hardwood increases its utility for rehabilitation. With such purpose, our team has carried out a wide experimental campaign of this type of unions on different species of timber [1], [2],[3].
One of the big problems which is present on having tried to materialize this type of unions is the choice of the suitable type of adhesive. In the present paper there are detailed the results obtained by our team in the experimental realized tests. To such effects there are tested 7 different adhesives: three two-component epoxies, a onecomponent polyurethane, a one-component neoprene, a two-component polyester and an two-component epoxi-acrilate. There were made prismatic specimens of chestnut timber of 48, 60 and 72 mm cross-section and five different lengths. Threaded steel bars of quality 8.8 and three different diameters were tested that were combined by five anchorage lengths. The type of test setup realized was pull-pull.
In the paper there is described the characteristics of the different types of adhesives from the point of view of execution of the specimens. The combines consideration of two factors, facility of steel rods to be glued into the holes and load capacity of the union, has revealed that the most suitable type of adhesive is the resin epoxy. Likewise, the curve load - displacement obtained for three resins epoxy tested demonstrate very few difference between they, in spite of treating itself about commercial resins not specifically formulated for the union with wood.

[1] Estévez Cimadevila J, Vázquez Rodríguez JA, Otero Chans MD. Int J Adhes Adhes 2007; 27(2):136.
[2] Otero Chans D, Estévez Cimadevila J, Martín Gutiérrez E. Int J Adhes Adhes 2008; 28(8):457.
[3] Otero Chans D, Estévez Cimadevila J, Martín Gutiérrez E. Mater Des 2009; 30(4):1325.

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ACEX083
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The Investigation of High-Temperature Mechanical Stability of Boron Carbide Modified Phenol-Formaldehyde Resin

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The high-temperature mechanic stability of boron carbide (B4C) modified phenol-formaldehyde resin was investigated by bond experiment. The high-temperature adhesive (PF+B4C) was prepared using phenol- formaldehyde (PF) resin as matrix and B4C particle as modification additive. Silicon carbide (SiC) blocks were bonded by the above PF+B4C, and the bond strength of SiC joints treated with high temperatures was tested at room temperature. It was shown that the SiC blocks were successfully bonded by the PF+B4C, and the bond strength of SiC joints treated with 700-800 °C was higher than 20 MPa. The characteristics of the PF+B4C were also investigated by scanning electron microscopy (SEM), energy dispersive X-Ray (EDX) detector, and pyrolysis gas chromatograph spectrum coupled with mass spectrum (py-GC-MS).

The results indicate that addition of B4C is responsible for the improved performance of PF resin residue treated with high temperature.

[1] C. Martin, J.C. Ronda, V. Cadiz, J. Polym. Sci. Part A: Polym. Chem., 44, 3503 (2006)
[2] D. Schmidt, K. Dewidson, L.S. Theibert, SAMPE, 32, 44 (1999).
[3] M.O. Abdalla, A. Ludwick, T. Mitchell, Polymer, 44, 7353 (2003)
[4] J. Bijwe, Nidhi, N. Majumdarb, B. K. Satapathy, Wear, 259, 1068 (2005)
[5] M.C.Wang, L.H. Wei, T. Zhao, Eur. Polym. J., 41, 903 (2005)
[6] O.N. Borisenko, G.D. Semchenko, M.A. Chirkina, I. V. Kasymova, Refract. Ind. Ceram., 47, 225 (2006)
[7] K.P. Unnikrishnan, E.T. Thachil, Int. J. Polym. Mater., 55, 385 (2006)
[8] K.A. Trick, T.E. Saliba, Carbon, 33, 1509, (1995)
[9] M. Sobera, J. Hetper, J. Chromatogr. A, 993, 131 (2003)
[10] J.I. Ozaki, W. Ohizumi, A. Oya, Carbon, 38, 1499 (2000)
[11] H.Y. Jiang, J.G. Wang, Z. C. Duan, F. Li, Front. Mater. Sci. China, 1, 35 (2007)
[12] I. Ogawa, T.Yamamoto, T. Hagio, H. Yoshida, K. Kobayashi, J. Ceram. Soc. Jpn., 94, 409 (1986)
[13] H. Steiner, J. Nucl. Mater., 345, 75 (2005)
[14] J.E. Sheehan, Carbon, 27,709 (1989)
[15] D.W. McKee, C.L. Spiro, E.J. Larnby, Carbon, 22,507 (1984)
[16] J.G. Gao, X.H. Su, L.Y. Xia, Int. J. Polym. Mater., 54, 949 (2005)
[17] Y.F. Liu, J.G. Gao, R.Z. Zhang, Polym. Degrad. Stab., 77, 495 (2002)

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ACEX086
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Temperature Dependence of the Fracture Toughness of Adhesively Bonded Joints

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Adhesives used in structural high temperature space and aerospace applications must operate in extreme environments. These adhesives which need to exhibit high-temperature capabilities have to maintain their mechanical properties at the intended service temperature and to maintain their structural integrity (resist thermal breakdown at elevated temperature). One of the adhesives which are able to withstand the temperature extremes that are experienced in the space environment and are able to maintain a good degree of flexibility at very low temperatures are the RTV silicone adhesives. They are used when considerable expansion and contraction is expected in the joint and flexibility is required as in the case of materials that have dissimilar coefficients of thermal expansion (CTE).

As is known, adhesive strength generally shows temperature dependence. Studies that present experimental results of adhesive joints with structural adhesives (especially epoxies) as a function of temperature generally show a decrease in strength with increasing and decreasing temperatures [1-3]. At high temperatures the cause is the low adhesive strength while at low temperatures it is the high thermal stresses. Similarly, a critical strain energy release rate (fracture toughness) is expected to show temperature dependence. In this study, the critical strain energy release rate in mode I

fracture for adhesive joints bonded with a high temperature RTV silicone adhesive was measured over a wide range of temperatures. Double cantilever beam tests were performed on specimens at temperatures of RT, 100 and 200°C.

[1] L.F.M. da Silva, R.D Adams, J. Adhesion Science and Technology 19 (2): 109-142 (2005).
[2] R.D. Adams and V. Mallick, J. Adhes. 43(1-2), 17-33 (1993).
[3] SG Kang, MG Kim, CG Kim, Compos. Struct. 78(3), 440–446 (2007).

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ACEX087
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Effect of Ti- 6Al- 4V Plates Roughness on the Strength of an Adhesive Bonding

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Adhesive bonding allows materials joining without heating them to high temperatures and is attributed to chemical or mechanical (interlocking) interactions at an interface.
In the present study the effect of surface roughness of Ti-6Al-4V plates on the strength of adhesive bonding was investigated. Various roughness grades of substrate surface were achieved by mechanical treatments. Scotch-Weld AF-163 2-OST (produced by 3M Company) structural adhesive was used. Optical microscope and SEM were used for interface characterization. Shear strength of joined samples were measured according to ASTM D1002. It was established that degree of surface roughness strongly affect the shear strength of the bonding and maximal strength of about 37 MPa was obtained.
The experimental results were treated using a model of multi-capillary structure of the surface, which allow taking into account the effect of the surface roughness on surface area and on the adhesive spreading at the interface. The capillary rise phenomenon for the substrates with various roughnesses will be discussed.

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ACEX092
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Evaluation of Adhesion and Aging of a Glass Treated with Atmospheric Plasma Torch

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In many buildings, a continuous glass closing is carried out to avoid external aluminium profiles, hence appearing a complete glass facade. To manufacture such a structural glazing, silicone is being used. This research has studied silicone-glass adherence, and the influence of atmospheric plasma treatments on this adherence. Two different silicones have been used: a commercial silicone (sealant) and a special silicone for glass applications. The glass has 1.87 mm thickness and it is fully transparent.

First, glass surface energy was studied, measuring contact angles with four different liquids and using OWRK method to calculate the surface energy. Then, plasma treatments were carried out at two different speeds (10 and 1 m/min), and the surface energy of treated glasses was measured. Moreover, the change of surface energy with time after treatment

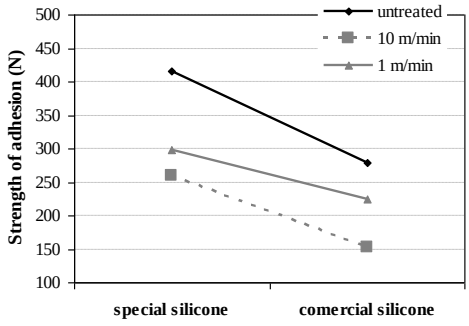

Figure 1. Influence of plasma treatment on adherence

(up to 30 days) was evaluated. Adherence tests were carried out following ASTM D 454 standard. Silicone was cured on the glass for 7 days before testing, using aluminium equipment to measure the strength of the bond. Both untreated and treated glasses were tested.

Results show that surface energy increases when plasma treatment speed is reduced, and that glass partially recovers its initial surface energy value with aging alter treatment. Adherence tests show a diminishing of strength in treated glasses.

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ACEX093
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Structural and Mechanical Characterization of γ-Methacryloxipropyltrimethoxysilane (MPS) on Zn-Electrocoated Steel

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Anaerobic adhesives have found an extensive use in many applications in the mechanical engineering industry as sealers, threadlockers and retainers on metal surfaces. These adhesives have shown a good behaviour with thread parts and components with Cr [VI] coatings. Hexavalent chromium is a carcinogenic material and its use is limited or prohibited for environmental regulations in several countries, such as de United States and the European Union. In order to avoid this problem, nowadays non-chromated zinc coatings are used, however, anaerobic adhesives are not very effective with these types of coatings. Silane coupling agent could be an alternative to improve the behaviour of these coatings with the anaerobic adhesives.
The aim of this work was to investigate the effect of the silane treatment on Zn-electrocoated steel. The silane used was γ-methacryloxipropyltrimetoxysilane (MPS). Analysis of silane layers was done by means of Fourier Transform Infrared (FTIR). In addition, single lap shear test and pull test were used to compare the strength of anaerobic adhesive joints on Zn coated specimens with different surface treatments.

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ACEX095
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Experimental Investigations and Numerical Modelling of Adhesive Joint of Aluminium Strips Reinforced by Rivets for Industrial Applications

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The paper deals with experimental investigations of adhesive joint of aluminium strips reinforced by rivets, which can be applied for different branches of engineering. The experiments with application of digital image ARAMIS system allows for exact monitoring of the deformation process of the considered hybrid joint. The numerical simulations, done with ABAQUS code, enable investigations of: stress concentrations in different parts of joints and an analysis of the whole structural systems up to the final failure.

Introduction

The contemporary demands in different branches of engineering require application of new multi-component materials and structural systems. Appropriately chosen joining technology can offer significant enhancement of structural system performance in terms of effectiveness, reliability, safety and other design criteria. The modern applications of hybrid joints are of great technological interest as they permit to combine and to enhance the individual effects of each kind of joint [1-3]. This is of great importance for modern applications in different branches of engineering: aerospace, mechanical and civil. The advantages of application of hybrid joints are the following:

- higher static and fatigue strength
- stiffer structure
- two-stage cracking process before the final failure (in adhesive layer, in rivets)
- better corrosion resistance

Therefore in this paper we will focus on the analysis of mechanical response of adhesive joint of aluminium strips reinforced by rivets.

Experimental investigations

The aim of the paper is to investigate experimentally the mechanical behaviour of adhesive joint of aluminium strips reinforced by rivets for industrial applications in aerospace. The considered joint was subjected to uniaxial loading. The tests in this paper were performed for:

1. classical adhesive joint in order to investigate material parameters for numerical modelling of the hybrid joint
2. pure joining of the parts by a rivet
3. hybrid joining of the structural elements in order to investigate the reinforcement effect.

The experiments with application of digital image ARAMIS system allowed for on-line monitoring of the deformation process of the considered joining elements. The particular distributions of displacement fields at the joint surface were estimated for any stage of loading process. The size effect concerning the adhesion area was also investigated form mechanical point of view.

Numerical modelling

Numerical modelling was performed for experimentally investigated specimens. The materials parameters, necessary for calculation, were estimated from experiments. FEA modelling was done with the help of ABAQUS code. The exemplary results were

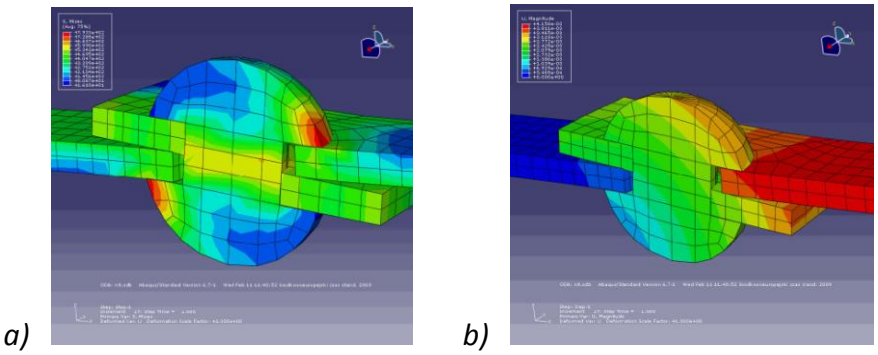

Fig. 1 Final failure of the joint just before the final failure

presented in the Fig. 1. Fig. 1a illustrates the Huber – von Mises stresses distribution in the joint parts, whereas Fig. 1b presents displacements field in the joining parts.

The results investigated within the paper lead to the following major conclusions:

The strengthening of joints by addition of rivets significantly improve static strength

The final failure of the joined structural system significantly depends on the surface adhesive area

The stiffening effects of the hybrid joint lead to higher reliability and durability of the structural system

References

[1] A.V. Pocius, Adhesion and adhesives technology. Ney York: Hasner (1997).

[2] R.D.Adams, W.C.Wake, Structural adhesive joints in engineering. London/New York, Publishers (1986).

[3] B.Irning, Applications widen for structural adhesives in metal bonding, Weld J (1994).

[4] S. Gómez, J. Onoro, and J. Pecharroman, Int. J. Adh.&Adhesives, 27, 263 (2007).

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ACEX096

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Ceramic Metal Adhesive Joints for High Temperature Aerospace Applications

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Aerospace applications require the use of high performance materials to successfully handle the demanding environments encountered. Extreme temperatures (up to 1000ºC) and stresses are common and present a great technical challenge. Heat shielding is one of these critical components in aerospace design, as it requires extremely reliable performance and high damage resistance, always coupled with low structural weight. Bonded adhesives joints are already used for these components, but we believe that their advantages can be further explored and to achieve even lower weight and better damage resistance.

This work focuses on the development and study of an adhesive joint configuration optimized for handling high temperature loads. The studied joints are composed of a ceramic tile, an adhesive layer and a metallic substrate. This is intended to simulate a commonly used heat shield configuration. The main variables in this configuration are the ceramic tile geometry and configuration, the adhesive layer geometry and the adhesives used. The combination of different types of adhesives allows the simultaneous exploration of the advantages of adhesives with very diverse mechanical properties and temperature resistance. Practical advantages of this configuration are improved joint resistance in large thermal amplitude and better distribution of loads caused by thermal expansion. Study and optimization of these configurations is performed with the help of finite element models.
An experimental setup was also devised to acquire valuable data, namely temperature distributions, thermal deformations and final joint resistance. The experimental setup also mimics actual heat shield geometry. High temperatures can be applied to the head shield while mechanical loads can be applied to the mechanical substrate. An instrumentation cluster measures and registers various data points. This data is then used to improve the finite element models. The experimental setup is also valuable to adjust and modify the more practical aspects of the shield configuration.

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ACEX097
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Determination of the Envelopes for Mode-Mixity Evaluation for Adhesive Systems

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Introduction

This study is about the effect of the adhesive thickness and adhesive ductility on the mixed mode loading of Double Cantilever Beam joints. The project is divided into three main tasks. The first task is about the development of a finite element model using a cohesive zone model to design an experimental device based on the standard ASTM D6671D. The second task is concerned with the generation of experimental results in mixed mode varying the type of adhesive and the adhesive thickness. In the third task, the experimental results will be used to develop an adhesive toughness model as a function of the mode mixity. The work presented here reports the testing using the dual actuator load frame from Virginia Tech's Engineering Science & Mechanics Dept.

Dual actuator load frame

The development of a dual-actuator load frame [1] has facilitated tests evaluating the mixed-mode fracture behavior of adhesively bonded joints. The experiments focused on evaluating the critical strain energy release rate that characterizes mode I, mode II and mixed-mode I/II fracture of different material systems. The dual-actuator load frame permits the use of standard double cantilever beam specimens over the full range of mode mixities. The precracked ends of the specimen were connected to the grips of the two actuators and the other end of the specimen was clamped at the base. By simultaneously applying different displacement rates with the two independently controlled actuators, different levels of mode-mixity were obtained at the locus of failure.

Samples for experimental evaluation

The DCB specimens that were used in the tests were obtained with two 2311 steel beams sandblasted before applying the adhesive, which was two epoxy-based products, and a Polyurethane .

The values for the energy release rate for each adhesive resulting from the DCB experimental testing are shown in table 1.

Table1. Energy release rate values for the three adhesives.

		Average	Deviation
Arladite AV138M with HV998 hardener	J_{Ic} [N/m]	345,9	47,8
Araldite 2015	J_{Ic} [N/m]	525,7	80,8
Sikaflex-255 FX	J_{Ic} [N/m]	2901,1	121,9

The 0.2 mm, 0.5mm and 1mm thickness of the adhesive layer was approximately controlled with the insertion of skims at the two ends of the sample. A razor blade skim was used to promote the crack initiation.

Analytical evaluation

The tests are conducted with symmetric DCB specimens and asymmetric displacement rates. Applied displacements result in a combination of pure mode I and pure mode II loading. The forces exerted on the two beams are measured by load cells attached to each actuator and the fracture components are calculated with the following:

$$F_I = (F_R + F_L)/2$$
$$F_{II} = (F_R - F_L)/2 \qquad 1$$

where FR and FL are the forces measured by the two load cell. The two values of the SERR are calculated with the following equations.

$$\mathcal{G}_I = \frac{F_I^2 a^2}{EIb}$$
$$\mathcal{G}_{II} = \frac{3F_{II}^2 a^2}{4EIb} \qquad \mathbf{2}$$

where b is the width of the bond, I and E are the moment of inertia and the elastic modulus of the adherends, respectively, and a is the crack length. FI and FII refer to the imposed force in mode I and II. The global mode mixity is then indicated with the angle Ψ.

$$\Psi = ArcTan\left(\sqrt{\frac{G_{II}}{G_I}}\right) \qquad \mathbf{3}$$

The tests were run, imposing two displacement rates with the actuators, in order to cover different mode mixity levels. During the tests the values of the imposed displacements, the forces at the actuators and the crack length were monitored and recorded. An interesting observation is that for almost all the tests, excluding those in pure modes or SLB configuration, the value of Ψ increases as the test progresses and the crack grows. This trend is expected from the analytical evaluation of the failure process. The value of Ψ is not uniquely set by the displacement rates imposed at the beams, but is affected by crack length and increases for growing crack length.

Conclusions

The study focused on the mode mixity that results from the superposition of fracture modes I and II. The tests were performed on DCB specimens using a dual actuator load frame. The specimens consisted steel beams bonded with epoxy-based adhesive and polyurethane. The dual-actuator load frame is a testing machine that permits to characterize thoroughly the mixed mode fractures just carrying tests on DCB specimens constructed with symmetric beams. This aspect simplifies the phase of specimen construction.

The aim of this undergoing project is the development of fracture envelopes for different adhesives and thicknesses. These envelopes can be useful in designing adhesive joints and contributing to design a mixed mode bending test apparatus based on the Reeder Crews MMB delamination apparatus [2].

Acknowledgments

The authors would like to thank the contribution of Edoardo Nicoli, for his work in experimental testing at Virginia Tech. The authors also acknowledge the financial support of Fundação Luso Americana para o Desenvolvimento (FLAD) through project 314/06, 2007 and IDMEC.

References

Hitendra K. Singh, Soojae Park, DonOhanehi and David A. Dillard, "ADesign Space for a Novel Dual-Actuator Mixed-Mode Test Frame",Proceedings of the 29th AnnualAdhesion Society Meeting, Jacksonville,FL, 2006.

Reeder JR, Crews JH, AAIJ 1990;28(7):1270-6

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ACEX098
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Control of Adhesion Properties of Polymers by Surface Roughness Modification

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Most of polymeric materials, particularly polyolefins and derivatives, present a low surface energy which is the cause of their low wettability and limits processes such as adhesive bonding, painting or metalizing. Many methods have been developed and used to modify polymer surfaces for improved adhesion, including mechanical treatments, wet-chemical treatments with strong acids or bases, exposure to flames or corona discharge.
In this paper we study the improvement of adhesion properties of several polymeric materials (high and low density polyethylene, polypropylene and silicone) by means of surface roughness modification using abrasive papers of different grain size (80, 180 and 1000) and cleaning the materials with methyl ethyl ketone (MEK) in order to obtain a variation of their surface energy. We measure the surface roughness using a HOMMEL TESTER T8000 device equipped with a diamond stylus which provides measurements of arithmetic mean roughness Ra, (DIN 4768).
The total surface energy of polymers and their polar and dispersive fractions are estimated through contact angle measurements using six different liquids (diiodomethane, ethylene glycol, glycerol, nitromethane, 1,5-pentanodiol and water) and the variation of surface energy data are analized using the Owens-Wendt-Rabel- Kaelble (OWRK) calculus method. We find a non-linear relationship between roughness, grain size of the abrasive papers used and the polymeric surface energy.
Additionally, we perform measurements of static friction coefficient by the standard method UNE-EN 14713 and make a comparison with those obtained in metallic materials (steel, aluminium and brass).

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ACEX099

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Evaluation and Identification of Damage Models for the Finite Element Simulation of Structural Adhesives

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Using structural adhesives as a complementary or an alternative solution to spot welding, riveting or clinching is now a well established fact in the automotive industry. During the design phase of a vehicle this implies to be able to accurately predict the behaviour of structural adhesives using finite element simulation. This task is impossible using classical material constitutive models [1]. Indeed, the choice of a model describing the behaviour of structural adhesive up to their complete failure is driven by several considerations such as the capability of the model to describe their complex behaviour that depends on pressure and loading path. The need to reduce design and computation time is also a crucial issue. An additional requirement lies in the identification of material parameters ruling the behaviour of the adhesive.

Many tests such as double cantilever beam, end-notched flexure, thick or modified thick-lap shear [2], hollow butt-bonded cylinder and other specimens combining tension and shear loads are devoted to this task and it is not obvious to a priori state if some of them best suits for parameter identification in terms of operating time and resulting simulation accuracy.

This paper aims to compare a coupled elasto-plastic damage model implemented in a User Material Subroutine with an interface traction-separation elastic-damage model available under Abaqus for the simulation of the structural adhesive SikaPower-490. The potential of several experimental tests will be evaluated and compared for the identification and validation of relative material parameters.

[1] P.Jousset, M. Rachik and S. Koch, Adhäsion Kleben & Dichten, 03, (2008).
[2] J.Y.Cognard, R.Créac'hcadec and L.Sohier, Trends in Computational Structures Technology, p.223-246, Eds B.H.V Topping and M. Papadrakakis (Saxe-Coburg Publications 2008)

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Study of epoxy adhesive solutions for a ceramic effort sensor on a steel ball bearing

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In order to enhance today's car active safety standard, the automotive manufacturer SNR industry is seeking to get real time measurement of the tyres – road efforts thanks to a sensor bonded to the wheels ball-bearings. This PhD research work aimed to provide a reliable industrial bonding solution for a ceramic sensor on conventional ball bearing steel using structural adhesive. This industrial joint shall withstand a wide range of temperatures with pretty brutal thermal changes and also severe humidity conditions.

The first part of this paper deals with the adhesive formulation influence on the initial thermomechanical properties of five products based on DGEBA, Novolac and mixture of both [1]. These adhesive shall be manufactured to ensure a compromise between a structural bonding and to be soft enough to resist the thermal stresses. Depending on those formulations, we observed different behaviours in term of glass transition temperature, cross-linking time and flexibility.

In a second time, the formulations parameters and curing process influences on the assembly integrity are quantified by adherence tests. When thinking about durability and lifetime estimation of adhesive-bonded assemblies, the biggest concern lies on interface strength and degradation. Searching for a mechanical test leading to 100% interfacial failures leads us to use the "crown test" [2] for steel/adhesive interface and flexure test to ceramic/adhesive one after some modifications and adjustments of dimensions have been performed by finite elements analyses.

[1] M.A. Boyle, C.J. Martin, J.D. Neuner ; Epoxy Resins ASM Handbook 21,78 (2001)
[2] B Hassoune-Rhabbour., V Nassiet., Y Baziard., J. A Petit., Euradh'2004, Breisgau- Germany, 593 (2004)

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Fracture Behavior of a Typical Adhesive Joint in a Car Body under Static Loading

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Although the adhesive bonds are of great importance for joining the body skin to the main car structure, they are normally modeled as no-failure elastic or elastoplastic materials in numerical simulations. The difficulty mainly comes from two facts, (1) the singularity, material non-linearity and high gradient in adhesive stress field requires a complex fracture mechanics approach for modeling the adhesive joint behaviour, and (2) due to geometric disparity, the thin adhesive layer needed a very fine mesh comparing to the other parts in the car structure model. In order to evaluate a more realistic behaviour of adhesive joints, a post-processing work has been developed here on the basis of a pre-existing GM car structure model. First, a sub-model including the adhesive joint was extracted from the original model and the adherends were remodelled in LS-DYNA as shell elements after a mesh refinement of 4.0 ´ 4.0 mm. An adhesive layer with a constant thickness of 0.4 mm was then inserted between the parts in the form of solid elements (0.1 ´ 1.0 ´ 1.0 mm). The nodal displacements of adherends were then determined by interpolating from the original mesh for the particular loading case. In the new sub-model, an elastic behaviour was considered for the adherends while an isotropic elastoplastic model represented the adhesive mechanical characterization. The implicit solver of LS-DYNA was used to determine the adhesive stress field and nodal forces produced from the new nodal displacements. The strain energy release rate (G) in adhesive layer was determined from the results by using a virtual crack closure technique. The maximum calculated value of G was about 200 J/m2 for the particular loading case of this study that was lower than the measured critical value Gc for the toughened heat-cured epoxy adhesive but comparable to fatigue Gth. The validity of results was also verified by performing similar analysis on the standard double-cantilever-beam joint after comparing the results with available experimental data.

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ACEX122
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Comparison of Shear Strength Tests on Epoxy -Joined Ceramic Component (and CMCs)

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Many ceramic materials possess properties that make them desirable for specialized applications; fabrication, however, of components with complex shapes is difficult and costly.
Therefore, there is a need for satisfactory methods for joining ceramic components (or ceramic composites) together or to components made from dissimilar materials. Since joined structures should be designed to be loaded in shear stresses, the main test configuration is the shear type. Unfortunately, shear tests have several drawbacks: it is very difficult to have pure shear stress without other components of stress, and it is almost impossible to have a homogeneous shear stress distribution. In this paper a large number of different testing solutions are examined.
Each sample (carbon/carbon composites (C/C) or advanced ceramic (Al2O3 , SiC)) was joined by an adhesive epoxy resin (Araldite AV 119) with a well known behavior: the adhesive is not to be considered as a suitable joining material for high temperature applications, but to be a generic fast joining "tool/device" to obtain a large number of joined samples in reasonable time. In fact an experimental approach to this problem requires a statistically relevant number of tests. Results have been compared and critically discussed in order to define advantages and disadvantages of each test. Weibull distribution is being used to model extreme values such as fracture strength in these shear tests configuration.

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ACEX125
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Hybrid Bonding of Advanced High Strength Steels in the Lightweight Body Shell Design for the Automobile Manufacturing

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In the lightweight body shell mass production of automobiles, the application of hybrid bonding techniques become more and more important in the future. One of these hybrid bonding techniques is the combination of adhesive bonding and resistance spot welding called weldbonding. The target of the contribution is to show the influence of high-viscosity and low-viscosity structural adhesives on the process reliability of the weldbonding process and the mechanical properties of the hybrid bonded joints [1]. The given results are based on the application of a polyurethane-based, an epoxy-based and a rubber-based adhesive system for joining a mild and some different advanced high strength steels (AHSS) [2]. It will be shown that both the process reliability of the hybrid bonding process and the mechanical behavior of the hybrid bonded joints are influenced by the combinations of the base metals, the applied adhesive systems and the choice of the joining parameters. The behaviour of the weldbonded joints will be studied under quasi-static and impact loads. The discussion of the metallurgical structure of the weldbonded joints depending on the joining parameters will be given, too.

Furthermore, the fatigue behaviour of the weldbonded joints will be studied.

[1] H. Cramer, T. Bschorr, O. Hahn, H. Thommes, and F. Zech, Final Report for FOSTANo. P704/10, AiF-No.14476N (Forschungsvereinigung Stahlanwendung e. V., Düsseldorf, 2009)
[2] G. Weber and S. Göklü, Welding in the World Journal of the International Institute of Welding (IIW), Vol. 50, No. 3/4, pp. 3-12 (2006)

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ACEX129
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Environmental-Fatigue Damage Model for Adhesively Bonded Laminated Joints

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Adhesively bonded structures are in many cases subjected to aggressive environments along with cyclic loading conditions. The fatigue damage accumulation in these adhesive structures will be accelerated considerably by the aggressive environmental conditions. In this current research, the combined moisture-fatigue damage in adhesively bonded laminated joints is investigated. A cohesive zone approach is employed to model the adhesive behaviour with a traction-separation response. Using a coupled diffusion-stress analysis, the combined degradation of the adhesive material under environmental conditioning and cyclic stresses is modelled. A normalised moisture-based damage criterion is employed for the adhesive material degradation due to environmental conditioning, and a strain-based damage parameter is used to model the degradation under cyclic stresses. The combined environmental-fatigue damage model is implemented in Abaqus/Standard using a user-subroutine. Fatigue tests are performed on two joint configurations: (a) a laminated doubler in bending and (b) a laminated single lap joint. The laminated joints consist of a monolithic aluminium substrate and a laminate that is manufactured by bonding aluminium laminae. An aerospace film adhesive is used for bonding the monolithic substrate to the laminate. The same adhesive is also used to manufacture the bonded aluminium laminate. The joints are exposed to de-ionised water at 50oC and fatigue tests are conducted for different withdrawals. The tests are performed at different load levels and S-N curves are obtained. The back-face strain measurement and the in-situ video microscopy techniques are employed to monitor the fatigue damage initiation and propagation under the different conditions. The measured degradation in fatigue performance with increased environmental conditioning is successfully predicted by the combined environmental fatigue-damage modelling.

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ACEX134
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Bonding and Disbonding Characteristics of Impregnated Laminated Veneer Lumbers Exposed to See Water

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The use of wooden composite materials is increasing gradually. One of these composite materials is Laminated Veneer Lumber. Main purpose of this research is to determine the resistance characteristics of laminated veneer lumbers both impregnated and bonded with different adhesives. For this purpose, Scotch pine wood was used. For the impregnation process, the mixture of protim-paraffin, Tanalith-c (CCA) and creosote were used.

In the used Laminated Veneer Lumber, PVAc-D4, phenol formaldehyde and D-VTKA adhesives which were resistant to water were used. The retention amount of impregnated samples and the density of control and Laminated Veneer Lumbers were determined. Control and impregnated samples were exposed to water in Amasra district of Bartın for 3, 6, 9 and 12 months relatively. Afterwards, the density and the tangential pressure strength of the samples exposed to water for 3, 6, 9 and 12 months and not exposed to water was determined.

The highest tangential pressure strength of 39.56 N/mm2 was obtained with the scotch pine samples which were unimpregnated and not exposed to water, and the lowest tangential pressure strength of 5.24 N/mm2 was obtained with the scotch pine samples which were unimpregnated and exposed to water for 12 months.

Consequently, it is said that the use of impregnated LVLs increases their resistance against the marine fungus. Substances as Protim-paraffin impregnation against sea water has provided the highest protection. Adhesives for the delivery of D-VTKA has the highest pressure. Examples of laminated veneer lumber resistance were higher than the examples massive. Duration of all instances as the resistance was observed in the fall.

[1] Winandy, J. E., Wood Properties, Encyclopedia of Agricultural Science. Orlando, FL: Academic Press: 549-561. Vol. 4. October (1994)
[2] Skaar, C., “Wood-Water Relationships”, The Chemistryof Solid Wood, 127-172, New York,(1983).
[3] Simpson, W., TenWolde, A., Physical Properties and Moisture Relations of Wood, Wood handbook, chapter 3, Madison, (1999).
[4] Bozkurt, Y., “Ağaç Teknolojisi”, İ. Ü., Orman Fakültesi, Yayın No: 3403- 380, İstanbul, (1986)
[5] Blomquist, R.F., Ed. “Adhesive Bonding of Wood and Other Structural Materials”, Educational Module for Materials Science and Engineering (EMMSE), The Pennsylvania State University, University Park, PA,(1983).
[6] “Adhesive Bonding of Wood”, Technical Bull. No. 1512, U.S Department of Agriculture, Forest Service, (1975).
[7] Örs, Y,. Özçifçi, A. and Atar, M., “Klebit 303, Kleıberit 305.0 ve Süper Lackleim 308 Tutkallarının Yapısma Dirençleri”, Turk J Agric For 23 (3): 757–761 (1999).
[8] Badwin, R. F., “Plywood and Veneer-Based Products: Manufacturing Practices”, Miller Freeman Inc., San Francisco.
[9] Colak, S. Aydın, I. Demirkır, C. and Colakoğlu, G., “Some Technological Properties of Laminated Veneer Lumber Manufactured from Pine (Pinus sylvestris L.) Veneers with Melamine Added- UF Resins”, Turk J Agric For 28 (1):109-113 (2004)
[10] Vick,C.B. and Okkonen, E, A., “Strength and Durability of one-part Polyurethane Adhesive Bonds to Wood”. Forest Products Society Member. Forest Products Society (1998). Forest Prod. J. 48(11/12):71-76.
[11] Uysal, B., “Influence of Pretreatment on Shear Strength of Various Wood Species”.J. Apply Polym. SCI. 100: 245-252, (2006).
[12] TS 3891. Adhesives polyvinyl acetate emulsion (For Wood), Ankara,(1983).
[13] Producer Firm Text, Polisan Dilovası-Gebze, Bolu, Turkey (1999).
[14] TS 2472 Wood - Determination of Density for Physical and Mechanical Tests, Ankara, (1976).
[15] TS 6956 EN ISO 4287, Geometrical product specifications (GPS) - Surface texture: Profile method - Terms, definitions and surface texture parameters, Ankara, (2004).
[16] BS EN204. Non-structural adhesives for joining of wood and derived timber products. BS (British Standards), England, (1991).
[17] ASTM D 1413– 6, Standard Test Method of Testing Wood Preservatives By Laboratory Soil Block Cultures, Annual Book of ASTM Standards, 452-460, (1976).
[18] TS 5430 EN 204 Classification of Adhesives According to Bond Strength Used At Wood Industries, Ankara, (2003).

[19] TS 4086 Wood- Determination of Volumetric, Ankara, (1981).
[20] TS 4084 Wood- Determination of Radial and Tangential Swelling, Ankara, (1983).
[21] Rowell, R. M., "Chemistry of Solid Wood", Advances in Chemistry Series No.207, American Chemical Society, Washington, DC, (1984).
[22] Ottosen, L.M., Kristensen, I.V. Electrochemical reuse of CCA from wood. Report, BYG.DTU, Technical University of Denmark, (2002).
[23] Vick, C. B., "Adhesive Bonding of Wood Materials" Wood Handbook, Chapter 9, (1994).
[24] Kurt, Ş., Change of Some Technological Characteristics of Impregnated Laminated Veneer Lumbers (LVL) In Sea Water, PhD Thesis, Zonguldak Karaelmas University, Turkey, (2006).

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The Effects of Aging on the Thermal Resistance of Adhesive

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In this study, the level of destroying that the thermal aging will form over the bonding strength of adhesives and the time that the destroying forms have been determined based on the types of adhesives. As wood material, the mostly preferred Oak (Quercus petreae L) wood, and as adhesives, PVAc, Desmodur-VTKA (D-VTKA), Phenol Formaldehyde (PF), Melamine Formaldehyde (MF) and Urea Formaldehyde (UF) adhesives have been used. Sample patterns have been formed based on the standards of BS EN 205, adhesive resistances of samples which were tested in terms their thermal aging characteristics with the periods of 30, 60, 90 days and control, at 40, 60 ve 80 °C conditions based on the standards of ASTM - D1183 – 3 have been determined.

Thermal aging is not subject to sessile oak the waiting times, types of glue and control group comparisons end of may the total time D-VTKA glue in 14%, PVAc glue in 16 % of PF glue 8 %, UF glue and 4 % in the MF glue 6 % in adhesion resistance loss has been identified. Consequently, at high temperatures PF adhesive can be advised as the building material used for long terms.

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ACEX137
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Parametric and Robust Analysis Affecting Peel Strength Between Flexible Circuit and Stiffener

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The CNN206 is one type of flexible circuit products in hard disk drive manufacturing. This product has been produced more than 25 million units per year and the peel strength between flexible circuit and stiffener is a key critical to quality for customers. Since the flexible circuit is moving during reading and writing data in hard disks. The products fail to meet the specification of this quality characteristic cause the hard disk damage. Therefore the objective of this research is to analyze and control factors affecting peel strength between flexible circuit and stiffener on the CNN flexible circuit products. Analysis was conducted using Design of Experiments [1] and Six Sigma approaches [2]. It is difficult to control and predict peel strength due to the fact that there are up to 31 individual processes involved in flexible circuit manufacturing, and each process consists of many process input variables that may affect peel strength [3]. After reviewing a variety of literature – flexible circuit manufacturing journals, and academic textbooks– the potential processes that might be affected to peel strength are the processes relating to polyimide surface preparation (laser/aqueous cleaning, panel cleaning, plasma cleaning, and OSP coating processess) and stiffener lamination (adhesive lay-up, fast lamination, aqueous cleaning,and post baking ,and outgassing baking processess). The data analysis of lower peeling strength products showed that all of defective products caused by adhesion failure between the polyamide surface and glue surface. Therefore the potential processes that contributed to peel strength can be narrowed to four processes which are directly related to polyimide surface preparation. They are: (1) laser/aqueous cleaning; (2) panel cleaning; (3) plasma cleaning; and (4) OSP coating. Using a 24 full factorial design (with+, and without- the process) analyzing these key processes, it was found that the panel cleaning process does not significantly affect peel strength. Further analysis was carried out on the remaining three processes with 48 process input variables by using Six Sigma tools such as the cause and effect (C&E) matrix, failure modes and effects analysis (FMEA), and one-way ANOVA hypothesis testing. These analyses were able to screen out the process input variables down to six parameters. In order to find the top three significant parameters, a 26 Design of Experiments analysis was performed for the second variable screening. The resulting three significant parameters were: plasma time; plasma prebake temperature; and ultrasonic time. This information led to the creation of a transfer function using central composite design (CCD), which improved the peel strength from 14.77 lbs/in to 16.64 lbs/in. This was achieved by decreasing the plasma prebake temperature from 250 °F to 210 °F; fixing the ultrasonic time at 30 s; and fixing the plasma time at 12 min. This experiment was also able to estimate the key process parameter tolerance, which gave a robust region for peel strength: ultrasonic and plasma times between 20 to 30 s, and 10 to 15 min, respectively; and the plasma prebake temperature fixed at 210 °F.

[1] Douglas C. Montgomery, Design and Analysis of Experiments, 5th ed., John Wiley & Sons (2001).
[2] Forrest W. Breyfogel III, Implementing Six Sigma, John Wiley & Sons (1999).
[3] Deepak Chichili, Roger Bossert and Jeff Brandt, Investigation of the Bond Strength of Polyimide Adhesive [Online] Available at : http://tdserver1.fnal.gov/tdlibry/TD-Notes/1998%20Tech%20Notes/TD-98-004.doc (1 August 2007).

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ACEX143

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Strength Recovery in Epoxy Adhesive Joints under Cyclic Moisture Conditioning Environment

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This paper presents a study of the strength degradation and recovery in single lap joints after moisture absorption and desorption. The diffusion characteristics of the epoxy adhesive were determined by gravimetric experiments for an absorption-desorption cycle. Non-Fickian moisture absorption was observed during absorption, whereas, moisture desorption could be represented by Fickian diffusion. Single lap joints, manufactured with aluminium adherends, were conditioned in water at 50°C and 70°C and tensile testing was carried out on half of the joints to determine the effect of moisture on the joint strength. The remaining half of the joints were dried and then tested.
The results of the tensile tests showed a decrease in the joint strength after conditioning followed by a high degree of recovery after drying. This was investigated by analysing the failure mode of the joints by microscopy and digital image analysis. High resolution digitised failure surface images were processed to determine the ratios of cohesive and interfacial failure. The moisture concentration in the joints was determined by the finite element method using a dual Fickian model for the conditioned joints and Fickian diffusion model for the dried joints and a comparison with the failure surfaces was carried out. The analysis revealed differences in failure modes in the conditioned and dried joints and a good correlation between the failure strength and the percentage of cohesive failure.

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ACEX144

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Failure analysis of bonded t-peel joints: efficient modelling by standard finite elements with experimental validation

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The paper describes an efficient procedure, based on standard finite element techniques, for the failure analysis of bonded structures. The work assesses the accuracy of the proposed method in the prediction of the elastic and post-elastic response of bonded T-peel joints by applying a singularity-free stress failure criterion.
The proposed method relies on standard modelling tools and regular finite elements, routinely supported by most commercial packages. The method describes the adherends by semi-structural elements (plates or shells), the adhesive by means of a single layer of solid elements, and applies internal kinematic constraints to reproduce the structural continuity. A previous work published by the authors [1] demonstrated the efficiency and the accuracy of this reduced model in calculating the elastic stress for many 2D and 3D geometries. Subsequently, the authors extended the method to the post-elastic field by adopting the simple failure criterion based on singularityfree peak stresses proposed in [2] and obtaining encouraging results [3].
Benchmark for the model is the load-deflection curves obtained by an ad-hoc experimental campaign on T-peel joints. The test campaign was developed using Design of Experiment criteria, which ensure a good reliability of the results. The accuracy of the model appears satisfactory with respect to the experimental results, both in terms of maximum force and post elastic behaviour. The Von Mises based failure criterion adopted appears consistent and the CPU time needed for the analysis is minimum thus corroborating this efficient procedure for the analysis of very complex structures.

[1] D. Castagnetti and E. Dragoni, Int. J. Adhes. Adhes., doi: 10.1016 / j.ijadhadh. (2008).
[2] L. Goglio, M. Rossetto and E. Dragoni , Int. J. Adhesion Adhesives, 28, 7, 427 (2008).
[3] D. Castagnetti, E. Dragoni, A. Spaggiari, "Efficient Post-Elastic Analysis of Bonded Joints by Standard Finite Element Techniques", Accepted for publication on JAST, (2009).

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Damage Modelling of Adhesively Bonded Joints Subjected to Fatigue Loading at Different Load Ratios

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In this research, the mechanical behaviour of adhesively bonded joints under fatigue loading has been studied and predicted using finite element modelling. A mixed-mode bi-linear traction-separation description of the cohesive zone model has been employed to simulate progressive damage in the adhesive bond line. Moreover, a strain-based fatigue damage model has been integrated with the cohesive zone model to simulate adhesive degradation due to fatigue loading. The developed model was capable of accommodating fatigue loading parameters such as the mean load and the load ratio. The model has been validated against experimental data obtained from fatigue testing steel lap joints manufactured using a 1 part heat cured epoxy pasted adhesive at three different load ratios. The correlation between the experimental and predicted fatigue lives was very good.

Further validation has been made using aluminium lap joints in tension and laminated doublers in bending, both bonded with the same aerospace film adhesive. Using two different joints with the same bonding system provides significantly different states of stress in the loaded adhesive. Fatigue testing has been carried out at various load levels and load ratios on these joints. The laminated doubler in bending was taken directly from a much larger stiffened panel. The fatigue model was implemented for the two adhesively bonded joints. The backface strain technique as a localised damage assessment was utilised to examine the evolving damage during the fatigue testing and validate the methodology. Furthermore, video microscopy images were used as supporting evidence of damage evolution and the backface strain technique.

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Dynamic Study of Adhesively Bonded Single and Double Lap Joints

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Composite structures in many transportation applications may be subjected to moderately high speed loads. Hence, the dynamic behavior of composite joints needs investigation. In this work, we were concerned by studying the dynamic behavior of composite materials and adhesively bounded single and double lap joints, under moderately high rates and also by their numerical modeling.

Adhesive bonding performances, led this technique to gain a wide use for composite assembling in transport construction. In such application, the structures are subjected to dynamic and high speed loads. Therefore the rate dependent behavior of these materials needs to be investigated. Several methods were successfully applied to investigate the rate dependent behavior of adhesive polymers and composites based polymeric matrix [1-4]. But more investigations are required on the dynamic material behaviors and the experimental methods. On the other hand, the dynamic behavior of composite assemblies remains few investigated, whereas the failure of composite structures occurs generally within their assembly area.

It is on the aims of this present work to improve the knowledge about the adhesively bonded composites behavior under different loading rates and building F.E. models capable to predict their strength with accuracy. The rate-dependent behaviors of adhesive joints and composites have been experimentally investigated using a moderately high speed tests. Then a composite double lap joint specimens (D.L.J.) and aluminum D.L.J. were tested under quasistatic and dynamic tension. In addition, this work is concerned by the modeling of the rate-dependent damageable behavior of the concerned materials and their F.E. implementation. Thus, a rate dependent damageable cohesive element was then implemented in ABAQUS explicit using a VUEL and was employed to model the failure of the bonded area.

[1] J. Fitoussi, F. Meraghni, Z. Jendli, G. Hug and D. Baptiste, Compos. Sci. Technol., 65, p.2174 (2005).
[2] M. Tarfaoui, S. Choukri and A. Neme, Compos. Sci. Technol., 68 (2), p.477 (2008).
[3] L. Goglio, L. Peroni, M. Peroni, M. Rossetto, Int. J. Adhes. Adhes., 28 (7) , p.329 (2008).
[4] X. Xiao, Polym. Test, 27 (2), p.164, (2008).

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ACEX158
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Repair of Wood Trusses Loaded in Tension with Adhesively-Bonded Carbon-Epoxy Patches

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Wood and wood products are amongst the most important construction materials. Wood is generally used in frames, buildings, truss roof structures in buildings, bridges, towers, railroad infrastructures and many more applications. Damage and failure behaviour of wood members in tensile, compressive or shear loading must be taken into account in wooden structures subjected to high working stresses. Wood strength depends on the external loads, causing different stress states, and grain orientation. Wood exhibits its greatest strength in tension parallel to the grain, and a few applications load a wood member in pure tension, such as trusses in the most varied applications. For a safe design, predictive methods and models for the simulation of structural behaviour are required. One of the possible approaches is

the Finite Element Method. In this work, the tensile strength of repairs on wood members in pure tension is addressed experimentally and numerically, using carbon-epoxy patches. The repair consists of the replacement of the wood damaged portion and reinforcement with carbon-epoxy plates bonded at two opposite faces. A parametric analysis was carried out on the overlap length between the composite reinforcement and the undamaged part of the beam. The numerical analysis used the Finite Element Method and Cohesive Zone Modelling to simulate damage initiation and propagation in different materials. Trapezoidal cohesive laws in pure modes I and II were used to represent the ductility of the adhesive used. As to the experimental failures, damage propagation in the wood beam was also simulated. The comparative analysis of the test results and the simulations showed a good correlation between them.

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Local Stress Analysis of the Fatigue Behaviour of Adhesively Bonded Thick Composite Laminates

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Results of fatigue tests on adhesive lap joints of thick (10 mm) composite laminates are presented and discussed. Specimens of different overlap length (from 25 to 110 mm), different shape (with and without taper) and different materials (composite on composite, composite on steel) were fatigue tested and distinct fatigue curves were obtained in terms of maximum applied force and number of cycles to failure. In order to investigate on the relationship between peak elastic stresses in the adhesive layer and fatigue life, a 2D structural analysis of the joints by the finite element method was performed. The analysis, inspired to the approach proposed in [1] for static strength, evidenced a close relationship between the peak elastic stresses and the number of cycle to failure, as all experimental points in terms of peak Tresca stress and number of cycles to failure collapsed within a band of relatively low scatter, irrespective of the shape of the joint and the overlap length. This behaviour, similar to that obtained by applying the N-SIF concept in [2], suggested that peak elastic stresses in the adhesive layer could be adopted as a design criterion, at least as an engineering tool for industrial applications.

In order for this method to be applied to the design of real components made of thick composite laminates, the sensitivity of the model results to the type of finite elements (2D or 3D, solid or shell), to the mesh grid dimensions and to the type of elements used to model the adhesive layer (solid or cohesive) was investigated and results compared with those obtained with those obtained with the 2D models. The limitation of the proposed approach with reference to the role of crack propagation are also discussed.

[1] L. Goglio, M. Rossetto and E. Dragoni. Int J of Adhesion & Adhesives 28, 427, (2008)
[2] M. Quaresimin, M. Ricotta. Int. J. of Fatigue 28, 1166, (2006)

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ACEX163

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Parameter Determination of Mixed-Mode Cohesive Zone Model for Co-Cured SLB Joint Using Design of Experiment Techniques

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Because the behaviour of the adhesive joints could be different by adhesive properties and interface characteristics, so various modeling methods have been proposed to simulate adhesive joints. In these previous methods, a cohesive zone model, which consists of a cohesive zone instead of an adhesive layer, is widely used to simulate the behaviour of the adhesive joints. Cohesive parameters of the traction-separation law should be obtained to use the cohesive zone model. It is known that cohesive parameters are affected by adhesive properties and interface characteristics, so in most cases, these parameters are iteratively obtained by matching numerical results to experimental results.
In this paper, systematic method is proposed to obtain cohesive parameters using optimization technique based on a design of experiment and metamodels. In order to perform the design of experiment, appropriate sampling points are selected. Then a difference between numerical and experimental load-displacement results is defined as an error and metamodels such as response surface method and kriging are constructed to surrogate the error. Cohesive parameters are obtained by applying the numerical nonlinear optimization algorithm to minimize the error. The proposed method is applied to a mixed-mode single leg bending (SLB) joint to obtain cohesive parameters. From these parameters, the mixed-mode cohesive zone model is constructed and applied to the simulation of the SLB joint to compare with experimental results. It is shown that the cohesive zone model well described the behaviour of the SLB joint.

[1] M. Alfano, F. Furgiuele, A. Leonardi, C. Maletta and G.H. Paulino, Int. J. Fract., 155 (2008).
[2] S. Li, M.D. Thouless, A.M. Waas, J.A. Schroeder and P.D. Zavattieri, Eng. Fract. Mech., 73,
64 (2006)
[3] M.F.S.F. De Moura, J.P.M. Goncalves, J.A.G. Chousal and R.D.S.G. Campilho, Int. J. Adhes.
Adhes., 28, 419 (2008)

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Strength Estimation of Adhesively Bonded Tongue and Groove Joint of Thick Composite Materials using Genetic Algorithm Approach

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The bonding strength of adhesives is influenced by many factors such as, the length of bondline, bonding thickness, pre-stress on near the free edges of bond line and material of the joining parts, etc. Since the all these factors affect the strength of the adhesively joined parts, the effects of these parameters need to be investigated. The present paper describes the use of stochastic search process that is the basis of Genetic Algorithm (GA), in developing tensile strength estimation of adhesively bonded thick woven E-glass/vinyl ester laminates. Non-linear estimation models are developed using GA. Developed models are validated with experimental data.

Genetic Algorithm Tensile Strength Estimation Model (GATSEM) is developed to estimate the strength of the adhesively bonded joint. Selection of Steel S235JR insert materials and selection of Aluminum 5083 insert materials 1.7 times and 1.2 times increased the joint strength compared with the selection of composite insert materials, respectively. There is a 2.0 times increment on the joint strength by applying pre-stress on the edge of tongue and groove geometry. The joint strength can be significantly improved by selecting appropriate the design parameter values.

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Keywords: Thick composite materials, Bonded joint; Tensile strength, Genetic algorithm; Tongue and groove geometry.

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ACEX172

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Robust Shape Optimization of the Tubular Butt Joint for Characterizing Thin Adhesive Layers under Uniform Direct and Shear Stresses

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Measuring the mechanical properties of a thin adhesive layer subject to uniform stress distributions is an important test for predicting the adhesive behavior under working conditions. Thin-walled tubular joints, bonded end to end and subject to torsional loading, are commonly employed to characterize the adhesives under fairly uniform shear stress fields. Unfortunately, the application of an axial loading to the same geometry leads to a distribution of direct stresses in the adhesive with strong concentrations at the edges of the bondline [1]. These stress concentrations, caused by the different stiffness of adherends and adhesive, jeopardize the usefulness of this simple specimen for testing the adhesive under uniform direct stresses. This paper suggests a new geometry of the tubular butt joint characterized by a distribution of direct stresses under axial loading as regular as the shear stresses under torsional loading. To this aim, a groove on the internal and external surfaces of the adherends is introduced so as to increase the local compliance of the adherends close to the stress concentrations in the adhesive. The optimal shape of the groove is identified in two steps. As first a computational optimization is performed in order to define the qualitative features of the profile that best achieve the goal. In the second step the precise shape of the groove is established by means of robust design techniques

carried out using the Taguchi approach [2]. This second step involves the analysis of many geometries and adhesive properties to identify the single grove shape that best regularizes the stresses for most experimental conditions.
A preliminary computational optimization has shown that a circular groove near the adherendadhesive interface strongly limits the stress concentrations in the adhesive layer. With this modification, the tubular butt joint becomes a universal specimen for applying to thin adhesive layers any combination of uniform shear and direct stresses.

[1] R. D. Adams, W. C. Wake, Structural Adhesive Joints in Engineering, Elsevier, 1984.
[2] M.S. Phadke, Quality Engineering Using Robust Design, Prentice Hall, 1989.

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Design of a Solid Double Cup Specimen by the Dual Finite Element Method for Tensile Strength Test of Adhesives

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In previous researches [1] a double cup test probe [2,3] has been simulated using the finite element method for tensile strength testing of adhesive joints, studying the influence of the geometry of the specimen on the distribution of stress when it undergoes static tensile strength tests.
In this paper we introduce new variables in the model. The test piece is not a plate of homogeneous thickness, we simulate a solid specimen. Furthermore the test piece is pasted across its surface to the jaws of the testing machine using a rigid adhesive. We find that de stress distribution on the double cup adhesive joint is more homogeneous and the tangential stresses are minimized.

References

[1] M.A. Martínez,, P Muñoz, J. Abenojar, F. Velasco. Optimizing the design of a double-cup specimen through finite element methods, for tensile test of adhesives.J. Adh Sci Tech, (in press)
[2] D. Gieske, O. Hahn. Ermittlung mechanischer Kennwerte von Durchsetzfügeelementen. Conference Proceedings. Wärmearme Fügetechniken Paderborn (1993) 24-25
[3] D. Radaj, A. Giering. Local stress parameters of the spot welded specimen. Welding in the World. 35, 1 (1995) 12-22

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ACEX179
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Adhesively-Bonded Repair Proposal for Wood Members Damaged by Horizontal Shear Using Carbon-Epoxy Patches

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In this work, an adhesively-bonded repair technique is proposed for wood members damaged by horizontal shear and under bending loads, using carbon-epoxy patches. Horizontal-shear is characterized by crack growth near the neutral plane of the wood beam, normally originating from checks and shakes. Wood members showing sharp changes in growth ring density or extremely low humidity contents are particularly likely to fail by this mechanism. The repair consists on adhesively-bonding carbon-epoxy patches on the vertical side faces of the beam at the cracked region to block sliding between the beam arms. An experimental and numerical parametric analysis was performed on the patch length, aiming the full re-establishment of the undamaged beam strength. The numerical analysis used the Finite Element Method and Cohesive Zone Modelling, including an inverse methodology for the characterization of the adhesive layer. Trapezoidal cohesive laws in pure modes I and II were used to account for the ductility of the adhesive used. The cohesive laws in pure modes I and II were determined with Double Cantilever Beam and End-Notched Flexure tests, respectively, using an inverse data fitting method. The fracture energies in pure modes I and II were obtained from the respective test and the remaining cohesive parameters were estimated fitting the experimental and numerical P-d curves. To account for the experimental failures, damage propagation along two different planes within the wood beam was also simulated. Using this methodology, a good correlation with the experiments was found on the different parameters evaluated.

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ACEX182
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Reliability of Fine-pitch Flip-Chip Bonding with Non-conductive Film Using Ultrasonic Energy

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The electrical devices in modern world tend to be miniaturized and have multi-functional performance. Therefore, many microelectronics manufacturers have been interested in the flip chip package, because of its many advantages such as smaller foot print and higher electrical and thermal performances than the conventional wire bonding method. Recently, interests in ultrasonic flip chip bonding technology has been growing due to its benefits of lower cost, lower operation temperature and shorter bonding time than conventional flip-chip bonding such as thermal bonding [1]. However the improvement of ultrasonic flip chip bonding is essential for high reliability because of its lower mechanical strength than the conventional flip chip bonding [2]. In this study, the reliability of flip-chip bonding with different non-conductive film

using ultrasonic energy was evaluated in temperature and humidity (TH) tests. The Si flip-chip and glass substrate were prepared for chip on glass (COG). The ultrasonic bonding with non-conductive film was carried out under optimum bonding pressure and time. The electrical resistance of flip-chip bumps was compared with different TH test time. Fatigue cracks were analyzed with scanning electron microscopy (SEM).

[1] J.L. Jo, J.M. Koo, J.B. Lee, J.G. Lee and S.B. Jung, J. Korean Phys. Soc., 54, 1334 (2009).
[2] B.I. Noh, J.M. Koo, J.L. Jo, and S.B. Jung, Jpn. J. Appl. Phys., 47, 4257 (2008).

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ACEX186
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Enhancement of the Durability of Joints of Polymer Composites Adding Nanofillers to Epoxy Adhesive

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The composite materials of epoxy matrix reinforced with carbon fibers are widely used in the aerospace industry due to their excellent mechanical properties, high chemical and thermal strength and their low weigh. Taking into account the great complexity and usually the vast size of the pieces which make up an aircraft, the joint of these materials becomes essential. The adhesive joints are an interesting alternative to the mechanical rivets. They minimize the stress concentrations, do not require holes and present low cost and weigh [1]. The most used adhesives for joining this kind of materials are epoxy thermosets. These joints usually present a suitable behaviour in presence of shear tensile and fatigue but they show serious limitations in aggressive environments [2].

The present research is centred in the addition of carbon nanotubes and carbon nanofibers into epoxy adhesives in order to enhance the mechanical and thermal properties of the resin, to increase their electrical conductivity and even the strength, toughness and durability of their joints. It was confirmed that the addition of carbon nanofillers into epoxy adhesive enhances the durability of these joints in aggressive environments although this enhancement depends on the applied surface treatment to the adherend. In order to explain these results different properties were determined. The contact angle and surface energy were measured. Also, an electron microscopic study of the fracture surfaces was carried out. Also, the water uptake of the epoxy adhesives was researched analysing the amount of absorbed water and their plasticization effect.

[1] R. J. Moulds, Handbook of Adhesives and Sealants 2, 197, 2006.
[2] E. M. Petrie, in Epoxy adhesive formulations (Mc Graw-Hill, London, 2006)

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ACEX192
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Double-Lap Adhesive Bonded-Joints Assemblies Modeling

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This work presents a refined model of the stress distribution in double-lap joint assemblies. We define all the components of the stress field function of the $\sigma_{xx}^{(1)}(x,y)$ stress in the first substrate and then we introduce these components into the potential energy formulation. A variational method applied on the potential energy of deformation was used and we solve the differential equation to obtain the minimum. This model can better predict the intensity and stress distributions in the double-lap adhesive joint assembly (figure 1).

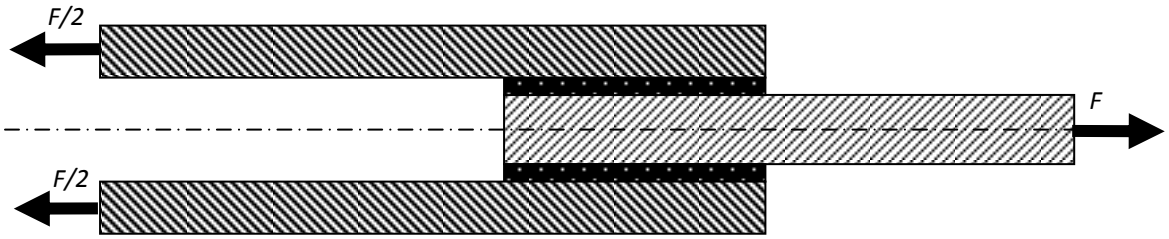

Fig. 1. Double-lap adhesive joint assembly.

[1] O. Nemeş, Contribution à l'étude des assemblages collés cylindriques et plans, PhD. Thesis, INSA Toulouse, France (2004).

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ACEX203
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Optimization of Adhesion Properties of Polypropylene (PP) Substrates by UV-Graft Polymerization of Acrylic Acid (AA)

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Polypropylene (PP) is industrially used in a wide variety of applications. As a consequence of its low surface energy, adhesive properties are poor. Many technical applications require good adhesion properties so, it is necessary to modify surface activity of polypropylene.[1-3] In this work, we have used a photopolymerization process with ultra violet light (UV) to promote grafting of acrylic acid monomer onto polypropylene surface. The main aim of this work is to promote surface changes (polarity and roughness changes) to enhance adhesive properties on a polypropylene substrate.

The photopolymerization process has been carried out with benzophenone (BP) as photo initiator. [4] Surface changes have been followed by contact angle measurements with four different test liquids (water, formamide, diiodomethane and glycerol) and subsequent surface energy calculation. The obtained results show that optimum wettability (maximum decrease in contact angle) is obtained for exposition times in the 180-210 sec. range. FTIR-ATR analysis on PP surface has confirmed the presence of polar groups which have been interlocked during the photopolymerization process. Adhesion joints prepared with surface treated PP have been characterized by T-peel tests and the overall results are in agreement with those obtained with contact angle measurements and surface energy calculation.

[1] H.P. Deng and W.T. Yang, Eur Polym J, 41, 2685 (2005)
[2] J.P. Deng, L.Y. Liu and W.T. Yang, J Appl Polym Sci, 99, 2810 (2006)
[3] J.P. Deng and W.T. Yang, J Appl Polym Sci, 95, 903 (2005)
[4] L.B. Kong, J.P. Deng and W.T. Yang, Macromol Chem Phys, 207, 2311 (2006)

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Effect of Plasma Treatment on Interfacial Adhesion in Thermoplastic Composites

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The use of natural fibres as reinforcement in thermoplastic matrix composites is increasingly replacing the conventional inorganic fibres. Especially, natural fibre reinforced thermoplastics have a good potential in the future as a substitute for wood-based material in many applications.

The interfacial behaviour between the fibres and polymer matrices has long been recognised as a key factor influencing the overall properties of composite materials. Fibre-matrix interfacial phenomena is an important factor that determine the main mechanisms of damage accumulation and propagation [2]. Physical surface activation by electric discharge (corona, cold plasma) a popular technique for surface oxidation and activation by changing the surface energy of the cellulose fibres increasing its wettability [3]. However due to the high instability of the species generated during and after the plasma treatment, hydrophilic properties achieved by the plasma treatment are rapidly lost [4].

The aim of this work is improve the interfacial adhesion between the plasticized PVC matrix and fibres coming from agave Americana by using plasma technology. Different plasma processing variables were used in order to establish the optimum treatment conditions. The plasma treatment promotes the surface activation of natural fibres and by this way, an increase in the interfacial adhesion polymer-filler has been achieved and consequently an improvement of mechanical properties.

1. K. Van de Velde, P. Kiekens Polym. Test, 21, 433 (2002).
2. J. Gassan, A.K. Bledzki Compos. Sci. Technol., 59, 1303 (1999).
3. A.K. Rana; A. Mandal, S. Bandyopadhyay Compos. Sci. Technol., 63, 801 (2003).
4. N.V. Bhat, D.J. Upadhyay J. Appl. Polym. Sci., 86, 925 (2002).

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INVITED TALK

ACEX206
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The Influence of a Surface Treatment on the Effectiveness of Toughened Acrylic Adhesives/GRP Composite Joints

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Nowadays, the use of composite materials has extended significantly in various industrial sectors. This is due to the excellent mechanical properties that can be reached and the weight reduction they can provide. In these materials, the adhesive joint is considered an optimal alternative, as mechanical joints require holes in the substrate, which may cause cuts in the fibers and, as a result, fatigue phenomena, resistance reduction and a weight increase [1]. Most adhesive unions in composite materials studies have focused basically on epoxy adhesives, while there are very few studies of other adhesives families like toughened acrylic or elastic adhesives. The most used treatments for composite materials are grit blasting and mechanical abrasion [2]. Corona discharge and atmospheric plasma treatments are also used [3]. The aim of this work is to determinate the effect of the surface treatment on the effectiveness of toughened acrylic adhesives in the fiberglass/epoxy composite materials joints.

The material used as adherend was a glass reinforced epoxy composite. The surface treatments used in this study were degreasing, grit blasting, silanization with γ-MPS and atmospheric plasma treatment. The characterization of the surface after the treatment was made by Scanning Electron Microscopy (SEM), contact angle and roughness measurements. The mechanical properties of these joints were determined with simple lap shear (SLS) and double cantilever beam (DCB) tests. In addition, its effect on the durability with wedge test (WT) was also studied. The ageing conditions used in this study were 50ºC and 95% RH.

References

[1] Q. Benard, M. Fois and M. Grisel, Int. J. Adhes Adhes, 25, 404 (2005).
[2] Z.A. Aga and W.E. Woldesenbet, J. Adhesion Sci Tecnol, 21, 51 (2007).
[3] J.K. Kim, H.S. Kim and D.G. Lee, J. Adhesion Sci Tecnol, 17, 329 (2003).

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ACEX208
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Effect of Surface Modification on Adhesive Property of Patterns Fabricated by Direct Printing Method

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Direct printing methods, such as ink-jet printing, gravure, screen printing method, are interesting alternatives to conventional photolithography for the production of electronic devices due to reducing process time and cost. In our previous study concerning screen printing method with Ag nano-paste, we could observe the patterned shape that is not completely straightened, which has wavy edge of the patterns because of slight spread of the nanopaste after printing on the wafer. To fabricate more straightened pattern, proper surface modification on SiO2 deposited Si substrate is needed. However, many of the methods for surface modification are restricted to certain material properties of the substrate and/or require expensive equipment and complicated procedures. Among various surface modification methods, atmospheric pressure plasma processes are considered to be attractive for industrial applications because of their low cost, high throughput, and ability to operate without vacuum systems. In this study, we examined the effect of surface modification using atmospheric pressure plasma on patterned shape and adhesive property with fabricated patterns by screen printing method. The hydrophobicity of surface modification on SiO2 deposited Si substrate using atmospheric pressure plasma was conducted by a number of treatment time and various discharge power. The hydrophobicity of the SiO2 surfaces were determined by measuring the contact angles of water droplets applied onto the surfaces using a microsyringe. We used a commercially available Ag nanopaste containing 73 wt% Ag nanoparticles in α-terpineol. Ag nano-paste was screen printed onto a SiO2 deposited Si wafer. The sintering temperature and time were fixed at 200 ℃ and 30 min. The microstructure and thickness profile of the sintered patterns were examined using scanning electron microscope and α-step, respectively. The adhesion of metalized Ag pattern after sintering was measured with a scratch test.

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ACEX211
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Strength Analysis of Al/Mg Adhesive Bonded Single-Lap Joints

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Magnesium (Mg) alloys are nowadays assuming an increasing importance in lightweight structural components manufacturing. The key properties of Mg alloys, e.g. low density and good mechanical behaviour at higher temperature, are currently driving the production of lightweight structural components in the aerospace, automotive and ship building industries [1]. On the other hand, the manufacturing process of such components often requires joining Mg alloys to different materials, mainly Aluminium (Al) alloys. Such a goal could be achieved by fusion welding technologies, but the formations of brittle intermetallic compounds as well as the occurrence of residual stresses and joint distortion affect the reliability during service. As a consequence, alternative methodologies need to be sought. From this standpoint, adhesive bonding technology is on of the most promising because of the improved mechanical performances of bonded components (e.g. higher fatigue strength, weight reduction, etc.) as well as of the better understanding of failure mechanisms [2]. However, a comprehensive knowledge of the mechanical behaviour of Al/Mg adhesive bonded joints is still missing, and then further efforts are required for a widespread and reliable use for load bearing structural

components. The focus of the present work is the analysis of Al/Mg (AA6082T6/AZ31B) bonded single-lap joints (ASTM D1002). Two industrial grade epoxy (Loctite-Henkel Hysol 9492 and 9466) suited for general purpose applications are compared and different surface modification strategies are examined, i.e. standard grit-blasting and laser surface treatments. Finally, experimental results (e.g. joint strength) are assessed using the finite element method and the locus of failure is analyzed using scanning electron microscopy.

[1] M.K. Kulekci, Int. J. Manufacturing Technology, 39, 851 (2008).
[2] M. Alfano, F. Furgiuele, A. Leonardi, C. Maletta, G. H. Paulino. Int. J. Fracture, in press (doi: 10.1007/s10704-008-9293-4).

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ACEX235
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Circumferentially Notched Tensile (CNT) Specimen: a New Technique for Interfacial Adhesion Characterization

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Fabrication of a thin or thick coating of one material deposited onto a substrate of a different material gives rise to stresses in the coating due to difference in coefficients of thermal expansion, chemical reactions, lattice mismatch, or other physical effects. Therefore, the most failure prone area in this composite system often resides at the interface between the film and substrate [1]. In order to make multi-layered coating devices and structural composites with long-term reliability, the fracture behaviour of the material interfaces must be determined. However, none of the existing interfacial fracture toughness testing methods is fully conformed to theory of fracture mechanics, as is obvious from the dispersion in the existing data and unpredictability in determining the interfacial toughness evaluation procedure. The proposed method recommends an innovative interfacial fracture toughness testing procedure applicable to wide range of coating materials, which is also anticipated to overcome the deficiencies associated with the existing methods.
A simple method is developed for evaluating the interfacial fracture toughness of coating on substrate using circumferentially notched tensile (CNT) specimen. When a crack extends on a bimaterial interface, mixed modeconditions usually prevail. The method is based on common tensile test of materials and is competent forestimating the mixed mode fracture toughness over a wide range of phase angle (_). The evaluation of interfacial strength is a complex task due to the complexity of loading, small dimension of coating and material conditions of interface cracking and coating spallation. The crack propagates along the interface under mixed mode due to the asymmetry in the material properties about the interface and possible asymmetry in loading[2].The highlight of this work is to measure the adhesion of coatings, based on fracture mechanics principles. The pre-crack is generated based on the presumption that interface strength between coating and substrate depends on materials used i.e. by introducing a foreign material between coating/substrate system as a weak interface. In this study, sub-modelling method of finite element analysis is used to assess the energy release rate, phase angle and stress intensity factors for coating/substrate system. Samples were observed in scanning electron microscope (SEM) and optical microscope to characterise the fracture pattern. Based on the findings, it has been concluded that this new proposed method is be an easier testing method to evaluate the adhesive property of coatings on metallic substrate in comparison to the traditional methods.

1. Volinsky, A.A., N.R. Moody, and W.W. Gerberich, Interfacial toughness measurements for thin films on substrates. 2002. 50(3): p. 441-466.

2. Hutchinson, J.W., Suo, Z, Mixed Mode Cracking in Layered Materials Advances in Applied Mechanics, 1992. 29: p. 63-191.

INVITED TALK

VIP-ACEX004
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Stress Intensity Factor in Bonded Joints: Influence of the Geometry

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The singularity of the elastic stress field in bonded joints is a well established feature, since the pioneering papers of Bogy [1]. Since then, several research works has been spent to investigate the conditions and the factors that govern the presence of the singularity. From the practical viewpoint, a recent approach has been proposed to simplify the evaluation of the stress intensity factor [2], avoiding the need for detailed meshing of the corner at the adhesive/adherend interface. A typical criticism to this description is that the real interface never presents an ideal square edged corner, which is usually assumed to evaluate the singularity.
Another object of research related to bonded joints is the seek for optimal geometrical conditions, such to minimize the stress concentration at the ends of the overlap [3-5]. Most of the related papers have tackled this study as an optimization problem whose solution is sought by varying some geometrical details, such as adherend chamfer or adhesive spew. The optimal condition is assessed (usually by finite element models - FEM) by considering the stress peaks, and this is questionable since, due to singularity, the stresses are unbounded (thus, in case of FEM, the results are mesh dependent). This work aims at encompassing the two aspects mentioned above. More realistic cases of the local geometry, namely adhesive spew and fillet are considered, and these geometrical details are regarded as factors in the optimization, which is formulated in terms of reduction of the singularity order.

References

[1] D.B. Bogy, J. of Appl. Mech., 38, 377 (1971).
[2] L. Goglio, M. Rossetto, J. of Adhesion Sci. Technol., in press (2009).
[3] T.P. Lang, P.K. Mallick, Int. J. Adhes. Adhes., 18, 167 (1998)
[4] G. Belingardi, L. Goglio, A. Tarditi, Int. J. Adhes. Adhes., 22, 273 (2002).
[5] Min You et al., Int. J. Adhes. Adhes., 28, 71 (2007).

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INVITED TALK

VIP-ACEX022
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Recommended Choiceof Adhesive Bonded Artificial Knee Replacement

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Therehavebeengreatadvancesinextendinghowlonganartificialkneewillllast.Thecurrentinvestigationdealswithoneofthemostimportantparametersincontrollingthelifespanofartificialknee,whichisthethicknessofthepolyethylenelayerofTibiaTrayofartificialkneejoint.Threedifferentthicknessofpolyethylenelayers(8,9,and10mm)areavailableathospitalsassembledwithsimilaridenticaltibiatrays.Thismakeskneesurgeonsconfusedwhichpolyethylenelayerthicknesstochoose.Thepresentworkshowedthata10mmlayerisrecommendedforactivepatients,whilethe9mmlayerisrecommendedforelderpeople,duetotheirreflectionontheadhesivelayerandsurroundingbones.

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INVITED TALK

VIP-ACEX025

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Modeling Flow and Yield Behaviors of Conductive Epoxy Adhesives During Processing and Cure

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Nickel (Ni) filled Epoxy adhesives can be used as integrated circuit (IC) packaging materials due to their lower cost than epoxy/silver adhesives with acceptable electrical conductivity [1-3]. In this work, chemorheological behaviors of Epon830/Ni/DETA adhesives (10~60 wt% of Ni) were investigated during processing and cure, as a function of shear rate, resin conversion, Ni volume fraction and temperature. Strongly nonlinear characteristic of filled epoxy/Ni systems was revealed, and steady shear had to be employed for the chemorheological analyses. Strong non-Newtonian flow behavior was also observed for epoxy/Ni adhesives during cure. The power-law model, Castro-Macosko model, Liu model, and the Arrhenius model adequately describe the effects of shear rate, resin conversion, filler volume fraction, and temperature on chemoviscosity, respectively.

In yield stress determination, the preshear effect manifests itself from successive shear rate sweeps with the same sample, and one shear rate sweep was employed as the preshear conditioning to obtain reproducible results. Shear thinning generally occurs for epoxy/Ni suspensions. The fractal dimension (Df) method was employed to describe the observed flocculated structures, and a higher Df value was observed with the Epon815C adhesive system, which is approximately 19 times less viscous as compared to Epon830.

[1] J. Zhou and E. Sancaktar J. Adhesion Sci. Technol. 22, 947 (2008).
[2] J. Zhou and E. Sancaktar J. Adhesion Sci. Technol. 22, 983 (2008).
[3] J. Zhou and E. Sancaktar J. Adhesion Sci. Technol. 22, 957 (2008).

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INVITED TALK

VIP-ACEX026

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Tearing/Debonding as a Test for Characterization of Cohesive Laws in Adhesives

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To be able to predict the strength of adhesive joints accurately, correct material data of adhesives are essential. Hence, it is critical to develop reliable testing methods to obtain the constitutive behaviour of adhesive layers. In use, adhesives are constrained to thin layers. Thus, an adhesive constrained into a layer is expected to behave differently compared to the adhesive as a bulk material. Under loading, the size of the Failure Process Zone (FPZ) in the adhesive layer is often much larger than the thickness of the layer. Thus, the small scale FPZ condition is not fulfilled and the traditional Linear Elastic Fracture Mechanics (LEFM) can not be applied. At the same time, experiments show that test specimens are prone to produce unstable crack propagation and combined adhesive/cohesive fracture patterns appear frequently, specially when mixed mode loading (peel and shear) is involved. Cohesive law should be taken as the basic fracture property for adhesives characterization; cohesive laws must be determined experimentally. The effect of loading rate and adhesive layer thickness on the cohesive law shape has to be investigated experimentally. The coupling of elasticity, adhesion and fracture make difficult interpretation of test results, specially if the adhesive is an elastomer, which has a failure strain of several hundred percents. A new test has been proposed, combining tearing of the adhesive layer and debonding from the substrate in a controlled way and using a simplified geometry. Results are closely related to the stiffness, work of fracture and adhesive energy of the adhesive system, all of them plying simultaneously an active role during the very same test.

[1] E. Hamm, P. Reis, M. LeBlanc, B. Roman, E. Cerda, Tearing as a test for mechanical characterization of thin adhesives films, Nature Materials, Vol. 7, May 2008.
[2] J.L. Högberg, B.F. Sørensen, U. Stigh, Constitutive behaviour of mixed mode loaded adhesive layer, Int. J. Solids and Structures, 44, 2007.

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INVITED TALK

VIP-ACEX028
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Impact Fatigue of Bonded Joints

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This paper presents the results of an investigation into the behaviour of adhesive joints exposed to repeated low-velocity impacts i.e. impact fatigue (IF), and compares this with standard fatigue (SF), i.e. non-impacting, constant amplitude, sinusoidal loading. The fatigue life was investigated using bonded aluminium alloy (7075-T6) single lap joint (SLJ) specimens and it was seen that IF resulted in shorter fatigue lives than SF at similar loads. Fatigue crack growth was investigated using bonded carbon fibre reinforced polymeric (CFRP) lap strap joints (LSJs). It was seen that IF resulted in

crack initiation and fast crack propagation at lower loads than SF, indicating that IF is a potentially dangerous form of loading for bonded structures. Two typical patterns of failure were seen; a cohesive failure in the adhesive, which was related to slow fatigue crack growth, and a mixed-mechanism failure that was associated with fast fatigue crack growth. Various methods of predicting IF have been proposed and compared with the experimental data. Changes of the fracture mechanism in specimens were modelled using a mixed mechanism fracture model (MMFM), which was able to represent the experimentally observed acceleration of fatigue crack growth rate when the cracks path changes.

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INVITED TALK

VIP-ACEX030
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Creep Strength Prediction of CFRP Lap Joints Bonded Adhesively

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Creep strength of adhesively bonded lap joints of CFRP plates has been investigated experimentally and analytically. Since CFRP is a promising material for future car structures because of its light weigh, establishing its joining method is very important. Adhesion is appropriate for the material. For car use, creep resistance at high temperature is vitally important.

In this study, creep tests of CFRP lap joint specimens bonded with an epoxy adhesive has been carried out to determine the variation of creep strength with respect to applied loads. The same tests have been also conducted in different temperatures and a creep master curve at ambient temperatures is obtained. Figure 1 shows the creep master curve of the joints at room temperature. The linear visco-elastic properties of the cured adhesive bulk have been also measured with stress relaxation tests (Fig.2). Finite element analysis has been carried out to determine the relation between the creep rupture of the joints and lording duration. The prediction results with FEM shows similar tendency to the creep master curve although they are slightly lower than the experimental results as shown in Fig.1.

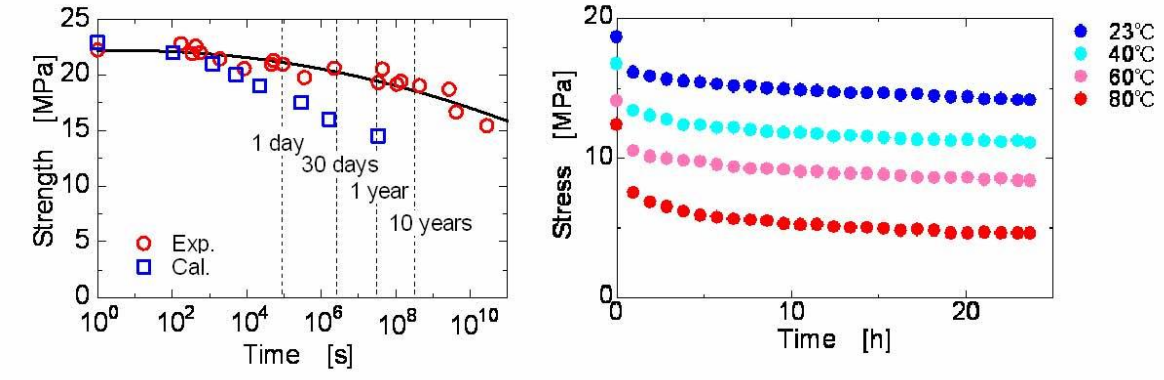

Fig.1 Creep master curve and FEA Prediction Fig.2 Relaxation function of cured adhesive bulk of CFRP lap joints

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VIP-ACEX032
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Bi-Material Joining for Car Body Structures: Experimental and Numerical Analysis

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A very important issue in car design nowadays, is the trend in using new, smart and multifunctional materials. In the next future, well-known and widely used materials like deep-drawing steels will be probably substituted by high strength steels aluminium alloys, magnesium alloys, and various types of polymeric materials and composites [1] and [2]. There are several reasons for this change: the structure weight reduction, the need for higher stiffness and strength of the car body structure, and, last but not least, cost reduction. Many problems are linked to the introduction of new materials: their properties are still not completely known, the usually adopted technologies are sometimes not usable anymore, and new environmental and protection problems arise. Additional problems are associated to the joining techniques. For several years the car body assembly techniques were fully dominated by spot-welding but resistance spot-welding (SW) weld cannot be used to join different materials. Among the various alternative solutions, the most promising are adhesives.

In this work the use of adhesive as joining system of different material was investigated by means of experimental tests on specimen and simple components. A numerical simulation technique was developed to describe and understand the phenomenon. Furthermore, since the behaviour is influenced by the loading rate and the materials used in this application are known to be strain-rate sensitive, static and impact loading conditions were examined.

[1] G. Davies, Materials for automobile bodies, Elsevier, Oxford (2003).
[2] G. Belingardi and M. Avalle, Advanced materials for automotive applications, Mobility Vehicle Mech 30 (2–3) (2004), pp. 51–65.

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VIP-ACEX033
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A progressive Damage Model for the Prediction of Fatigue Crack Growth in Bonded Joints

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Fatigue loading is common and it is often responsible of failures and a detailed knowledge of the fatigue behaviour, especially for structures designed using a fail-safe or damage-tolerant design method, is fundamental. A power-law representation of the crack growth rate (Paris' law [1,2]) as a function of the range of applied strain energy release rate (SERR), can be used for the estimation of the fatigue life based on the propagation of a defect of given initial size. This can be done by numerical integration for simple geometries, for which an analytical closed-form expression of the SERR is known. In more complex cases, the finite element simulation can be used to calculate the SERR, but this implies to build up a new model at each crack length increment. In this work the traditional fracture mechanics concepts are linked to the finite element simulation by means of damage evolution in a cohesive zone model. A similar procedure was used in [3] to predict fatigue delamination in composites. The basic idea is to link the fatigue damage rate in the cohesive elements to the macroscopic crack growth rate through a damage homogenization criterion. In this way the experimental crack growth rate is related directly to damage evolution in the cohesive zone, that is no additional parameters have to be tuned differently for example from [4]. In [3] only constant SERR geometries were presented, which granted a quite straightforward implementation into finite elements, but at the expenses of a lack of generality. In this work the procedure was applied to bonded joints and improved with automated computation of the SERR and a continuous updating of the crack length. The procedure was implemented in the ABAQUS FEM code by means of an external Fortran subroutine for the Mode I loading case, and the implementation for Mixed Mode I/II is under way. Additionally, a different damage definition was proposed that allows reproducing more closely than in [3] the fatigues crack growth experiments.

REFERENCES

1. P.Paris, M. Gomez, W. Anderson - A rational analytical theory of fatigue. Trend Eng 13 (1961) 9.
2. P. Paris, F. Erdogan - Critical Analysis of propagation laws. J Basic Eng 85 (1963) 9.
3. A.Turon, J. Costa, P.P. Camanho, C.G. Dàvila - Simulation of delamination in composites under high-cycle fatigue. Composite 38 (2007) 2270.
4. S. Maiti, P. H. Geubelle - A cohesive model for fatigue failure of polymers, Fract. Mech. 72 (2005) 691.

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INVITED TALK

VIP-ACEX034

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Stress Analyses and the Strength Predictions of Bonded Shrink Fitted Joints under Push-off and Torsional Loadings

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Shrink fittings have been used commonly for joining cylindrical components such as shafts and gears in mechanical structures. Recently a shrink fitted joint with an anaerobic adhesive (bonded shrink fitted joint) has been used in order to improve the joint strength and to reduce the assembly weight. In a reliable design of bonded shrink fitted joints, it is necessary to know the contact stress distributions at the interfaces. In this study, the interface stress distributions of bonded shrink fitted joints under a push-off force and a torsional load are analyzed by using axisymmetric theory of elasticity as contact problems. A test was conducted to determine the relationship between the normal stress and the shear stress (this test is called an analogous test). Using the interface stress distributions and the test results, a method for estimating the joint strength is proposed. In the numerical calculations, the effect of the outer diameters and Young's

moduli of the rings and the engagement length on the contact stress ditributions at the interfaces are examined. The joint strengths of bonded shrink fitted joints under a push-off force as well as a torsional load were measured. In the experiments, the effect of the shrink fitted interference and the outer diameter of the ring on the joint strength were examined. The numerical results are in a fairly good agreement with the experimental results. It is found that the strength of a bonded shrink fitted joint is greater than that of a shrink fitted joint subjected to both the push-off force and the torsional load.

Keywords: Bonded shrink fitted joint; stress analysis; push-off test; torsional loads; adhesive layer; joint strength; repture: anaerobic adhesive.

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ACEX080

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Influence of the Timber Density in the Axial Strength of Joints with Glued-in Bars. An Experimental Approach

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Joints made with glued-in bars have many possibilities for the design of timber structures. They can be used for unions of new buildings or for the recovery of ancient elements with biotic agents attacks or moisture damages. Since seventies many studies have been carried out to characterize the resistance of these unions when they are made in elements of glued laminated timber (glulam). These studies indicate traditionally that the axial strength of the unions made in glulam depends on some geometric parameters (anchorage length, bar diameter, adhesive thickness ,etc.) and depends on the density of the timber too. Our research team has been studying for a long time the behavior of these unions when they are made in sawn timber [1], [2], [3]. It has been studied the influence of different geometric and material parameters in the axial strength of the glued-in steel rods.

This paper summarized the experimental results for joints made in pieces of sawn timber of two different species. Densities and mechanical properties of these species are very different. The experimental study was carried out for different geometric configurations: threaded steel bars of 10 and 12 mm diameter, adhesive epoxy with a millimeter of thickness and five anchorage lengths. Aim to compare they were testing equal specimens made with both different timber species. The experimental results show that the axial strength of the unions does not increase linearly with the timber density. This result contradicts many of the traditional design proposals which were suggested for joints made in glulam elements.

[1] Estévez Cimadevila J, Vázquez Rodríguez JA, Otero Chans MD. Int J Adhes Adhes 2007; 27(2):136.
[2] Otero Chans D, Estévez Cimadevila J, Martín Gutiérrez E. Int J Adhes Adhes 2008; 28(8):457.
[3] Otero Chans D, Estévez Cimadevila J, Martín Gutiérrez E. Mater Des 2009; 30(4):1325.

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ACEX072

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Analysis of Mechanical Behavior of Sintered Products of Ethylene-Propylene-Diene-Monomers Crumb Rubber (EPDMCR) Using Adhesives

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The synthetic and natural rubbers have been use in many research works; individually or mixed with various plastics [1-3]. The ethylene-propylene-diene monomer (EPDM) is between the synthetic rubbers the rubber of higher increased consumption in market. The Ethylene-propylene-diene monomer is used for a wide range of products, including O-rings, gaskets, window and door seals, wire and cable insulations, roller covers, conveyor belts, hoses and water-proofing sheets. The main use of EPDM, more than one third of world production is for automotive applications. The rest is used in building construction and other uses specially those that require degradation resistance in weather conditions. Unlike other rubber products parts for cars, namely tires, EPDM rubber has received much less attention in relation to recycling and the search for new alternatives to the obtain useful products [4].
The present work consists of carrying out a study on the influence that the use of adhesives exerts in the mechanical behaviour or recycled material. The use of different adhesives; latex and polychloroprene has been analyzed, in order to understand their influence on the mechanical properties of products obtained. The samples of composite material using EPDM residues and adhesives have been obtained by means of thermal compression. The interaction produced between particles and the adhesive is the responsible of the final characteristics of material obtained.

[1] H. Osman, H. Ismail, M. Mariatti, Polym. Plast. Tech. Eng., 47(1), 23 (2008).
[2] D.K. Setua, YN. Gupta, Thermo. Act., 462(1-2), 32 (2007).
[3] C. Nakason, A. Kaesaman, Z. Samoh, S. et al. Polym. Test., 21(4), 449 (2002).
[4] T. Sutanto, F. Picchioni, L. P. B. M. Janssen, J. Appl. Polym. Sci., 102, 5028 (2006).

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ACEX147
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Environmental-Fatigue Damage Model for Adhesively Bonded Laminated Joints

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Adhesively bonded structures are in many cases subjected to aggressive environments along with cyclic loading conditions. The fatigue damage accumulation in these adhesive structures will be accelerated considerably by the

aggressive environmental conditions. In this current research, the combined moisture-fatigue damage in adhesively bonded laminated joints is investigated. A cohesive zone approach is employed to model the adhesive behaviour with a traction-separation response. Using a coupled diffusion-stress analysis, the combined degradation of the adhesive material under environmental conditioning and cyclic stresses is modelled. A normalised moisture-based damage criterion is employed for the adhesive material degradation due to environmental conditioning, and a strain-based damage parameter is used to model the degradation under cyclic stresses. The combined environmental-fatigue damage model is implemented in Abaqus/Standard using a user-subroutine. Fatigue tests are performed on two joint configurations: (a) a laminated doubler in bending and (b) a laminated single lap joint. The laminated joints consist of a monolithic aluminium substrate and a laminate that is manufactured by bonding aluminium laminae. An aerospace film adhesive is used for bonding the monolithic substrate to the laminate. The same adhesive is also used to manufacture the bonded aluminium laminate. The joints are exposed to de-ionised water at 50oC and fatigue tests are conducted for different withdrawals. The tests are performed at different load levels and S-N curves are obtained. The back-face strain measurement and the in-situ video microscopy techniques are employed to monitor the fatigue damage initiation and propagation under the different conditions. The measured degradation in fatigue performance with increased environmental conditioning is successfully predicted by the combined environmental fatigue-damage modelling.

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ACEX179
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Numerical Evaluation of Three-dimensional Scarf Repairs in Carbon-Epoxy Structures

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High performance composites are being increasingly used in structures requiring high specific strength and stiffness. Automotive, marine, military, aeronautical and aerospace industries are the main fields of application of these materials. The widespread employment of carbon-epoxy laminates in these high responsibility and severely loaded applications introduces an issue regarding the handling of these materials after damage. Repair of these structures should be evaluated, instead of their disposal, for cost saving and ecological purposes. Under this perspective, the availability of efficient repair methods is essential to restore the damaged structure to an acceptable level of functionality. The development and validation of accurate predictive tools for the repairs behaviour are also extremely important, allowing the reduction of costs and time associated to extensive experimentation. Comparing with strap repairs, scarf repairs have the advantages of a higher efficiency and the absence of aerodynamic disturbance. The scarf repair procedure consists on the damaged material removal by drilling of a conical hole with a pre-determined angle. A patch with the complementary shape is then adhesively-bonded to the structure. This work reports on a numerical study of the tensile behaviour of three-dimensional scarf repairs of carbon-fibre reinforced plastic laminates, bonded with the ductile adhesive Araldite 2015®. The numerical analysis (by Finite Elements) was performed in ABAQUS® and used Cohesive Damage Models for the simulation of damage onset and growth in the adhesive layer. Trapezoidal cohesive laws in pure modes I and II were used to account for the ductility of the adhesive used. A parametric study was performed on the scarf angle. Different lay-ups were also tested for the laminate and patch. The results obtained allowed the establishment of design guidelines for repairing.

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ACEX181
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Effect of Piezoelectric Patches on Behaviour of Adhesively Single Lap Joint Subjected to Tensile Loading

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ABSTRACT
The powerful electro-mechanical coupling attribute of piezoelectric materials, enables these materials to act as effective actuators. Using this attribute, a smart adhesively single lap joint is developed by surface bonding piezoelectric patches onto a typical adhesive single lap joint. The forces and bending moments at the edges of the developed smart joint system can be adaptively controlled by adjusting the applied electric field in the piezoelectric patches, thus reducing the peel and shear stresses concentrations in the adhesive layer.
In the present paper, a smart joint system, integrated with actuating piezoelectric patches to adaptively create the additional forces and moments to reduce the maximum peel and shear stresses in the adhesive layer is investigated analytically. In order to further verify the effect of surface bonded piezoelectric patches in smart adhesively single lap joint, shear lag assumption is used in the analytical model to evaluate the shear stress distribution. The predicted peel stress is obtained using the beam on elastic foundation (BOEF) approach in the adhesive layer. Analytical model is developed that predicts shear and peel stresses in the adhesively bonded smart symmetric single lap joints, while accounting for the elastic adhesive behaviour. The joint is loaded by in-plane tension load and governing equations are solved directly by using the linear constitutive relationship of the adhesive. It is observed that the piezoelectric patched single lap joint could significantly reduce the stress concentrations at the lap joint edges. The influence of location and size of the piezoelectric patches in single lap joint is also investigated. A series of finite element analyses are also carried out to verify the integrity of the developed solution. Results from the computational numerical analyses are in good agreement with those obtained from the proposed analytical results, thus validating the solutions. The detailed results are presented in the full length paper.

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ACEX181
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Effect of Adhesive Patching on Charpy Impact Response of Repaired Notched Plate

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The Charpy impact tests were conducted on repaired notched aluminum plates and the absorbed energy and the fracture behavior of the plates were investigated. The aluminum plates contained a single-edge notch, have been repaired adhesively with metal sheet, composite and FML (fibre metal laminate) hybrid composite patches on one side. Some of the plates were repaired on two sides. One layer metal sheet, 3 and 5 layers laminated composite and 2/1 and 3/2 FML composite patches were used to repair the aluminum plates. Metal patch was made by Phosphor-bronze, composite patches were made by woven glass and woven carbon fibre laminates and the FML patches were made by combination of woven glass or woven carbon fibre laminates with Phosphor-bronze metal sheet. The aluminum plates had three different notch lengths. The results showed that the specimens had the FML patches with the same number of layers, what ever be the fibre, absorbed energy almost at the same level. It also showed that the notched specimens repaired with single and double-sided FML patches with carbon fibres, absorbed energy more than the other specimens repaired with other patches. Generally, as the notch length increased, the absorbed energy decreased by the notched aluminum plate with and without any patch. The effective role of patching in repaired specimens is pronounced in greater notch lengths. The detailed results are presented in the full length paper.

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ACEX181

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Mechanical Properties of Nanoclay Reinforced Epoxy Adhesive in Bonded Joint for Composite Material

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Bonded joints promote a more uniform stress distribution compare the other methods of joining such as bolting and riveting, where high stress concentrations occur. Also, numerous researches in last decade found that the thermal and mechanical properties of polymer composites could be effectively improved by using a small fraction of nanoclay content inside the composites.

This study is intended to characterize the mechanical properties of nanoclay filled epoxy adhesive in single lap adhesive bonded joint under both static (tensile) and dynamic (impact) loading. The nanoclay contents were 1, 3 and 5 wt% of epoxy resin. The nanoclay particles were distributed in the resin by stirring device and then the mixture of resin and clay particles was subjected to sonication using an ultrasonicator. Glass/epoxy composite adherends were fabricated and used to study the behavior of adhesively bonded joints. According to ASTM D3165, the tensile properties of the reinforced adhesive in shear are obtained. Also, the joints are subjected to in-plane and out-of-plane Charpy impact test. The results showed that the adhesive joint with 1% nanoclay particles had maximum strength for tensile loading and the highest values of Charpy impact energy were found for the joint with adhesives filled with 3% nanoclay particles. The detailed results are presented in the full length paper.

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ACEX186
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Surface Treatments of Carbon Fiber/Epoxy Laminates for Adhesive Bonding: Roughness Analysis by SEM Image Analysis

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The epoxy laminates reinforced with long carbon fibers are being used in numerous industries such as aerospace, naval and civil ones. This implies that it is necessary to research about their processability and manufacturing. In particular, in this study, we analyse the adhesive joint of these materials as an interesting alternative to the mechanical rivets. The adhesive joint minimizes the stress concentrations, does not require holes and presents low cost and weigh. Its main limitation is the necessity of previous surface treatment over the adherends in order to increase their wettability. The most common used surface pre-treatment of carbon fiber/epoxy laminates is peel ply due to its simplicity since they are applied during the processing of laminates. However, the strength, toughness and durability of the obtained joints are limited. Other used surface treatments are grit-blasting and plasma [1]. These have to be applied after the manufacture of composite and they require additional equipment but they usually give higher strength and toughness to the adhesive joints.

The present research is centred in the analysis of these surface treatments (peel ply, plasma and grit-blasting). The objective is to determine the changes produced in the substrates, analysing the surface chemical composition, surface energy and texture. For it, different analysis techniques are used. Between them, the image analysis of SEM micrographs is used [2] in order to measure the average roughness and other surface parameters which significantly affect to the joint strength.

[1] J. R. J. Wingfield, Int. J. Adh. Adh. 13, 151 (1993)
[2] S. G. Prolongo, G. Del Rosario, A. Ureña, J. Adh. Sci. Technol. 20, 457 (2006)

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ACEX192
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Numerical and Experimental Validation of Double-Lap Adhesive Joint Analytical Modeling

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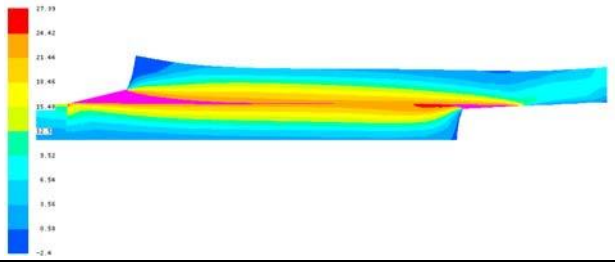
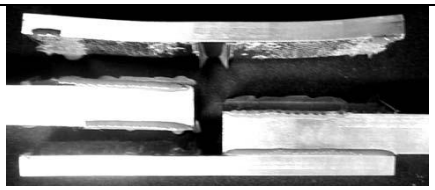
The paper presents a numerical analysis of double-lap adhesive joint assemblies After the CAD model, constraints and applied load definition, we made a stress field analysis.

The aim of this work is to validate an analytical model, based on an energy method, developed by the authors. Thus the analytical model makes it possible to determine the rigidity of the assembly and to obtain a simple formulation very rapidly which gives the total behavior of the assembly (figure 1).



a)



b)

Fig. 1. Deformations in double-lap adhesive assemblies: a) finite element; b) experimental.

[1] O. Nemeş, Contribution à l'étude des assemblages collés cylindriques et plans, PhD. Thesis, INSA Toulouse, France (2004).
[2] O. Nemeş, F. Lachaud, A. Mojtabi, M. Borzan and St. Grigoras, Mater. Plast. 45, 390 (2008).

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Optimization of Adhesion Properties of Low Density Polyethylene (LDPE) films by Corona Discharge Plasma

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Textile composite laminates based on a polymer film and polymer foam show interesting possibilities from an industrial point of view, finding a wide variety of applications in technological sectors such as automotive industry, aeronautics, packaging … The polymer film can contribute with good chemical barrier properties and the polymer foam can provide lightness and soft in the touch finishing. The main problem regarding these composites is the relative low surface energy of many polymer films which leads to poor adhesion properties. [1-3]
In this work, modification of low density polyethylene (LDPE) film surface has been carried out with the aim of optimizing adhesive joints to polyolefin foam. LDPE films were using corona discharge plasma with different powers (from 200 to

600 W) and several film advance rates (5 – 20 m min-1). Changes in solid surface energy were estimated through contact angle measurements. Mechanical performance of the adhesion joints was determined by T-peel tests and also the aging effects of several hydrothermal conditions have been studied to evaluate the usefulness of these laminate composites in technological applications. The optimum results are obtained for corona powers of 400-600 W and the film advance rate does not affect in a remarkable way Adhesive joints offer excellent mechanical performance and good durability in hydrothermal conditions.

[1] M.R. Sanchis, V. Blanes, M. Blanes, D. Garcia and R. Balart, Eur Polym J, 42, 1558 (2006)
[2] R. Sanchis, O. Fenollar, D. Garcia, L. Sanchez and R. Balart, Int J Adhes Adhes, 28, 445 (2008)
[3] M.J. Shenton, M.C. Lovell-Hoare and G.C. Stevens, J Phys D: Appl Phys, 34, 2754 (2001)

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Enhancement of Adhesive Properties of Polypropylene Substrates by Two-Steps UV-Graft Polymerization of Acrylic Acid

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Among the most versatile polymer matrices, polyolefins, such as polypropylene (PP) are thermoplastics with a high consumption because of their well-balanced physical and mechanical properties and their easy processability at a relatively low cost. Despite of this, PP is characterized by very low surface energy which has a negative effect on adhesive properties. In this work we have obtained by sequential UV surface photografting, the enhancement of adhesive properties of polypropylene with desirable wettability and reactivity. [1]
Polymerization by sequential ultraviolet light (UV) consists of 2 steps. In the first step, a sample containing a solution of a photoinitiator (Benzophenone) is irradiated by UV light. In the second step, the sample in a new dissolution containing the monomer Acrilic Acid (AA) is irradiated again by UV light. This process allows grafting of acrylic acid structures on polypropylene surface. [2, 3]
Surface changes have been evaluated by contact angle measurements with four different test liquids (water, formamide, diiodomethane and glycerol) and subsequent surface energy calculation .It was found that the sequential photografting process in two steps increases the grafting efficiency (Eg) and grafting yield (Yg). Moreover, the grafted AA increases the surface hydrophilicity; the water contact angle of the modified surface drastically decreases from the original 87.3° to less than 31° within 210 s of irradiation time in the first step and 180 s in the second one.

[1] J.P. Deng, L.Y. Liu and W.T. Yang, J Appl Polym Sci, 99, 2810 (2006)
[2] J.P. Deng and W.T. Yang, J Appl Polym Sci, 95, 903 (2005)
[3] L.B. Kong, J.P. Deng and W.T. Yang, Macromol Chem Phys, 207, 2311 (2006)

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VIP-ACEX004
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Designing Bonded Joints by Means of the JOINTCALC Software

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An important aspect for the success of the adhesives in the manufacturing industry is the capability of designing safe joints in fast and simple way. This originates the need for an ad hoc software tool, that should be easy enough for non-experts, intuitive for occasional users and also flexible to include a satisfactory collection of practical joint configurations. Accounting for these issues, Henkel AG & Co. KGaA has supported the work by a pool of Italian Universities that has led to the creation of the Jointcalc software [1]. This tool implements in its core the analytical solutions taken from the literature for the most important joint geometries, namely: the bonded sandwich (that covers cases of single lap joint under different loading conditions), the double lap, the coaxial assembly (loaded in tension or torque). The calculations are carried out in elastic regime, both for the adhesive and the adherends. This simplifying assumption is conservative in the sense that it does not account for the stress redistribution due to plasticity in the adhesive. A key aspect of Jointcalc development is the experimental failure criterion adopted, represented by an admissible region in the peel – shear stress plane [2]. The implementation has required the creation of an experimental database, specifically built for each one of the adhesives considered. Another key feature is the graphical interface that enables the user to choose the required case, input the data and examine the results. Since its appearance in 2004, Jointcalc has been applied to the design of several bonded parts, mostly of the transportation industry; this presentation reports some case histories.

References
[1] E. Dragoni, C. Gambaro, L. Goglio, F. Kleiner, "Jointcalc: An analytical tool to estimate the strength of adhesively bonded joints", Euradh 2008 - Adhesion 08, Oxford, UK.
[2] L. Goglio, M. Rossetto, E. Dragoni, Int. J. Adh. & Adh., 28, 427 (2008).

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INVITED TALK

VIP-ACEX023
Prof Jean-Yves Cognard
ENSIETA–France

Influence of Hydrostatic Pressure on the Behaviour of An Adhesive in an Assembly

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Adhesively bonded assemblies are widely used in different industries, but the prediction of the behaviour of these bonded joints is still approximate. Starting from a large data base of experimental results under tensile-shear loadings obtained using a modified Arcan fixture [1], a non-associated elasto-visco-plastic 2D model, suited to interface type elements, has been proposed to represent the behaviour of an adhesive film in an assembly [2] (epoxy resin HuntsmanÔ Araldite® 420 A/B). This model can be adapted to solid finite elements, using finite strain formulations. But, the development of 3D models, which are necessary to analyze industrial applications, requires more experimental information in order to accurately represent the yield surface.
Different studies underline the influence of the hydrostatic pressure on the behavior of adhesives [3]; but generally, only few experimental data are available in order to completely validate such models. Thus, the experimental results obtained with the Arcan fixture have to be completed. In a first step, tests under shear loadings, using a modified TAST specimen, have been performed in a specially designed pressure vessel mounted on a standard test machine, which allows pressures up to 100 MPa to be applied during mechanical testing. Those results are analysed in order to develop a 3D model which accurately represents the non-linear behaviour of an adhesive in an assembly.

[1] J.Y. Cognard, P. Davies, L. Sohier and R. Créac'hcadec, Composite Structures, 76, 34-46 (2006).
[2] R. Créac'hcadec and J.Y. Cognard, J. of Adhesion (accepted for publication, 2009).
[3] R. Rolfres, M. Volger, G. Ernst and C. Hühne, Trends in Computational Structures Technology, Saxe-Coburg, ISBN 978-1-874672-35-7, 151-171 (2008).

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VIP-ACEX023
Prof Jean-Yves Cognard
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Influence of Adhesive Thickness on the Behaviour of Bonded Assemblies

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This study is concerned with increasing the performance of composite structures by the use of adhesively bonded joints. The experimental and numerical analyses of the mechanical behaviour of bonded joints are particularly made difficult by the edge effects. Stress singularities can contribute to the initiation and the propagation of crack in adhesive joints. Therefore, understanding the stress distribution in an adhesive joint can lead to improvements in adhesively-bonded assemblies and to develop reliable experimental tests in order to analyse the non-linear behaviour of an adhesive in an assembly.
In the case of marine applications, large structures are often considered, thus it is important to analyse the influence of the adhesive thickness [1]. Experimental results, under tensile-shear loadings, using a modified TAST specimen and an Arcan type fixture [2], underline a reduction in mechanical properties with an increase of the bond line thickness. In order to numerically analyse those effects, results of asymptotic analysis under elastic assumptions [3] and results of the influence of the non-linear behaviour of the adhesive are presented taking into account the local geometries of the joint and of the substrate near the edge.

[1] J.Y. Cognard, R. Créac'hcadec, L. Sohier and P. Davies, Int. J. of Adhesion & Adhesives, Vol 28, 393-404 (2008).
[2] D. M. Gleich, M. J. L. Van Tooren and A. Beukers, J. Adhesion Sci. Technol., Vol. 15, pp. 1091–1101 (2001).
[3] D. Leguillon, J. Laurencin and M. Dupeux, European Journal of Mechanics A/Solids, Vol. 22, 509–524 (2003).

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INVITED TALK

VIP-ACEX024

Prof. Marcelo de Moura
University of Porto,
Portugal

Repair of Wood Trusses Loaded in Tension with Adhesively-Bonded Carbon-Epoxy Patches

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Wood and wood products are amongst the most important construction materials. Wood are generally used in frames, buildings, truss roof structures in buildings, bridges, towers, railroad infrastructures and many more applications. Damage and failure behaviour of wood members in tensile, compressive or shear loading are extremely important to account for in wooden structures subjected to high working stresses. Wood strength depends on the external loads, causing different stress states, and grain orientation. Wood exhibits its greatest strength in tension parallel to the grain, and a few applications load a wood member in pure tension, such as trusses in the most varied applications. For a safe design, predictive methods and models for the simulation of structural behaviour are required. One of the possible approaches is the Finite Element Method. In this work, the tensile strength of repairs on wood members in pure tension is addressed experimentally and numerically, using carbon-epoxy patches. The repair consists on the replacement of the wood damaged portion and reinforcement with carbon-epoxy plates bonded at two opposite faces. A parametric analysis was carried out on the overlap length between the composite reinforcement and the undamaged part of the beam. The numerical analysis used the Finite Element Method and Cohesive Zone Modelling to simulate damage initiation and propagation in different materials. Trapezoidal cohesive laws in pure modes I and II were used to account for the ductility of the adhesive used. To account for the experimental failures, damage propagation in the wood beam was also simulated. The comparative analysis of the test results and the simulations showed a good correlation between both.

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VIP-ACEX024

Prof. Marcelo de Moura

Determination of the Cohesive Law in Adhesive Bonded Joints under Pure Mode I Loading

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The objective of this work is to present a new methodology to obtain the cohesive damage law under pure mode I loading of adhesive bonded joints using the Double Cantilever Beam (DCB) test. A numerical model based on the finite element method and cohesive damage modelling was used to simulate damage initiation in the DCB specimen and validate the procedure. In the first step a predefined cohesive law is introduced in the numerical model. After, the model runs till the first integration point at the crack tip opens, thus simulating crack initiation. The local opening displacement

(w) at this point is recorded up to its complete failure. The evolution of the fracture energy JI is obtained using a suitable method derived from the beam theory, and based on the crack equivalent concept and specimen compliance [1, 2]. The JI = f(w) relationship is fitted by cubic polynomials and Prony-series functions. The cohesive damage law s = f(w) is then determined by differentiation of the resulting functions, i.e., s = dJI/dw, and compared to the one inputted in the numerical model. Good agreement was verified which validates the proposed methodology.

[1] M.F.S.F. de Moura, R.D.S.G. Campilho, J.P.M. Gonçalves, Compos Sc Technol 68, 2224 (2008)
[2] M. F. S. F. de Moura, R. D. S. G. Campilho, J. P. M. Gonçalves, Int J Solids Struct 46, 1589 (2009)

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VIP-ACEX026
Prof. J.C. Suarez Bermejo
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Viscoelastic Response of Beads Filled Adhesives for High Specific Energy Dissipation

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There are very efficient materials in absorbing mechanical energy after an impact when the weight is not an issue. It is necessary to look for new strategies when high-density materials and/or thick sections are not a viable option. A recent research has paved the way to develop new strategies for energy dissipation inside materials composed mainly of a granular media. Some theoretical models have shown that using beads with proper size and distribution it is possible the confinement of the energy inside the granular media, following a slow leakage of the energy out of the material. A new material has been developed to take advantage of this inspiring theoretical prediction. Metallic foam has been also employed as an energy absorbing material, and a real light one. Mechanisms of energy absorption and toughness enhancement are related to the free volume encapsulated among the metallic walls of the cells, and also to the mechanical and topological properties of those solid walls. The goal has been to employ several of these strategies to obtain a light and tough material, with a high-energy absorption capability related to their low density, and also to retain a certain residual strength after the impact to assess the structural integrity for the application in mind, that is, to assure also a good damage tolerance of our material. However, the real problem is to achieve a perfect combination of all these constituents, to build a multilayer hybrid material with a hierarchical structure for every level of organization, and interlayer adhesive joints working effectively to pass the energy from layer to layer, acting as a whole efficient system.

[1] C. Sánchez, H. Arribart, M. M. Giraud, Biomimetism and bioinspiration as tools for the design of innovative materials and systems; Nature Materials, April 2005.
[2] J. Hong, Universal Power-Law Decay of the Impulse Energy in Granular Protectors, Physical Review Letters, March 2005.

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VIP-ACEX034
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A Three-Dimensional Finite Element Stress Analysis and Strength Prediction

of Stepped-lap Adhesive Joints

of Dissimilar Adherends Subjected to Bending Moments
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Stress distributions in stepped-lap adhesive joints of dissimilar adherends subjected to bending moments are analyzed using a three-dimensional finite-element method (FEM). For establishing an optimum design method of the joints, the effects of some factors are examined. As the results, it is found that the maximum value of the maximum principal stress σ1 occurs at the butted edge of the adherend's interfaces with higher Young's modulus. The maximum value of σ1 decreases as Young's modulus ratio between two adherends and the adhesive thickness decreases while it decreases as a number of steps increases. In addition, the joint strength is predicted using the obtained interface stress distributions. For verification of the FEM calculations, experiments were carried out to measure the strains at the interfaces and the joint strengths. Fairly good agreements were found between the numerical and the experimental results. The joint strength of dissimilar adherends was found to be smaller than that of similar adherends.

Keywords: stress analysis; finite-element method; stepped-lap adhesive joints; joint strength; bending moments; dissimilar adherends

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ACEX069
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Numerical Prediction of Adhesive Strength Required for Optical Surface Finish

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An optical surface finish is an essential requirement in the performance of electronic and optical products, and microstructure, and metallurgical analyses. This paper centers on prediction of an appropriate adhesive strength needed to obtain an optical surface finish. Polishing process was virtually developed using general-purpose FE code. 2D process model was constructed with four parts, namely the base plate, the abrasive sheet, silicon workpiece and holder. Fixed diamond abrasive proposed by VTT Microelectronics was created in the FE model to overcome the modeling difficulty of loose abrasives, and to conveniently define polishing forces involved. Polishing forces were split into two – normal and tangential forces. The presence of micron-size diamond abrasive was modeled by using micron-sized elements and defining friction coefficient at the interface between silicon and abrasive sheet. The imaginary adhesive layer was created between every interface in the model with the aid of special elements. The magnitudes of polishing forces were defined according to the manufacturer's recommendation. The effect of adhesive strength on the interface stress concentration was then predicted. The appropriateness of the adhesive strength was justified by absence of high stress concentration in anywhere in the silicon. Numerical prediction was verified with experiment. Both were found in good agreement.

ADVANCED MATERIALS

ACEX184
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Investigation in the Use of Shape-Memory Alloy Wires to Create Prestressed States in Concrete Specimens

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The research project deals with the use of shape-memory alloys (SMAs) to enhance the mechanical performance of concrete. Concrete exhibits a damaging behaviour which can be improved by applying a uni- or multiaxial compression. SMAs are known as smart materials due to their peculiar mechanical properties, like the shape memory effect and the pseudoelasticity. These properties take their origin from an austenite-to-martensite phase transition occurring when stress or temperature changes. By combining concrete and SMA, a few studies have shown that the concrete behaviour can be improved by taking advantage of SMA properties [1, 2]. The objective of the present work is to investigate the relation between the mechanical properties of SMA wires used as external reinforcements and the prestressed states created in concrete specimens. Ni-Ti wires are used in the present study. Different steps must be followed to change the crystallographic state of the SMA wire in order to achieve a prestressed state in concrete: (i) austenitic state at "high temperature", (ii) self-accommodated martensitic state at room temperature (iii) prestrained martensitic state, (iv) wrapping, (v) again austenitic state by heating (vi) finally, austenitic state maintained when returning to room temperature. The stresses created in the concrete depend on certain thermomechanical parameters of the wire: transformation temperatures, Young's modulus, prestrain…. The presentation will describe the experimental measurement of parameters and their use for the assessment of confining or prestressing effects in concrete specimens.

[1] K. Moser, A. Bergamini, R. Christen and C. Czaderski, Materials and Structures, 38, 593-600 (2005).
[2] E. Choi, Y.S. Chung, B.S. Cho and T.H. Nam, Eur. Phys. J. Special Topics, 158, 255-259 (2008).

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ACEX196
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Evaluation of Electrochemical Characteristics for Casted AC7AV Aluminum Alloy

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The Al alloy is environmental friendly, easy to recycle, and provides a high added value to fishing boats [1]. Aluminum alloy do not corrode due to the formation of an anticorrosive passive film, such as Al_2O_3 or $Al_2O_3 \cdot 3H_2O$, which resists corrosion in neutral solution. In seawater, however, Cl- ions destroy this passive film [2-3]. We investigated on several electrochemical tests undertaken to determine the optimum conditions in seawater for corrosion protection of casted AC7AV aluminum alloy. The components of casted AC7AV aluminum alloy are similar with Al-Mg alloys (5XXX series) which are used for ship. Result of electochemical experiment, the optimum protection potential range with regards to hydrogen embrittlement and stress corrosion cracking was determined to lie between -1.3 and -0.7 V (vs Ag/AgCl).

Acknowledgment ; This research was financially supported by the Ministry of Education, Science Technology (MEST) and Korea Industrial Technology Foundation (KOTEF) through the Human Resource Training Project for Regional Innovation.

[1] S. J. Kim, Materials science forum, Vol. 510-511, p 158-161, (2006)
[2] S. J. Kim, J. Y. Ko, M. S. Han, The Korean journal of chemical engineering, Vol. 23, p. 1028-1033,(2006)
[3] S. J. Kim, S. K. Jang, J. I. Kim, Materials science Poland, Vol. 26, (2008)

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ACEX223
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Through Thickness Stress Analysis of Composite Adhesively Thick Bonded Joints Using Energy and Variational Methods

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Adhesive joints due to having low stress concentration, capability of joining and sealing simultaneously, etc., are the most suitable joints for composite structures. In the most previous analytical methods, adhesive layer is assumed to be very thin and through thickness stress distributions are ignored [1, 2]. Experimental results have shown that the load carrying capability decreases when the bondline becomes thicker [3] and design of thick layer adhesive joint, with the previous methods may cause to failure due to incorrect design.

In this paper, a mathematical model is presented based on energy and variational methods for through thickness stress analysis of adhesively thick bonded joints. In this model adherends are orthotropic laminates with general stacking sequences that modeled as Timoshenko beams. It is considered adhesive layer is homogenous and isotropic material and displacement components of each point of adhesive layer are determined as functions of displacements and slops of upper and lower adherends in that horizontal position. In this method by considering constitutive, kinematics and equilibrium equations, sets of differential equations for each zone of the joint are derived. The governing equilibrium equations (in each zone) are solved analytically and shear and peel stresses in each point of adhesive layer and deflections, stress and moment resultants in the adherends are determined. An example of adhesive joint is solved by this method and the results are compared with the previous researches considered thin adhesive layer assumption.

[1] R.D. Adams, J. Comyn and W.C. Wake, Structural adhesive joints in engineering, Chapman & Hall, London (1997).
[2] E. Selahi, Stress analysis of adhesive joints in composite structures, M.Sc. thesis, Shiraz University, Iran (2004).
[3] J.S. Tomblin, C. Yang and P. Harter, Investigation of thick bondline adhesive joints. F.A.A. Technical Report, DOT/FAA/AR-01/33 (2001).

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ACEX236
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A Computational Approach for Thermo-mechanical Characterization of Thermal Spray Coatings

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There is a growing interest in use of thermal spray coating as a suitable technique to apply protective layers on the surface of engineering materials. Thermal spraying is a general term for a group of coating techniques which deposit various materials available in powder or wire forms as molten or semi-molten particles onto the surface of a substrate [1]. A large choice of coating materials, including metals, alloys, ceramics, and carbides can be deposited using this method. Enhanced thermo-mechanical surface properties by coating are crucial in the design of turbine airfoils, next generation of aerospace applications, energy production, gas turbines, combustion engines, oil industry, electronics, automotive, printing and many other high-tech industries.

Generally, performing experimental tests to measure thermo-mechanical properties of the freestanding coating samples is hard due to the difficulty of separation of such a thin coatings (50- 500 μm) from substrate and preparation of sub size test samples. It is generally believed that the microstructural features will define thermo-mechanical properties of the coatings [2]. The coating microstructure may differ from those resulting from conventional processing routes and exhibit a layered type of structure including porosities, and micro-voids. An image based computational study focused on the microstructure features for interpretation of the mechanical and physical properties of the coating is presented. This multiscale computational scheme provides essential findings in coating and interface improvements and contributes to new horizons in material characterization. Multiscale material characteristics formulation is a new and demanded feature in modern material characterization. The proposed research work will pave the way for further understanding of coatings and interfacial material characteristics. To this end, superalloy and ceramic coatings will be examined for such experimental-computational study.

[1] L. Pawlowski, Thermal Spray Coatings, John Wiley & Sons, New York, 2008.
[2] P. Fauchais, Understanding Plasma Spraying, Institute of Physics Publishing, Journal of Physics D, 37, pp. 086–108, 2004.

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ACEX223
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Analysis of Dynamic Interlaminar Stresses in Antisymmetric Angle-ply Composite Laminated Plates

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One of the main causes of failure of composite laminated structures is delamination damage, which is significantly derived from interlaminar stresses [1]. Analytical solution of a first-order shear deformation theory is developed to study interlaminar stresses of antisymmetric angle-ply laminated rectangular plates subjected to forced vibration. In the theoretical formulations the effects of all the rotational inertia terms are considered. Also the change in the plate thickness is taken into account due to its important role in the edge effects. The governing equations of laminated plates are established by applying Hamilton's principle and are solved by using Levy's solution method. It is assumed that the plates have two simply supported opposite edges and the remaining boundary conditions are arbitrary. The functions of displacement components are obtained using the results of free vibration, which are obtained by solving the homogeneous form of equations of motion analytically using the state-space approach. Also the function of time is obtained using orthogonality relation, the Laplace transform and convolution integral.

First the natural frequencies and mode shapes for the case of free vibration and the time responses for the case of transient vibration are obtained and then dynamic interlaminar stresses are determined by integrating the three-dimensional local equations of motion and imposing given boundary conditions at the top or bottom surface of the laminate. The accuracy and effectiveness of the first-order theory in describing the localized three-dimensional effects are demonstrated by comparing the results of the present theory with those obtained from finite element method. Numerical results show that boundary conditions, configurations, E1/E2 ratio, side-to-thickness ratio and aspect ratio have significant effect on dynamic interlaminar stresses.

[1] X. Wang, Y.X. Wang and H.K. Yang, Dynamic interlaminar stresses in laminated plates with simply and fixed supports, subjected to free vibrations and thermal load, Compo. Struct., 68, 139-145 (2005).

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Towards a New, more Realistic, Thermo- and Electrodynamic Model of Electrotomy

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Continuous critical reviewing is necessary in medical engineering and should be one of the most important attributes of the biomedical / clinical engineer.
Electrosurgery is a very good example for that. Though it has been known for decades, there are still controversies on how it physically really works.
The known electro- and thermodynamical models of RF-electrotomy are summarized and discussed. Especially their discrepancies and thermodynamical inadequacy (regarding pressure, temperature and power / energy) are emphasized. The assumptions in the literature assume atmospheric pressure and range between two extremes: a) all the water of the cut volume has to evaporate to achieve cutting,
b) less than 1% of this water ought to evaporate to achieve cutting, which leads to an energy density discrepancy of nearly one to ten.
It is improbable, that cutting of the tissue in electrotomy would succeed due to a pressure equal to atmospheric pressure, since conventional "mechanical" cutting success is due to exercising a mechanical pressure on tissue much greater than atmospheric pressure.
Based on a qualitative proof of an “overpressure hypothesis” using "schlieren" photography, and depending on the thermodynamical similarity between electrosurgery and laser surgery , a new electro- and thermo dynamical model of electrotomy is introduced, which includes mainly, but not exclusively, the following points:
1) Cutting is due to partial evaporation under overpressure, consequently the energy needed is much lower than commonly thought.
2) Coagulation during cutting is due to arcs over vapor layer; their frequency probability correlates with the crest factor.
3) Tissue resistivity (load) is no longer invariant; it is temporal and spatial variant.

REFERENCES:
(1) H.A.Kelly, G.E. Ward: Electrosurgery, W.B. Saunders, Philadelphia, 1932.
(2) E. Lax (Hrsg.) : Taschenbuch fuer Chemiker und Physiker, Band 1, Springer Verlag, Berlin, 1967.
(3) W.M. Honig: The mechanism of cutting in electrosurgery, IEEETrans. Biomed. Eng.,BME22(1978),.58-62.
(4) H.-J. Reidenbach: Hochfrequenz – und Lasertechnik in der Medizin, Springer Verlag, Berlin, 1983.
(5) J.A. Pearce: Electrosurgery, Chapman and Hall, London, 1986.
(6) A.D. Zweig, H.P. Weber: Mechanical and thermal parameters in pulsed laser cutting of tissue, IEEE J. Quant. Electron., QE-23 (1987), 1787-1793.
(7) G. Lohr, K. Fastenmeier : Optimiertes Anschneiden in der HF-Chirurgie, Biomed, Technik, 37 (Ergaenzungsband), 1992, 143-144.

Keywords: electrosurgery, modeling, biophysics, biomechanics, over- pressure/temperature

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INVITED TALK

ACEX040
Prof. J.A. McGeough

Edinbruh, U K

Unconventional Cutting Technologies in Orthopaedic Ssrgery

Professor J.A. McGeough
Edinbruh, U K

Many advancements have been made in understanding the anatomy of the body in surgical operations. However surprisingly little development has occurred in the devices and methods needed for surgery. Surgical tools such as scalpels, hacksaws and drills have undoubtedly been improved in terms of the materials that are used, and the mechanisms that are employed. However they still adhere to the basic designs and mechanical methods adopted in previous centuries. They also face the inherent difficulties of accuracy of cutting, sterilisation, and thermal damage to neighbouring tissue, which can delay or prevent healing for example killing cells, necrosis.

Industry has also had to consider the limitation of traditional methods of cutting, for instance to deal with materials that are difficult to cut by conventional techniques, or to achieve acceptable accuracy. In the most recent half-century, unconventional methods of cutting and machining have had to be developed to overcome these difficulties. Their main attraction is that material removal or cutting may be obtained, not by high mechanical force, but by relying on alternative means of energy transfer or chemical reaction.

In this keynote paper, the prospects for utilising these unconventional methods in orthopaedic surgery are explored, although these techniques may also be applied to other areas of medicine that require surgical cutting.

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ACEX041
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Effect of Different Contact Boundary Conditions on the Reaction Forces Around a Dental Implant

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The purpose of this study was to consider the effects of different types of contact conditions on two different 3D models of the body of mandible, implants, O-rings and the housing. The implants were modeled without threads the 1st 3D FE model. Three different contact conditions were defined between the mucosa and prosthesis (bonded, rough and frictionless) and the boundary condition between the implants and the bones were contact bonded without micro-motion. In the second 3D model, the actual implant was modeled (with threads) and two contact conditions between the threads and the bones were defined separately, the first was bonded without micro-motion and the second was a rough contact with possibility of separation between the threads and the bones. The only contact condition that was defined between the mucosa and prosthesis in the 2nd 3D model was frictionless with the possibility of sliding motion without separation, which was resulted from the solution of the first 3D model. Two different loading conditions (type A and type B) were imposed to the both models. Both loading cases were unilateral consist of three concentrated forces (20N) in different directions. The locations of the forces were 1st premolar, 1st molar and 2nd molar on the left side. The model

was solved for ten different cases. The obtained results of the cases without frictionless contact conditions between the mucosa and prosthesis were not acceptable due to the false directions of the reaction forces. The results for the simplest contact boundary condition were 2.45N, 12.99N and 49.01N, and for the implants with threads were 13.19N, 13.10N and 36.99N for the first loading case. The results for different contact boundary conditions showed an increase in reaction forces of approximately 7.74% and 1.71%, respectively in both load cases with different boundary conditions. The results also showed that the effect of threads on the reaction forces and stresses around the implant is not significant and the only acceptable boundary condition between the mucosa and prosthesis is the frictionless contact condition with possibility of slip movement.

[1] Y. Tayama, T. Yamada, O. Araki, T. Seki & T. Kawazaki, Journal of Oral Rehabilitation. 28, 1064, (2001).

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ACEX050
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Analysis of the Influence of PMMA Cement Mantle Thickness in the Endurance Testing of Hip Prostheses

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In this study it has been investigated the influence of thin cement layer during fatigue tests. Therefore, the strains and the external loads applied during the fatigue testes were measured using strain gages inside the cement mantle and at particular stem positions. A test fixation apparatus was fabricated to develop this work. The apparatus follow the angles of adduction and flexion required by the ISO 7206-4 standard. A cylindrical support was produced to facilitate the stem fixation in the thinner cement layer. The conditions of preparation, temperature and composition of cement mantles were kept to allow comparison with the commonly used method. The fatigue tests were conducted with three specimens for each mantle thickness utilizing PMMA for the stem fixation. The measurements of strain gages were realized in the proximal and distal regions of the cement mantles and the lateral, frontal and medial regions of the stems. The tests were performed according ISO standard specifications and the data measurements acquiring and processing were realized by specific software. Additionally, the computer simulations of the two cement mantle condition were performed. The results suggest in both cases that there are no significant differences in the strain levels. The fatigue tests in the thicker cement layer specimens showed small strain increases in the stems. In this way the both apparatus have shown similar results. Besides that, it was possible to conclude that the damage accumulation at the cement played an important rule in strain imposed at the stem during five millions cycles fatigue testing.

[1] D. Janssen, J. Stolk, N. Verdonschot, J. Orthopaedic Research 23, 691, (2005).
[2] J. Stolk et al. Journal of Biomechanics 35, 499, (2002).
[3] M. Baleani, L. Cristofolini, M. Viceconti, Clinical Biomechanics 14, 339, (1999).

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ACEX063
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Engineering judgment of Children Bone Fracture

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Accidents, bone disease and age cause damage to different human bones and joints. All over the world, several thousands patients undergo surgeries for joints replacement or bone amendments due to car accidents while several other thousand undergo operations due to age and bone diseases.

Of bone fracture is the humerus fracture. The humerus bone is the upper arm bone that connects the shoulder to the elbow joint. A humerus fracture is an injury to the bone of the upper arm. Humerus fractures are generally divided into three types of injuries: The first of which is the proximal humerus fractures and occurs near the shoulder joint. The shoulder joint is a ball-and-socket joint, with the ball being the top of the humerus bone. Fractures of this ball are considered proximal humerus fractures. The second type is the Mid-shaft humorous fractures which occur away from the shoulder and elbow joints. Most humeral shaft fractures will heal without surgery, but there are some situations that require surgical intervention. The third type is the distal humorist fractures which are uncommon injuries in adults. These fractures occur near the elbow joint. These fractures most often require surgical treatment unless the bones are held in proper position. This type of fracture is much more common in children, but the treatment is very different in this age group. Fracture of shaft between the age of four and fourteen can be suitable for internal -modularly wire fixation. More orthopedic surgeons recently experience the technique, but the argument for the time to start mobilization and stability are still there.

In bone fractures, there are always several treatments for the same fracture. Sometimes surgeons wanted to know to which alternative they should give preference, for the benefits of the patent.

The research role is to gather information from CT scans and x-ray developed in Hospitals. Based on the x-ray of particular patent and using the Finite Element technique, an engineer can design (determining the size and appropriate material) and analyze appropriate nails and material used to suit that particular patient. In present work, a case of humerus bone fracture which is usually treated with two different techniques is investigated. These techniques are the opposite sided k-wire and the single sided k-wire fixation technique. The present work showed that both techniques are working, however opposite sided k-wire fixation technique is beneficial for top fracture treatment, while single sided k-wire fixation technique is beneficial for bottom fracture treatment. The research role is to gather information from CT scans and x-ray developed in Hospitals. Based on the x-ray of particular patent and using the Finite Element technique, an engineer can design (determining the size and appropriate material) and analyze appropriate nails and material used to suit that particular patient. In present work, a case of humerus bone fracture which is usually treated with two different techniques is investigated. These techniques are the opposite sided k-wire and the single sided k-wire fixation technique. The present work showed that both techniques are working, however opposite sided k-wire fixation technique is beneficial for top fracture treatment, while single sided k-wire fixation technique is beneficial for bottom fracture treatment.

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ACEX069
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Response of Bone Synthetic to Impact Load – Computation and Experiment

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State-of-the-art computational model was developed using LS-DYNA finite element code to predict response of bone synthetic to impact. The model geometry was initially constructed as 3D solid geometry in Solidworks mechanical package. Then the interior elements of micron size were modified to include porosity of the bone structure using spline-feature-extrude method. Pore size and mean porosity were defined as close as possible to the actual ones. The model was discretized with mixed elements of hex and tetra. Drucker-Prager yield model was incorporated into the FE modeling to simulate realistic deformation of the bone. Essential properties required for the material model were obtained through iteration of the computational model. In experimental method, dedicated fixture was developed for holding very delicate specimen and to eliminate geometrical errors during the test. Zwick Roell equipment was used for impact experiment. The same impact load as in computation was applied to the specimen. The specimen after subjected to impact was investigated under scanning electron microscope. Computation and experimental results were found to be qualitatively agreeable. This new computational model can be used as a virtual tool to efficiently determine response of human bone to various forms of loading.

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ACEX074

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Corrosion Resistance of Ti-6Al-4V Alloy after Diverse Surface Treatments

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Ti-6Al-4V alloy is widely used as a material for implants. Biocompatibility is a basic criterion of its usefulness as a biomaterial. The biocompatibility is mainly connected with physio-chemical properties of implant's surface. These properties should be adjusted to an organic environment of a human. Implant introduced to such system should not initiate cytotoxic, immunological and alergic reactions.

Long-term clinical experiences showed toxic influence of V and Al ions infiltrating surrounding tissues [1]. In order to minimize the ions infiltration, many methods of surface improvements were worked out [2].

In the paper the results of diverse methods of surface preparation on corrosion resistance of Ti6Al4V alloy were presented. The surface preparation consisted of the following operations: vibration treatment, mechanical polishing, and sandblast cleaning and electrolytical polishing. Such initially prepared samples were subjected to anodic oxidation process (in diverse conditions).

The corrosion test was carried out in the Tyrode's physiological solution with the use of the potentiodynamic method by means of recording of anodic polarization curves. On the basis of the obtained curves, characteristic values, determining pitting corrosion resistance, were determined. For the selected variants, a chemical composition of the surface layer was determined by means of the XPS method. Before and after the tests, samples' surfaces were observed in SEM.

[1] S.G. Steinemann, in G.D. Winter J.L. Leray and K. de Goot (eds.), Corrosion of surgical implants – in vivo and vitro tests. Evaluation of Biomaterials, Wiley, 1980.
[2] J.R. Goldberg, J.L. Gilbert, Biomaterials 25 (2004) 851–864.

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ACEX082
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Numerical Models of a Carbon Fibre Prosthesis for Athletes

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The right of disable person to lead a normal life has recently developed technologies and numerical techniques for optimization to substitute the lost limbs with analogous mechanical devices acting as the human body. In particular, for lower limbs amputated athletes, different prostheses have been developed in these last years: a general description of their evolution is proposed in [1].
Object of this study is a foot prosthesis allowing the disable athlete to run at agonistic levels. This prosthesis is composed of a single multi-layer lamina, with a curvilinear shape. The prosthesis is joined to the back part of the socket and replaces the athlete's foot and tibia areas. It aims to offer the functionality of the muscle-tendon group of a foot: not only its strength, but also its elasticity is important during the athlete's run, since it is supposed to be comparable with a sane leg. This can be obtained by the used materials, the prosthesis geometry and the joint to the socket. The analysed prosthesis is made of carbon fibre layers in a epoxy resin matrix, covered with a double layer of tissue. In this work static and fatigue tests are experimentally performed on the prosthesis, according to the standard [2]. A single force simulating the load components applied during the run is applied during the tests to produce mixed loads on the prosthesis. In parallel with the experimental tests, numerical simulations are performed, validating the FE model by the experimental results in terms of displacements and strains. In this way, a valid tool to check the stress state inside the prosthesis is obtained, and optimizations for the prosthesis thickness and mechanical characteristics of the used materials are proposed to improve the athlete's performances, also for variable loads in magnitude and direction during the time, thus simulating the phase of running.

[1] Pailler D. et al., Annales de réadaptation et de médecine physique, 47, 374 (2004).
[2] EN ISO 10328:2006, Prosthetics-Structural testing of lower-limb prostheses -
Requirements and test methods.

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ACEX088
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Simulations of Flow through Polymer Scaffolds Used in Bone

Tissue Engineering

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Flow-induced shear stresses have been found to be an important stimulatory factor for preosteoblastic cells seeded in 3D porous scaffolds and cultured under continuous flow perfusion. Local shear has been shown to promote osteoblastic differentiation, matrix deposition and calcification. Due to the complicated architecture of the interior pore space of the scaffolds, an analytical estimation of the local shear forces is impractical. The goal of this work is to model the behavior of the flow inside the pore space within the scaffolds through computations.

The scaffolds were prepared using Poly-L-Lactic Acid (PLLA) and salt leaching with various combinations of salt grain size. The preparation methodology can provide for different pore structure and for different porosity. Subsequently, the scaffolds were scanned and imaged with high resolution micro-computed tomography (μCT). The digital 3D image was used as the flow domain for a lattice Boltzmann method-based flow simulation. The results were validated against known analytical solutions for forced flow in an infinite channel, in a pipe and in an infinite array of spheres.

Using this approach we calculated the local fluid shear stresses inside the scaffold architecture, which are not possible using conventional, empirical methods. Over 30 different scaffold geometries were tested at different flow conditions in order to explore how the scaffold structure affects the fluid shear stresses. It was found that at a constant pressure drop different porosities of the scaffolds result in different surface stresses (with the least porous materials resulting in the highest surface stresses). In addition, the shear stresses experienced by cells inside the scaffold vary, and the shear stress distribution has a long tail of high stresses that lays to the right of the average of the stresses. The fact that the shear stress distribution is asymmetric shows that there are different regions within the scaffold that may experience surface shear stresses magnitudes apart. Such information can be used to optimize the scaffold design in order to achieve the desired surface shear stresses. Moreover, cell detachment can occur when the fluid shear is too high, thus placing constraints on the scaffold design.

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ACEX102
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Application of 3D Printing in Cranio-Maxillofacial Surgery

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Closing cranium and facial defects is a complicated task from the technical point of view. In the case of customized cranial implants first clinical cases are published at the beginning of nineties till today. There is no widely accepted method that is focused to customised implants for these defects in the Czech Republic. The traditional way of cranial implants fabrication and surgical fixation methods strongly depend on surgeon skills. Usually, it leads to a not required shape of the closed skull and face. It is not rare, that the final shape is very frustrating, and moreover incorrect shape can cause others clinical difficulties.

Our departement was the first in the Czech Republic which used CAD models for prototyping customized implants. We have operated fifteen patients in the Czech Republic since 2006. These patients are usually after decompresive

craniectomy. We used customized implants fabricated from the bone cement according to their CT data. All operated patines are without any clinical symptoms.

[1] Műller A, Krishnan K, Ederhard U, Mast G. The application of RP techniques in cranial reconstruction and preoperative planning in neurosurgery. J Craniofac Surg 2003; 14: 889-914.
[2] Giord S, Teschner M, Schrell U, Kevekordes B, Girord B. Computer aided 3-D simulations and prediction of craniofacial surgery: a new approach. J Craniofac Surg 2001; 29: 156-158.
[3] Stoodley MA, Abbott JR, Simpson DA. Titanium cranioplasty using 3-D computer modelling of skull defects. J Clinic Neurosci 1996; 3: 149-155.

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ACEX110
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New Ti Alloy with Low Modulus for Biomedical Application: Ti-35Nb-7Zr

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The ideal material for biomedical applications must possess excellent biocompatibility with no adverse tissue reaction, corrosion and wear resistance, low elastic modulus, low density, enough resistance and toughness to meet the effectives and reliability [1]. During the past decade, beta Ti alloys containing non-toxic elements (Mo, Zr, Nb, Ta and Fe) have been developed in an effort to match high strength with low modulus and most of the other requirements for an ideal bioalloy [2, 3]. Apart from the composition, performance of these alloys is greatly influenced by thermomechanical treatment that influences their microstructure and mechanical properties [4].
A new β type Ti alloy Ti-35Nb-7Zr (wt. %) is introduced in this work. This composition is proposed based on electron/atom (e/a) ratio investigation to get low modulus [1].
The Ti-35Nb-7Zr has been produced at DEMAR/EEL-USP in a laboratory scale by arc melting under argon atmosphere in a water cooled copper hearth. The ingots, with the initial diameter of 18 mm were submitted o β solution treatment (1000°C/2h), cold working until 6 mm of diameter and submitted to heat-treat at 1000°C/2h. The microstructures were investigated using Optical Microscopy, X-ray diffraction and hardness. The mechanical characterization was evaluated through uniaxial tensile tests. In this work the microstructure and the mechanical behavior, under different heat treatment and deforming are shown.

[1] Y. Zhentao, Z. Lian, Mater. Sci. Eng. A 438-440, 391 (2006).
[2] Y.L. Hao, S.J. Li. S.Y. Sun, R. Yang, Mater. Sci. Eng. A 441, 112 (2006).
[3] R. Banerjee, S. Nag, H.L. Fraser, Mater. Sci. Eng. C 25, 282 (2005).
[4] M. Geetha, A.K. Singh, K. Muraleedharan, A.K. Gogia, R. Asokamani, J. Alloys Compd. 329, 264 (2001).

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ACEX127
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Connective Tissue in Synovial Joints under Stress: Zone-Dependent Behaviour

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Articular cartilage is a load-bearing connective tissue, which has a very ordered ultrastructure that maintains tissue shape and provides unique meshwork that strengthens the tissue. Under mechanical load, however, a deformation in articular cartilage is observed, which indicates the deformation of cartilage matrix and collagen network organization. The understanding of the apparent and microstructural changes of cartilage under stress will be highly valuable in revealing the tissue adaptability to external loading and in assessing joint abnormalities. Recently, a microscopic MRI T2 anisotropy study and a polarized light microscopy technique were used to investigate subtle changes in compressed cartilage [1, 2]. A mechanical load will inevitably result in the deformation of the collagen matrix in articular cartilage. If a loaded specimen can be studied in high-resolution imaging, the resulted fibril deformation could provide important information regarding the fibril structure and molecular interactions at different tissue depths.

There are three distinguished zones, defined mainly from the collage fiber orientation, in articular cartilage: the superficial zone (SZ), the transitional zone (TZ), and the deep zone (DZ). Previous studies have investigated experimentally connective tissue behaviour in loading state using high-resolution imaging techniques [1, 3]. A theoretical model of connective tissue behaviour under mechanical stress will be presented taking into account the zone-dependent behaviour of connective tissue in loading state. The study will attempt to correlate its finding with previous experimental results from high-resolution images of articular cartilage. This can be useful in studies that characterize the events in mechanically induced joint diseases and in the early initiation of Osteoarthritis (OA).

[1] H.A. Alhadlaq and Y. Xia, Osteo. Cart., 12, 887 (2004).
[2] H.A. Alhadlaq and Y. Xia, JMRI, 22, 665 (2005).
[3] Y. Xia, H. Alhadlaq, N. Ramakrishnan, A. Bidthanapally, F. Badar and M. Lu, J. Struct. Boil. 164, 88 (2008).

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ACEX135
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3D Finite Element Analysis of dental resin cements using micro-CT data

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This investigation describes a new method for the generation of 3D models to interrogate complex dental systems through the finite element analysis (FEA) method. The effects on the stress pattern in a tooth restored with an all-ceramic crown cemented with resins of variable elastic moduli have been examined. Materials and Methods: A FEA model of a human tooth restored with an all-ceramic crown was constructed using micro-CT. Subsequently, the micro-CT scan of the restored tooth was segmented according to pixel density into its component parts (ceramic crown, resin cement, tooth, and pulp) using Mimics software (Materialise Co., Ltd). The various component parts were modified and

meshed using 3matic software. The meshed parts imported into the ICEM software (ANSYS, Inc) and reassembled and the mesh was further modified. FEA software (ANSYS Version 11) was used to apply an occlusal load of 200N to the buccal and palatal cusps of the tooth model. In each material the von-Mises stresses were evaluated with resin cements of different elastic moduli namely, 1.0 GPa and 100 GPa. Results: Both the ceramic/resin and resin/tooth interfaces were subjected to higher stresses with the higher elastic modulus resin. The resin with 1 GPa elastic modulus showed a more uniform stress distribution throughout the system compared to resin with 100 GPa elastic modulus. Stress concentration effects could be seen in the margin of the resin cements layer adjacent to the load application points. Conclusion: Micro-CT in combination with a range of software programs is an effective means of producing 3D model of complex dental structures. It was shown that the stress distribution within the restored tooth-crown system is highly dependent upon the elastic modulus of the resins.

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ACEX136
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Finite Lement Simulation of Elastosonography Applied to Breast Tumours

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Breast cancer is one of the most common types of tumours in women. In the last decades several new imaging techniques have been proposed to detect lesion in order to reduce invasive and expensive procedures, such as surgical biopsy. Elastosonography is an ultrasound technique aimed at noninvasive early-diagnosis of breast tumor lesions [1]. This technique is based on the observation that lesions appear stiffer than the healthy tissue: a compression stimulus is applied to the breast and the strain field is computed from the gradient of displacement obtained from pre- and post-stimulus echo RF data. However, this procedure presents some drawbacks because it is affected by subjective factors, e.g hand held operation, lesion location, transducer shape and size, breast shape and patient position, that can reduce its reliability. Numerical simulation can provide insight into the influence of these factors and give some indications for improvement. In this study both 2D and 3D breast models have been developed with a spherical inclusion embedded in a bi-layer background where the predominant types of tissue, adipose and glandular ones, were taken into account. Material properties have been considered linear elastic for the lesion and hyperelastic for the healthy tissues [2]. The effect of the transducer was simulated by applying compressive displacements or by including the transducer where a more realistic breast model was modeled. In order to improve the reliability of the models the effect of the gravity was also included and probabilistic FE analyses were performed assuming different contact models between the inclusion and the background or axial/axial-shear stimuli as input parameters. As output parameter the strain field contrast between the healthy and pathological tissues was considered assuming different regions of interest (ROI). The simulation results indicate that the ROI of the healthy tissue plays a significant role while, for a transducer tilt angle from 0° to 30°, the effect of the stimulus type on the contrast coefficient is negligible.

[1] J. Ophir, et al. Eur J Ultrasound, 3, 49 (1996).
[2] A.P. Palomar et al., Med Eng Phys, 30(9), 1089 (2008).

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ACEX141
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Development of a Rotational Ablating Tool for Calcified Atherosclerotic Plaque Removal

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Atherosclerosis is one of the major cardiovascular disease involving accumulations of lipids, white blood cells and other materials on the inside of the artery walls. Since the calcification found in the advanced stage of atherosclerosis dramatically enhances the mechanical properties of the plaque, recovering the original lumen of the artery remains a challenge. The high-speed rotational athrectomy, used with an ablating burr with diamond coating on the surface to remove the lesion produced optimal results in the treatment of calcified lesions than other methods. In this research, a high-speed rotational ablating tool with micro-scale concave/convex pattern onto the surface was developed. The concave/convex pattern was designed considering elasto-hydrodynamic lubrication effect, and fabricated on the tool surface using 20-watt Nd:YAG laser beam. The engraved concave/convex pattern has a dimension of approximately one-micrometer in depth and height. The ablation experiment was performed onto the prepared hydroxyapatite/polymer composite whose mechanical properties are similar to those of the calcified lesion. The characteristics of the tool performance were observed from the ablation force. Moreover, the size of debris generated during the ablation was investigated because the micro-particles larger than a red blood cell could obstruct the micro-circulation.

[1] R. M. Bersin and C. A. Simonton, Cathet. Cardiovasc. Interv., 58, 485 (2003).
[2] D. Ebenstein, Ph.D. Diss., Univ. of Cal., Berkeley, with Univ. of Cal., San Francisco, (2002).
[3] A. D. Roberts and D. Tabor, Proc. R. Soc. Lond. A., 325, 323 (1971).

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ACEX148
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A 3D Numerical Study of Oxygen Transport in Pulmonary Capillaries to Present a Proper Relationship between Respiration Rhythm and Athletes' Activity Levels

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Providing the body with sufficient amount of vital gases through respiration is a dominant factor specially in sport biomechanics. This has made the scientists to do variety of investigation around different affecting parameters on respiration process [1]. Observing that gas exchange, takes place in the alveolus, many researchers have focused on more real recognition of gas exchange system in pulmonary capillaries [2]. Investigating the gas transport from alveoli to the RBC shows that the diffusion characteristics of the pathway from alveoli to RBC and chemical reaction within the RBC are the most important phenomena. Adjusting the rhythm of breath is one of the important parameters that an athlete must consider. In this paper, the relationship between man's activity and respiration rhythm is studied. A numerical simulation is carried out on a 3D axi-symmetric model using computational fluid dynamics (CFD) method. The model considers the oxygen uptake in the pulmonary capillaries in alveolar microcirculation system. This model consists of three main parts: a stationary capillary membrane, a moving plasma region and four disk-shaped RBCs. sliding mesh technique is performed to simulate the motion of blood fluid during the process of diffusion. Using this technique in the cases that different regions of the model have movement with respect to each other will be beneficiary. Results show an inverse relationship between saturation time of RBCs and respiration rhythm. Using an inversion factor, a relationship is presented to assess the proper respiration rhythm for different exercise states.

[1] D. Aroesty, J. F. Gross, "Convection and diffusion in the microcirculation,"
Microvasc, vol. 2, pp. 247-267, 1970.
[2] J. P. Whiteley, D. J. Gavahan and Clive E.W. Hahn, "Mathematical modeling of
Pulmonary transport," J. Math. Biol., vol. 47, pp. 79-99, 2003.

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ACEX154
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From in-vivo cine-PC MRI to CFD and back. An Integrated Approach for New Insight in the Aortic Arch

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The knowledge of local haemodynamics is fundamental in the study of both onset and development of vascular disease. A detailed knowledge of fourth-dimensional (i.e. 3D along time) fluid dynamics relies on the analysis of blood flow structures (i.e. spatial velocity profiles, vortices, re-circulating zones and helical structures) that defines and characterizes the behaviour of a specific vascular district. On one hand, following the evolving technologies on non-invasive imaging techniques, the study of local haemodynamics can count today on in-vivo methods furnishing detailed spatial and temporal descriptions of unsteady blood velocity fields (3D cine-PCMRI) [1]. On the other hand computer sciences, mathematical modelling and hardware performances, permit to easily handle, in an in-silico environment, advanced computational fluid dynamics (CFD) modelling [2], with patient-specific geometries of vascular districts derived from the in-vivo images. Both of these worlds have some well-known limitations but the inter-exchange of knowledge, methods and algorithms between them can furnish today a new and privileged integrated research environment for the study of local haemodynamics. The present work describe a possible innovative virtuous cycle where the best of the two

environments, i.e. in-vivo and in-silico, is interlaced to furnish new insight on in-vivo quantification of local haemodynamics in the human aortic arch.

[1] Morbiducci U, Ponzini R, Rizzo G, Cadioli M, Esposito A, De Cobelli F, Del Maschio A, Montevecchi FM, Redaelli A. Ann Biomed Eng. 2009 Mar;37(3):516-31
[2] Morbiducci U, Ponzini R, Grigioni M, Redaelli A. J Biomech. 2007;40(3):519-34.

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ACEX160
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Human Injury and Impact Analysis with the Ballistic Helmet Under Splinter Impacts

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It is difficult to know human response to impacts while splinters colliding into a ballistic helmet. Although the ballistic helmet provides good protection, it still can't extinct the impacts which are caused by splinters. In this paper, at first, modeled ballistic helmet with CATIA program then put the helmet model into the ANSYS program done the modal analysis then again put the analyzed model into the ADAMS program connected with human model. Secondly, ADAMS/LifeMOD was applied to simulate the ballistic helmet impact under kneeling posture. Then analyze the human head, neck and vertebrae movement and impacts which were all caused by the ballistic helmet impacts. The head accelerations and the velocities were calculated and used the result proceeded injury analysis.

(7) B. Gamal, Y.J. Choi and B. Marc, Impact of Vertebroplasty Postoperative Biomechanics of Vertebroplasty , No. 73, pp.144~150 (Biomechanica2006).

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ACEX168
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Adapting a 3D Scanner for Improving the Reading of Residual Limbs within

a CAD/CAE Environment

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The manufacturing process of orthopedic prostheses (i.e. sockets) requires good quality reading techniques of the residual limb of amputees. The challenge is to obtain accurate geometry information of the limb and, consequently, better manufacturing processes of both transfemural and transtibial prosthetic sockets. It is very important to be able to customize these readings trying to be as faithful as possible to the actual profile of each patient. Within this context, it was designed 3D mechanical scanner for reading residual limbs shape based on reverse engineering techniques which may produce a CAD representation of the limb via appropriated graphical sheets. The first release of the equipment was conceived to work purely by mechanical means. The first results were encouraging as it was able to achieve a great decrease concerning the degree of uncertainty of measurements when compared to traditional methods that are very inaccurate and outdated. Although the pure mechanical version of the equipment improved the readings, it still required someone to input the plotted points data to an academic CAD software called OrtoCAD. This task is performed by manual typing which is time consuming and carries very limited reliability. These drawbacks were overcome by designing the second release of the scanner equipment in which it was developed an electronic variation of the reading table components now capable of performing an automatic reading (i.e. no human intervention). An interface software (i.e. drive) was built to facilitate data transfer. Now much better results were obtained meaning less degree of uncertainty (at least five times lower). Additionally, it was proposed an algorithm to convert the CAD geometry, used by OrtoCAD, to an appropriate format and, therefore enabling the use of rapid prototyping facilities. As a result, the manufacturing process of prosthetic sockets could be automated.

Keywords: 3D Scanners; CAD; prosthetic sockets.

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ACEX176

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Effect of Interface Properties on the Effective Properties of Biopolymer Composite Materials

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Weak adhesion between constituents in starch-zein composites has been proved using nanoindentation experiments [1]. In order to quantify the effect of imperfect interface at the elastic properties of the composite, a Finite Element (FE) model is presented. Starting from the generation of typical 2D microstructures representing the result of a thermomoulding process, circular zein particles are embedded in a starch matrix. Particles are allowed to overlap in order to represent flowability of the filler into the matrix. Zein fraction in the composite is varied in the full range (0-100%). The generated microstructures are converted into a finite element model, where the influence of interface is modelled thanks to a cohesive zone model [2]. The predicted results show that Young's modulus of the composite is significantly affected by the spatial distribution of interfaces. When the phase ratio is small enough, the interface effect is localized around filler clusters. Increasing further more the phase ratio leads to a percolation of the interface. In particular, interface percolation perpendicular to the loading direction predicts the lowest modulus. When the filler

phase becomes predominant, the interface effect weakens. Based on the former discussion, an effective law is suggested using a simple non-linear function between the effective modulus and the phase ratio.

References
[1] S. Guessasma, M. Sehaki, D. Lourdin, A. Bourmaud, Viscoelasticity properties of biopolymer composite materials determined using finite element calculation and nanoindentation, Comput. Mater. Sci., 44,371 (2008).
[2] X.P. Xu, A. Needleman, Numerical simulation of fast crack growth in brittle solids, J. Mech. Phys. Solids, 42,1397 (1994).

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ACEX187
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Characterisation of Bovine Cortical Bone by Tensile and Three-Point Bending tests

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Cortical bone is a hierarchical composite material consisting of a mineral reinforcement embedded in a collagen matrix. Moreover, it is an anisotropic material with a heterogeneous structure which can undergo considerable changes in composition. The adequate characterisation of the mechanical behaviour of bone tissue is of great importance, namely because of its socio-economic impact.
In this work, elastic properties of cortical bone from bovine femur, along the longitudinal-tangential plane, were evaluated through tensile and three-point bending tests. The tensile mechanical tests were carried out on an Instron 5848 MicroTester machine with a displacement rate of 0.2 mm/min. Both fresh and dried samples of adult bovine bone tissue were manufactured. Thirteen specimens with nominal dimension of 59(L)×6(T)×3(R) mm3 were prepared from the mid-diaphysis of the femur. Since the use of strain gauges is not practical in this application, the digital image correction method (ARAMIS-GOM system®) was selected for strain measurements. The texture pattern was created over the surface of the bone tissue by means of a graphite pen (Schwarz/black medium-2907 M, Faber-Castell); due to some roughness of the specimen's surface, dark spots were created over the natural light colour of the bone. An 8-bit Baumer Optronic FWX20 camera coupled with a Nikon AF Micro-Nikkor 200mm f/4D IF-ED lens were used for image grabbing. For comparison and evaluation purposes, specimens were tested afterwards by carrying out bending test with a displacement rate of 0.5 mm/min, assuming the Euler-Bernoulli beam theory. Finally, the influence of density, porosity and weight fractions of water, collagen and mineral phases on the measured elastic properties was also investigated.

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ACEX191
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Self Organizing Maps Used To Human Vocal Image Segmentation

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The process of voiced sounds production can be described as follows: air coming from the lungs is forced through the narrow space between the two vocal folds, which are set in motion in a frequency governed by the tension of their tissues. The vocal folds change the continuous flow that comes from the lungs into a series of pulses. Then, as the flow passes through the oral and nasal cavities it is amplified and changed until it is finally radiated from the mouth [1]. This complex process can be modeled by a system of integral-differential equations and can be better evaluated using a 3D model, based on MRI images. In this paper we studied a segmentation process to enhance the principal human vocal boundaries. We used self organizing maps (Kohonen Neural Networks) to automatically classify main texture regions, based on texture descriptors vectors, obtained by co-occurrence matrix [2][3]. The main components analysis is used to determine the best texture [4].

[1] E. Cataldo, J.C. Lucero, F.R.Leta, L. Nicolato, Synthesis of voiced sounds using low-dimensional models of the vocal cords and time-varying subglottal pressure, In: Mechanics Research Communications, Elsevier, v. 33, n. 2, p. 250-260, (2006).
[2] R.C. Gonzalez, R.E. Woods, Digital Image Processing, Vol. 1, p.675, T. Robbins, 2nd Ed., Prentice-Hall, New Jersey, (2002).
[3] R.M. Haralick, K. Shanmugam, I. Dinstein, Textural Features for Image Classification. In: IEEE Transactions on Systems, Man, and Cybernetics, vol. SMC-3, n. 6, November (1973).
[4] S. Haykin, Redes Neurais Princípios e Prática, Vol. 1, p.483, D. Grassi, Ed., Bookman, Porto Alegre, (2001).

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ACEX199
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Biomechanical Evaluation of a C3-C5 Human Cervical Model Created by Computer Tomography CT and 3-D Scan under Compression Loading

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This paper presents a numerical evaluation of a pair of C3-C5 human cervical models created with different modeling techniques. Computer Tomography and 3-D Scan Z-Corp 700® was used to create each model. Biomechanical effects on the cervical section C3 to C5, as well as the effects on a cervical plate implant under compression loads derived from three scenarios. The first one refers to the effect of the head weight over the considered section. In the second case, it is assumed that the average patient weight is supported by C3 and C5 vertebrae. In the last one, the compression load

failure is applied to C3, in order to simulate extreme loading conditions due to a possible accident. Von Misses criteria was used for the analysis of the results. The purpose of this study is to evaluate, using the Finite Element Method (FEM), the stability and mechanical behavior of cervical plates under compression loading conditions, under two different modeling techniques. This is to evaluate the numerical behavior for each FEM model to establish the disparity of a classic technique in the case of the Computed Tomography [1] and the use of 3-D Scan. It is noteworthy that cervical plates are useful to restore stability of the spine by improving the inter-vertebral fusion, particularly when the cervical body has been damaged. The modeling and obtained results for the cervical section and cervical plates were obtained, for the 3 cases, considering the mechanical properties of the implant material (Titanium alloy Ti-6A1-4V).

[1] J.A. Beltrán-Fernández & et. Al, "Modelling of a Cervical Plate and Human Cervical Section C3 – C5 under Compression Loading Conditions Using the Finite Element Method, Transtech publications "Applied Mechanics and Materials", Vols. 13-14-2008 p.p. 49-56,UK.

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ACEX209
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Distributed Model for Flow Simulation in Wire-on-Tube Condensers

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The preoccupation with ecological issues is gaining attention nowadays, mainly in\ concern of atmospheric ozone layer, greenhouse effect, and requirement of new less pollutant sources of energy. In the refrigeration field such concern has motivated several researches and big investment aiming to improve thermodynamic efficiency of its main components: evaporators, condensers, compressors and expansion devices. This work presents a numerical model to simulate the unsteady refrigerant fluid flow in wire-ontube condensers, the kind widely used in vapor compression cycle based domestic refrigerator. The refrigerant fluid flow inside condenser tube is complex and during the refrigeration system operation, long unsteady periods can happen as a consequence, forexample, of starting or stopping the system and variation of operating conditions of the system. During such periods the flow regions can appear or disappear, which difficulties the flow modeling. The present model considers the refrigerant flow inside the tubes divided in a region of superheated vapor flow, two-phase flow region and a subcooled liquid region. The refrigerant flow is taken as one-dimensional and the homogeneous flow model is employed for the two-phase flow region. The fundamental equations governing the flow through wire-on-tube condenser are derived from the mass conservation, momentum and energy conservation laws. The energy conservation equation for the tube wall condenser is also solved to obtain the wall temperature distribution. Finite Volume approach is used to obtain the discretization of the governing partial differential equations and the resulting set of algebraic equations was solved by successive iterations. The model allows prediction, in steady and unsteady states, of refrigerant mass flow rate, pressure, quality, refrigerant and wall temperatures distributions along the tube, as a function of the heat exchanger geometry and operating conditions. In order to validate the developed model, the results obtained are compared with data available in the literature.

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ACEX215

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Three Dimensional Finite Elements Modeling of Human Knee in response to external loads

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The knee is one of the most commonly injured joints in the human body. 3D FE modeling is a useful tool for understanding of the stress – strain distributions within articular cartilage in response to external loads and investigating both the prevention of injury and the pathological degeneration of the joints. This paper proposes 3-D dynamic finite element (3-DDFE) model based on the digital data set from the human Knee section. The analysis was constructed to demonstrate the effectiveness of the 3-DDFE model as a potential Knee fracture investigatory technique. The fresh Computerized Topography (CT) scans were used for the Kneel analysis and the Magnetic Resonance Imaging (MRI) images for the brain model. The 3-DDFE analysis of human Knee would allow the assessment of the injurious effects of different impact conditions and enable the development of enhanced Knee fracture and protection criteria for human Knee.

Objective
The objective of this paper is to develop an anatomically based model of 3-D dynamic finite element of the human Knee, which can be used to predict injury in response to external loads.

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ACEX228
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Direct and Indirect Employee Questionnaires for Assessing Patient Safety in Saudi Hospitals

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This paper provides information on the reliability and validity of direct and indirect employee questionnaires developed in a study of patient safety. A collaborative community perspective represented by King Abdel-Aziz city for science and

technology project currently underway at the King Saud University, examines the impact of human engineering intervention on both direct and indirect employees. This paper describes the employee questionnaires, which survey various elements of the work system (e.g., heavy workload, inexperience/lack education, staffing issues, fatigue, inadequate technology, distractions, lack of vigilance, lack of adherence to medical administration policies, time constraints, and patient safety climate), the care process, and employee outcomes (e.g., job satisfaction, stress, perceived quality and safety of care provided). Data from a sample of 932 direct staff members and 99 indirect members are used to examine reliability, construct validity, convergent validity, and predictive validity. The results provided evidence for the reliability and validity of the study's employee questionnaires.

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ACEX079
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Sensitivity Analysis of a Vehicle Passenger Model for Ride Comfort Assessment

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The paper deals with the parameter sensitivity analysis of a passenger/seat model that can be used for ride comfort assessments. The final aim is to produce a comprehensive framework for enabling vehicle seat designers to develop comfortable (and healthy) seats, especially for those people who spend their lives working on vehicles. In previous papers, a model of the seated passenger was derived by hand and experimentally validated. In this paper such a model has been refined and an additional validation was performed either by comparing it with a mathematical model derived by means of a commercial software, either by experimental activities.
On the basis of such validated models a sensitivity analysis has been performed, aiming to identify the parameters affecting ride comfort. Actually many parameters seem relevant to describe the ride comfort of a seated road vehicle passenger. There are parameters referring to the stiffness and damping of the seat (horizontal and vertical cushions, respectively), referring to the geometry of the seat, referring to the size and inertia properties of the body segments, referring to the stiffness and damping of the different parts of the human body. A total of 47 parameters were accounted for. Different vibration excitations were considered, i.e. vehicle passing over cleats or running on a randomly profiled road. Different discomfort indices taken form the literature and regarding the ride comfort assessment were considered, namely the vibration dose value (VDV), the SEAT index, the ISO/BS weighted discomfort index, the bare rms accelerations respectively along the spine axis and orthogonal with respect to the spine axis.
The results highlight the influence of the excitation of the road, not only on the response of the model, but mainly on its parameter sensitivity analysis. This seems to be a crucial fact that suggests further and more in-depth analyses. Additionally the size and weight (percentile) of the human subject are of crucial importance on estimated ride comfort. Given an irregular road profile, and a human subject, the comfort indices are much sensitive to the dimensions of body segments. Namely the respective lengths of the thigh and of the torso were found to be important. The posture of the body on the seat horizontal cushion seems influencing considerably the ride comfort. The mass of the abdomen emerged as an important parameter in the sensitivity analysis. Other important parameters are the ones describing the many different seat stiffnesses and dampings.

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ACEX074
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Numerical and Experimental Research on a New Design of Plate for Corrective Osteotomy

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On the basis of the unsolved problems, the work is focused on biomechanical evaluation of an osteotomy plate – tibia system of clinically recommended geometry. On the basis of the analysis, properties of alternative biomaterials were determined.
The aim of the biomechanical analysis was determination of displacements, stresses and strains of the system for corrective osteotomy. The obtained results are important for selection of structure and mechanical properties of metallic biomaterials intended for this type of implants. The stresses in the individual parts of the system, depending on displacement of the bone fragments, are very important for appropriate geometrical design, hardening of the applied biomaterial and formation of physio-chemical properties of the surface. For the biomechanical analysis, a new geometrical form of plate for corrective osteotomy was chosen. The analysis was carried out with the use of the finite element method by means of the ANSYS commercial code. In order to verify numerical results, experimental researches were carried out. The obtained results clearly showed that the established geometry and the determined boundary conditions, reflected the real system correctly. In spite of the applied simplifications, it seems that FEM analysis was useful, which was indicated by high correlation between displacements obtained in the numerical and the experimental analyses.

[1] M. Kaczmarek, and J. Marciniak, J. of Acta and Biomech. Vol. 4, p. 408-423, (2002).
[2] D. Ring, K. Prommersberger, J. González del Pino, M. Capomassi, M. Slullitel, and J.B. Jupiter, J. of Bone and Joint Surgery. Vol. 87, p.1503-1509, (2005).

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ACEX102
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Analysis of the Potential Association of Spinal Implant Stability

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The replacement of intervertebral disk is nowadays a common surgery intervention, but knowing its stability is still a crucial question. Usually we use several diagnostic methods for determining it, e.g. RTG or CT. We suppose to use

resonance frequency analysis (RFA) for finding the stability of this junction. The RFA was already used with succeed in dental implantology. For the first time by Meredith in the nineties and this technique has been widely used since.

The first step was to find out natural frequencies of this system: intervertebral disks, vertebrae with intervertertebral disk replacement. We used software MSC.ADAMS, where a simplified model of spinal column with intervertebral disk was carried out. For verifying natural frequencies of the system we have provided in vitro experiments.

We suppose that so called stability depends also up to intervertebral pressure. We found a strong coloration between resonance frequencies and intervertebral pressure, during in vitro experiments. We hope to find out the relation between RFA and the stability in the future work.

[1] Meredith N, Allene D, Cawley P. Quantitative determination of the stability of the implant-tissue interface using resonance frequency analysis. Clin Oral Impl Res 1996; 7:261–67.
[2] Sjőstrőm M, Lundgren S, Nilson H, Sennerby L. Monitoring of implant stability in grafted bone using resonance frequency analysis. A clinical study from placement to 6 months of loading. Oral Maxillofac Surg 2004; 34:45–51.
[3] Rabel A, Köhler SG, Schmidt-Westhausen AM. Clinical study on the primary stability of two dental implant systems with resonance frequency analysis. Clin Oral Investig 2007;11:257–65.

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ACEX135
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Angulation of Outer and Inner Bow Configurations: Comparing 3 High Pull Headgear Systems

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Since the prediction of molar movement in orthodontic treatment is of great importance, a thorough understanding of the relationship between various force vectors and resultant molar movement produced by different configurations of high pull headgear is clinically necessary. The problem is to apply forces via high pull headgear, so that the force on the right molar along tooth axis is of greater magnitude than that on the left molar. Methods: the purpose of this study was to analyze 3 different asymmetric configurations of high pull headgear using finite element method. Results: reaction forces acting on both right and left molar were calculated along mesiodistal direction (distalization force), buccolingual direction (expansion force) and tooth axis in 3 different configurations of high pull headgear and four different levels of loads including 250, 500, 750 and 1000 gr per side.
Conclusion: analyzing the results obtained shows that the configuration in which both inner and outer bows bent upward exerts the greatest intrusion force on right molar, while the configuration with only inner bow bent upward exerts the least intrusion force and the greatest distalization force on the right molar.

Keywords: high pull headgear, molar, intrusion force, distalization force.

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Biomechanical Analysis of the Pressure Distribution on the Sole of the Human Foot

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In this work, a biomechanical study of the pressure distributions on the sole of the foot is presented. For this purpose, the human walk and the mechanical behavior on the sole of the foot is studied. There were considered the average weight of two patients and the geometry of the sole. In the first case, the influence of the pressure on a healthy foot is analyzed and the last one a patient using an unusual and arched footwear.

For this, a finite element model of a Mexican patient is created using experimental and numerical technique. 3D - Scanner Z-Corp® is used to build the model. Furthermore plantar surface images of the patient are analyzed using MATLAB® software in order to locate principal where the stresses affects in several forms. [1] [2]

The purpose of this study is to evaluate the results and locate the principal affected areas for cases in which the flat and arched foot are loaded considering the own weight of each patient. [3] This assessment contributes to know the principal areas of the stress and strain in two different type of foot. This is to help to develop a system to monitoring and collect variables in accordance to the movements in human walk, variations in the centers of gravity, muscle contractions and parameters about rheumatoid arthritis and diabetes mellitus, congenital defects, mechanisms of injury or traumas such as: sport practicing, heavy work, and therefore those caused by deficiencies in surgery.

[1] Jason Tak-Man Cheung and Ming Zhang, Finite Element Modeling of the Human Foot and Footwear, 2006 ABAQUS Users' Conference.

[2] Sandra M. Blanco R., Angelo Zamudio D. y Jaime Delgado S., Sistema telemétrico para el monitoreo de la presión plantar, CLAIB 2007, IFMBE Proceedings 18, pp. 686–689, 2007.

[3] A. Gefen, M. Megido-Ravid, Y. Itzchak, M. Arcan, Biomechanical Analysis of the Three-Dimensional Foot Structure During Gait: A Basic Tool for Clinical Applications. Transactions of the ASME, Vol. 122, DECEMBER 2000.

COMPOSITES AND MULTIPHASE MATERIALS

ACEX043
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TRIBOLOGICAL PERFORMANCE OF POLEYSTER COMPOSITES FILLED

BY VEGETABLE OILS

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Short fiber reinforced polymer composites are nowadays used in numerous tribological applications. New developments are still under way to explore other fields of application for these materials, Friedrich [1]. Polymer composites containing different fillers and/or reinforcements are frequently used as sliding surfaces. Friction is able to induce major consequences on surface polymer properties (wear, scratch, etc.), Bahadur [2]. Kawakame and Bressan [3] concluded that wear resistance of polymers and composites depends on the relative humidity and normal load.

In the present work, friction coefficient and wear rate of polyester composites reinforced by graphite fiber with different diameters and impregnated by vegetable oils (Corn, Olive, and Sunflower oil) were measured to develop new engineering materials with low friction coefficient and high wear resistance which can be used in industrial applications as bearing materials. It was found that composites of 10 vol. % corn oil and 10 vol. % graphite fibers of 0.7 mm diameter show relatively low friction coefficient and low wear rate. Corn and sunflower oil display good tribological behavior of the polyester composites.

Keywords: Polyester Composites, Vegetable oils, Graphite Fibres, Friction and Wear

References

[1] Friedrich K., Zhang Z., and Schlarb K., Journal of Composites Science and Technology, 65, 2329 (2005).
[2] Bahadur S., Journal of Wear, 245, 92, (2000).
[3] Kawakame M., and Bressan J., Journal of Materials Processing Technology, 179, 74, (2006).

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Macroscopic stability analysis in periodic composite solids

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In the theory of composite solids with heterogeneous microstructure subjected to large deformations, the investigation of microscopic stability using homogenization procedures plays a central role since microscopic failure mechanisms in these materials are often induced by instability phenomena. Moreover the stability analysis allows to define the region of validity of the standard homogenization procedure [1,2]. A fundamental measure of stability based on the homogenized constitutive properties is the strong ellipticity condition of the homogenized moduli tensor. This condition allows obtaining un upper bound beyond which the microstructure is surely unstable, thus providing an unconservative prediction of the primary microscopic instability load. In order to investigate alternative macroscopic conditions able to obtain accurate prediction of the microscopic instability mechanisms in composite solids with periodic microstructure, a stability analysis on the micro and macro scales is here carried out. Numerical applications for fibre-reinforced and cellular

microstructures with hyperelastic constituents are developed by implementing a one-way coupled finite element approach. Results show the ability of the proposed macroscopic stability conditions based on the positiveness of the homogenized moduli tensor related to specific work-conjugate stressstrain measures, to give conservative predictions of the primary instability load along the examined monotonic macrostrain paths.

[1] G. Geymonat, S. Muller, N. Triantafyllidis, Arch. Ration. Mech. Anal., 122, 231-290 (1993).
[2] C. Miehe, J. Schroder, M. Becker, Computer Methods in Applied Mechanics and Engineering, 191, 4971–5005 (2002).

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ACEX062
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Effects of Nano-CaCO3 Content on Tensile Properties of PPS/GF Ternary Composites

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The nanometer calcium carbonate (nano-CaCO3) filled polyphenylene sulfide (PPS/GF) reinforced with glass fiber ternary composites were fabricated in this paper, and their Young's modulus, tensile strength and tensile elongation at break were measured at room temperature, to identify the influence of the content and surface treatment of the nano-CaCO3 particles on the tensile mechanical properties of these ternary composites. It was found that the Young's modulus, tensile strength and tensile fracture strength of the composites increased slightly with an addition of the weight fraction ( ) of the nano-CaCO3 particles, and the maximal increase of them was more than 7.5% at . When was less than 4%, the tensile elongation at break of the composites increased obviously and then increased gently with an increase of , and the maximal increase was more than 21% at . Relatively, the tensile properties of the PPS/GF/nano-CaCO3 composite systems for the particle surface treated with titanate coupler were somewhat better than those of the systems for the particle surface treated with stearic acid.

Keywords: PPS; glass fiber; nano-CaCO3; composite; tensile mechanical property

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ACEX068
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Static Analysis of Antisymmetric Cross-Ply Thick Laminated Plates Using a Layerwise Theory: The Lévy-Type Solution

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The full LWT of Reddy [1] is used to analyze the bending problem of Antisymmetric cross-ply thick laminates with finite dimensions. The solution procedure is based on a generalized Lévy-type solution [2] where two opposite edges of the plates are simply supported and the remains are arbitrary. Combinations of simply supported, clamped and free boundary conditions are considered. The governing equations of equilibrium, which are derived by using the principle of minimum total potential energy, are transformed into a set of coupled first-order linear ordinary differential equations with constant coefficients. The exact solutions of these equations are obtained using the state-space concept. Then application of the boundary conditions yields equations for the deflections and stresses. The numerical results are converged, with desired level of accuracy, by using ten numerical layers in each physical lamina. For all the results, the static interlaminar stresses are computed with the help of local equations of equilibrium. The plate geometry, which characterizes a very thick plate, is considered to be an adequate test of reliability of the method at least as far as simply supported plates is concerned. The results obtained from this theory are compared with the Lévy-type solution of various equivalent single-layer theories that are available. These include the classical laminated plate theory (CLPT), the firs-order shear deformation plate theory (FSDPT), and the third-order shear deformation plate theory (TSDPT). Moreover, the ANSYS finite element package is used to analyze the same example problems. Finally, the results are given and compared in graphical and tabular form.

Keywords: Thick laminates; Static analysis; Layerwise theory; Exact analytical solution

References

[1] J.N. Reddy, A generalization of two-dimensional theories of laminated composite plates,
Commun Appl Numer Methods, 3, 173 (1987).
[2] J.L. Goldberg, A.J. Schwartz, Systems of Ordinary Differential Equations, An Introduction (Harper and Row, New York, 1972).

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Investigation of the influence of ground tire rubber (GTR) in the mechanical and thermal properties of recycled thermoplastic materials

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The elastomeric wastes, coming from the shredding of tires, are very abundant. In Europe about 60% of end-of-life tires are recovered in some way and the rest ends up in storage or in landfills [1]. This storage or deposit generates a source of

environmental problems like mosquitoes and rats and a high risk of burning and consequently a high toxicity risk. The research for new alternatives for use it in different ways is a world target, especially obtaining products of more added values. One of the possibilities is the investigation of mixtures between GTR and plastics wastes, in our case using thermoplastics waste [2,3]. Thermoplastics Waste (TPW) are also abundant, although the nature of thermoplastics let us, in some cases, the incorporation into the production process again, but the percentages of TPW to new products is limited in amount due to the variation in properties of obtained product, normally reducing the mechanical and degradation properties. The absorption of waste by industries could be high when using only TPW for manufacturing products but obtaining consequently low properties [4].
The present work analyse the influence of the addition of GTR particle to TPW in the mechanical and thermal behaviour on thermoplastic recycled matrices. The mixtures are homogenized previously in hot rollers and then sintered using a hot press. Subsequently we analyze the adhesion phenomena produced between GTR particles and the thermoplastic matrix. The interaction between the particles of GTR and the matrix is responsible for the final properties of the material obtained.

[1] X. Colom, F. Carrillo, J. Cañavate, Compo Part A: Appl. Sci. Manuf., 38(1), 44 (2007).
[2] L. Calabrese, A.Valenza, Compo. Sci. Tech., 63(6), 851 (2003).
[3] A.P. Mathew, S. Packirisamy, S. Thomas, Polym. Degra. Stab., 72(3), 423 (2001).
[4] J. Qin, H. Ding, X. Wang, M. Xie, Z.Yu, Polym. Plast. Tech. Eng., 47(2), 199 (2008).

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Computational Modelling and Experimental Characterisation of Heterogeneous Materials

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Heterogeneous materials can exhibit behaviour under load that cannot be described by classical continuum elasticity. Beams in bending can show a relative stiffening as the beam depth tends to zero, a size effect. Size effects are captured in higher order continuum elastic theories such as micropolar elasticity. The drawback of higher order theories is the requirement of addition constitutive relations that are often difficult to establish experimentally. Further more the finite element method, of great benefit in classical elasticity, has shown limitations when applied to micropolar elasticity. The determination of additional constitutive relations and the computational modelling of micropolar elasticity will be discussed in light of the simple problem of a model heterogeneous material in 3 point bending.
The model heterogeneous material was created by drilling holes in aluminium bar in a regular pattern, with the hole axis through the plane of bending. The bending tests show that a size effect is present. These results are compared against discretely modelling the beam geometries in a finite element package, which again shows the size effect. These two bending test are used to extract the additional material properties required for micropolar elasticity. A comparison is then made against analytical solutions, numerical solutions using a micropolar beam finite element and a micropolar plane stress control volume method.
It will be shown that the need for extensive experimental testing to determine the additional constitutive properties may not be necessary with the appropriate use of numerical methods.

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ACEX116
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Multi-Component Composites

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Assuming that a composite material is a complex structure it is obvious that is hard to describe all its properties in terms of its parts properties. The electromagnetic properties of the composite depend not only on the electromagnetic properties of the components but on quality and nature of the interface between the components and its electromagnetic properties.

One question is, for example, if it is possible that a composite material can be, at the same time, a meta-material. Powders are used as fillers in order to obtain bi-components composites. There is no structural order in such a filled composite, the most important aim being the uniform distribution of particles in matrix. The powders can be dielectric as talc, clay or ferrite can be magnetic active as ferrite, or electric active as CNT or carbon nano-fibers. All these powders have effects on the electromagnetic properties and mechanical properties of the composite [1]. There are some inconveniences regarding the use of powders because their particles tend to aggregate when are dispersed into a polymer [2]. That is why even their use is improving the electrical properties of composites the powders cannot be used in high concentrations [3].

The electric and thermal properties of filled epoxy are investigate through standard methods to find out the best filling solution in order to form fabric reinforced composites with special properties. It is possible that using various fillers in various layers of a composite to obtain materials with controllable properties. Also, various fabrics used as reinforcement in various layers of a laminate could offer the opportunity to control all the properties of a composite material.

[1] C. E. Powell, G. W. Beall, Current Opinion in Solid State and Materials Science, 10, 73 (2006).
[2] R. Guzman de Villoria, A. Miravete, Acta Materialia, 55, 3025 (2007).
[3] K. Tohgo, A. Masunari, M. Yoshida, Composites: Part A, 37, 1688 (2007).

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ACEX145
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Fabrication of Smart Structure Using Shape Memory Alloy Wire Embedded Hybrid Composite

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Shape Memory Alloys (SMA) have been actively studied in many fields utilizing their high energy density, and an SMA wire embedded composite, especially, could be used as smart material for load carrying structure and actuator. The composite material such as Glass Fiber Reinforced Plastic (GFRP) can sustain large load, but at the same time the high stiffness of the material limits the displacement range of the SMA wire embedded composite. In this research, an SMA wire embedded hybrid composite was designed and fabricated to make a larger displacement than the SMA wire embedded single composite. The hybrid composite is designed as ∩-shape and it is comprised of three parts with different stiffness materials, GFRP with higher stiffness at both ends and silicone rubber with lower stiffness in the middle to increase the displacement range of the structure. The SMA wire embedded hybrid composite could be actuated by applying electric current through the embedded SMA wire. The fabricated composite was mechanically fastened to prevent separation between the wire and the composite laminae induced by temperature rise of the wire. The displacement of SMA wire embedded hybrid composite was examined by measuring strain of the upper and lower surface of the composite.

[1] P. Krulevitch, A.P. Lee, P.B. Ramsey, J.C. Trevino, J. Hamilton and M.A. Northrup, J. Microelectromech. Syst., 5, 270 (1996).
[2] T. Sugawara, K. Hirota, M. Watanabe, T. Mineta, E. Makino, S. Toh and T. Shibata, Sensors and Actuators, A130, 461 (2006).
[3] E.A. Khidir, N.A. Mohamed, M.J.M. Nor and M.M. Mustafa, Sensors and Actuators, A147, 593 (2008).

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How to modify resin formulations to optimize infusion process?

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The manufacturing of large composite parts in the field of aeronautics is increasingly important because the gain from weight-saving is of most significance.

Mechanical properties of composite materials depend on the used manufacturing processes. Composite Liquid Molding processes are currently used and more precisely the infusion processes. In this case, the resin flows through the fibrous medium by creating vacuum between input and output of the infusion system under in the transverse and longitudinal directions of the reinforcements.

In order to better control this process, it is necessary to define new resins gathering suitable properties for an optimized infusion process such as viscosity, thermal conductivity, gel time adapted to pieces dimensions and wettability on fibre surface…

Thinking and searching for a resin in aeronautics applications for structural pieces lead to use epoxy resin. Consequently this work is based on collaboration between researchers in process, formulation and physico-mechanical characterisation fields.

The first results of this PhD research work is devoted to the optimization of the different resins cure cycle by use of differential scanning calorimetry and rheometry. Classically the cure process is divided in three steps. The first temperature must be judiciously chosen to make the viscosity of the resin to be low enough and the cure limited so that it allows a satisfying impregnation of reinforcements in the infusion step. The purpose of the second step is to develop the polymer crosslinking. Then, a post-cure is used to achieve the polymerization by reducing the number of unreacted epoxy endcaps. For one resin among all, degradation temperature and last cure temperature are dangerously close. As evidence the mechanical properties are sharply decreased during use.

In the second objective of this work, some mechanical parameters such as viscosity before curing and as elastic modulus, glass transition temperature, rupture load and elongation at break after curing are reported and analysed compared to the industrial requirements before and after ageing in water.

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Failure Mode for Unidirectional Fiber Reinforced Composites

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The paper presents a failure model applicable for unidirectional fibers reinforced composites that point out the fiber-matrix interface role in the mechanics of failure process. The model is applicable in any plane stress state case. The ABAQUS/Standard finite elements program is used to point out the applicability of failure model. The deformation of a rectangular plate with dimensions of 100x100 mm, having a hole in the middle with the diameter of 50 mm, was analyzed. The plate is realized from composite materials with unidirectional fibers oriented at an angle of 45º. It was chosen this geometry because it is often met in assembling process of composite structures. The visualization and the interpretation of the simulation results have been made with the help of ABAQUS/Viewer module. The obtained diagrams reflect a very good concordance between the predictions of the failure model and the results provided by other models. This confirms the hypothesis that stayed at the foundation of the unidirectional composite failure model formulation.

[1] H. Iancău and O. Nemeş, Materiale compozite. Concepție şi fabricație (Ed. Mediamira, Cluj-Napoca, 2003).
[2] E. Sabău, Contributions regarding mechanical behaviour of composite structures with polymeric matrix, PhD. Thesis, (Technical University of Cluj-Napoca, Romania, 2009).
[3] L.P. Kollár and G.S. Springer, Mechanics of composite structures, (Cambridge University Press, USA, 2003).
[4] M.R. Jones, Mechanics of composite materials, Second Edition, (Taylor & Francis, USA, 1999).
[5] O.O. Ochoa and J.N. Reddy, Finite element analysis of composite laminates, (Kluwer Academic Publishers, USA, 1992).

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VIP-ACEX031
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Experimental Characterization of the Influence of Thermal Residual Stresses on the Stiffness of Composites Plates

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The adequate use of composite laminates requires the development of accurate numerical and experimental tools for the design of these structures. In this work the influence of cure induced thermal residual-stresses on the stiffness of reinforced carbon/epoxy plates was experimentally characterized.
Three different plate stiffener geometries are used to illustrate the effects of structural topology. One group of plates was manufactured by co-curing the reinforcers at 177 oC and a second group was manufactured by secondary bonding of the reinforcers to the plate at room temperature. Square reinforced plates (360 mm × 360 mm), produced with symmetric laminates, were mounted in a test rig such that they were simply supported at the four vertices. The loads were statically applied to the plates at the center of the plate and at a point distant 108 mm from the center. The out of plane displacements of the plates were measured using a non-contact optical device with accuracy of 0.01 mm. For each tests, two images were captured. The first image was taken for unloaded plate whereas the second was captured after applying the load. The subtraction of the two images yields the plate displacements due to the applied loading.
Finite element models were implemented in Abaqus® taking the geometric non-linearities into account. Good agreement between experimental and numerical results was obtained. The results demonstrate the importance of thermal residual stresses on the stiffness of thin composite plates and the importance of geometric non-linear effects.

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ACEX083

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Physical-chemical character of phenol-formaldehyde resin in pyrolysis

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To study the pyrolysis chemical character of phenol-formaldehyde (PF) resin, non-isothermal kinetics is investigated using thermogravimetry analysis (TGA) at controlled heating rates. The research indicates that the pyrolysis process consists of four consecutive distinct stages. The anterior two stages are named as diffusion reaction region, while the third stage is characterized as a random nucleation and its subsequent growth, and the latest one can be defined as a chemical reaction region. According to the calculation results of the apparent activation energy Ea, the changes of entropy, enthalpy and Gibbs free energy, the anterior three stages are non-spontaneous processes. While the fourth stage proceeds spontaneously.

[1] J.I. Ozaki, W. Ohizumi, A. Oya, Carbon, 38, 1499 (2000)
[2] B.D. Park, B. Riedl, E.W. Hsu, Polymer, 40, 1689 (1999)
[3] K.A. Trick, T.E. Saliba, S.S. Sandhu, Carbon, 35, 393 (1997)

[4] K.A. Trick, T.E. Saliba, Carbon, 33, 1509 (1995)
[5] N.I. Makarevich, N.I. Sushko, A.I. Ivanov, J. Appl. Spectrosc., 265,31 (1977)
[6] L. Vlaev, N. Nedelchev, K. Gyurova, J. Anal. Appl. Pyrol. 81, 253 (2008)

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An Analysis of Jelly Roll Expansion under full Charge State of Li-Ion Secondary Battery

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The secondary battery is a device which can recharge. The kind of secondary batteries were NiCd, NiMH, Li-polymer and Li-ion battery etc.. A considered analysis model was Li-ion batteries. Those batteries have the best efficiency in same space. Li-ion secondary battery includes cathode, anode, separator and each safety device such as can. A considered analysis model of Li-ion secondary battery was jelly roll type. Jelly roll type was composed many layers such as cathode, anode, separator and foil. In this paper, simulation of jelly roll expansion under SOC(State of Charge) 100% was carried out. The expansion analysis was performed by applying material properties of cathode, anode, separator and foils which obtained through the uniaxial tension test. The expansion analysis of of Li-ion secondary battery was carried out by finite element analysis.

[1] ANSYS MANUAL, Swanson Analysis Systems Inc. (2006).

DAMAGE AND FATIGUE

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DAMAGE DETECTIONS OF NONLINEAR VIBRATING THERMALLY LOADED PLATES

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Vibration-based methods (VBM) are widely used for structural health monitoring and damage detection (DD) in structures. They are based on the fact that any changes introduced in a structure result in changes in its dynamic behaviour. The application of these methods sometimes is limited by the need of a precise enough model of the structural vibration response. If some nonlinearities or environmental conditions (like the elevated temperature, for example) are not taken into account in the model, the methods will give a false alarm due to a discrepancy between the measured and the model response. The temperature changes can and do affect substantially the vibration response of a structure. Thus in some cases the presence of a temperature field can either mask the effect of damage or increase it, which will cause a VBM method to give no alarm when a fault is present or give a false alarm. This is why it is vital to be able to take into account the temperature changes when developing VBM procedures. The main objectives of this study are: (i) to study the influence of the defects, the elevated temperatures and their combination on the dynamic characteristics of the plate and on its geometrically nonlinear dynamic response; (ii) on the base of the analyzing Poincaré map of the structural response to propose criteria for identifying the irregularities (defects) in the structure, considering the elevated temperature.
The application of the proposed approach is demonstrated on rectangular and square plates with defects at elevated temperatures. The temperature is accepted uniformly distributed along plate surface and thickness. The plates are subjected to a harmonic loading which leads to large amplitude vibrations and the influence of the damage on time-history diagrams of the plate, as well as on the geometry of the phase-state is studied. An approach was developed t which applies a criterion based on damage features which are in the same time sensitive to temperature changes. These features use the Poincaré maps of the structural vibration response. Taking into account the temperature influence on the extracted features allows the detection of damage and shows its location for structures subjected to temperature changes. The proposed DD index and the DD criterion show a very good ability to predict the damage and its location.

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Effects of Manufacturing-Induced Residual Stresses and Strains on Hydrogen Embrittlement of Cold Drawn Steels

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Cold drawn wires of eutectoid pearlitic steel are widely used for prestressing concrete structures (civil engineering) that usually work in hostile or aggressive environments, so that stress corrosion cracking of prestressing steel is a problem of major technological concern. In addition, there is general agreement that hydrogen embrittlement (HE) plays an important role in the environmental cracking of such a steel due to particular working conditions or to the local electrochemistry in the vicinity of a crack tip. In this framework, the Standard Test in Ammonium Thiocyanate was proposed by the International Federation of Prestressing (FIP) as a suitable experimental method for checking the susceptibility of high-strength prestressing steels to stress corrosion cracking in general, and particularly to hydrogen embrittlement. However, the FIP tests usually exhibit a high scattering of the results, which increases as the externally applied stress decreases. It can be caused by the distribution of residual stresses generated in the vicinity of the wire surface during the manufacturing (cold drawing) process.

Previous research [1] established an important milestone by obtaining a quantitative relationship between the level of residual stress (represented by theoretical residual stress laws) and the fracture behaviour of cold-drawn prestressing steel wires under HE conditions, but a detailed analysis of the influence of real residual stress profiles caused by cold drawing on the HE susceptibility of the wires has not been performed yet. This paper goes further in the analysis, so that the earlier developed computer model [1] is advanced [2-6] and applied to analyse the influence of the residual stress-and-strain profiles after cold drawing on the HE susceptibility of prestressing steel. Firstly, the drawing process is modelled by the finite element method to obtain the residual stress and strain distributions. Later, a model of hydrogen diffusion assisted by stress-and-strain is applied to compute the concentrations of hydrogen at every point and at every instant. Numerical results show the relevant role of residual stress and strain field in hydrogen diffusion, as well as the differences between short and long exposure times.

[1] Toribio, J and Elices, M., Int. J. Solids Structures, 28, 791-803, 1991.
[2] Toribio, J. and Kharin, V., Fatigue Fract. Engng. Mater. Struct. 20, 729-745, 1997.
[3] Toribio, J. and Kharin, V., Nuclear Engng. Design, 182, 149-163, 1998.
[4] Toribio, J. and Kharin, V., Int. J. Fracture, 88, 233-245, 1998.
[5] Toribio, J. and Kharin, V., Int. J. Fracture, 88, 247-258, 1998.
[6] Toribio, J. and Kharin, V., Fusion Engng. Design, 51-52, 213-218, 2000.

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Rate Sensitivity Effect on the Fatigue Behaviour of Electrodeposited Nanocrystalline Nickel

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Electrodeposited nanocrystalline (nc) nickel (Ni) with an average grain size of ~ 40 nm was found to have a greater value of strain rate sensitivity (SRS) in comparison with its commercial bulk counterpart, which has an average grain size of a few tens of micrometers, even at room temperature; the reason for this abnormality is still under investigation and the change in the plastic deformation mechanism with decreasing grain size from the dislocation-dislocation interaction to the grain boundary diffusion-controlled mechanism like grain boundary sliding [1] or to the dislocation-grain boundary interaction-mediated mechanism [2] has been reported recently. This fact implies that the strain rate may play a meaningful role in the fatigue behaviour of the electrodeposited nc Ni by introducing a higher flow stress with increasing strain rate and affecting the crack initiation mechanism.

In this study, the rate sensitivity effect on the high-cycle fatigue behaviour of the electrodeposited nc Ni film with a thickness of 40 mm was investigated by varying test frequency in the range of 0.3-30 Hz; the tests were carried out at room temperature under stress control mode. The results showed a clear rate dependence of fatigue life behaviour. At a given stress condition, the fatigue life increased with increasing frequency. The possible reasons for this enhanced fatigue life with increasing frequency are discussed in relating with the SRS, the predominant plastic deformation mechanism, and the crack initiation mechanism.

[1] M.A. Haque and M.T.A. Saif, PNAS, 101, 6335, (2004).
[2] Y.M. Wang, A.V. Hamza and E. Ma, Acta Mater., 54, 2715 (2006).

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Evaluation of characteristics for welding part in MIG welded by ROBOT for Al ship materials

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The fiber-reinforced plastic (FRP) ships, have many environmental and recycling problems, and there is no method to decommission an FRP ship. Al alloys are a superior to material for shipbuilding than FRP. However, A passivity film of Al alloys are destroyed in a seawater environment by Cl- ion, resulting in pitting[1-2] or intergranular corrosion[3]. The welding for Al alloy materials has many problems, such as deformation by welding heat, the working environment and weldin engineer technique.

In the study, it was carried out dissimilar welding for 5083-O and 6061-T6 Al alloy. The electrochemical and mechanical characteristics evaluated for specimen welded by ROBOT. The hardness of welding zone is lower than base metal and 5083-O heat affected zone. At the result of tensile test, the yield strength and tensile strength in welded with welding material of ER5183 present lower value than those of ER5556. The polarizaion trend for all metal showed the effects of concentration polarization due to oxygen. The Tafel experiments revealed that ER5183 welding specimen had the lowest corrosion current densities.

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[1] S. C. Dexter, G. Y. Gao, Corrosion, Vol. 44, p 717 (1988)
[2] P. C. Noble, Metals Forum, Vol. 6, p 59 (1983)
[3] K. Ravindranath, S. N. Malhotra, Corrosion, Vol. 50(4), p 318, (1994)

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A Study on Fracture Phenomena of Glass Filled Ceramics Using Shock Tube

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Fracture phenomena of plate and dome shape using shock tube for glass filled ceramics were carried out. Glass filled ceramics have been considered as a promising candidate material for the dome port cover of air breathing engine. This

part of the air breathing engine has an important role separating solid and liquid fuel, and needs the frangible characteristics that the fracture of a part should not affect the internal components of combustion. The objectives of this study are to evaluate the fracture pressures for various thicknesses and diameters of shock impact area. Also fracture phenomena of separated membrane using a shock tube compare with analytical method. The experimental apparatus consists of a driver, a driven section and a dump tank. The used material is glass filled ceramic made from Corning Company. Specimens are used 3, 4.5 and 6mm thickness. It is expected that the results obtained from this study can be used in the basic data for the dome port cover design of an air breathing engine.

Keywords: Glass filled ceramic, Shock tube, Fracture pressure, Fracture phenomena, and Dome port cover

[1] Masao Takegoshi and Takeshi Kanda, "Research Activity on Rocket-Ramjet Combined cycle Engine in JAXA," AJCPP 2008 (2008)
[2] Minwei Gong and Yiannis Andreopoulos, "Shock Wave Impact on Monolithic and Composite Material Plates: The Preferential Aeroelastic Response,"Journal of Sound and Vibration, No. 313, pp. 171~194 (2008).

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ACEX121

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Mode II Fracture Characterization of Sandwich Interfaces with the Use of a New Data Reduction Scheme

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This work addresses a numerical and experimental study on the End Notched Flexure (ENF) test, applied to fracture characterization of sandwich interfaces in pure mode II. The objective is to obtain the cohesive law under pure mode II adequate to simulate damage at the interface between the skin and the core. The accurate prediction of the cohesive laws characterizing damage under pure mode loading is essential for the formulation of cohesive mixed mode damage models used to assess the strength and reproduce failure of composite structures. A new data reduction scheme based on the beam theory and crack equivalent concept, named compliance-based beam method (CBBM) is proposed to measure the fracture energy in pure mode II. The formulation of this method accounts for the fracture process zone effects and considers an equivalent crack length in order to overcome difficulties inherent to crack monitoring during propagation. This method is applied to the experimental ENF tests and the fracture energy is obtained. In a next step, numerical simulations of the ENF tests are performed with the use of a cohesive mixed mode damage model [1] implemented within interface elements to simulate crack initiation and propagation at the respective interface. An inverse method was followed to obtain the remaining cohesive parameters of the model based on fitting the numerical P-d curve with the experimental [2]. It was verified that the numerical R-curves agree with the experimental ones validating the proposed data reduction scheme.

[1] R.D.S.G. Campilho, M.F.S.F. de Moura and J.J.M.S. Domingues, J. Comp. Sc. & Technol., 65, 1948 (2005).
[2] M.F.S.F de Moura, R.D.S.G. Campilho and J.P.M. Gonçalves, J. Comp. Sc. & Technol., 68, 2224 (2008).

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ACEX124

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Fatigue Behaviour of Bonded Anchors Subjected to Tensile Loads

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Following up recent fatigue analyses on the behaviour of noise barriers for high speed railways at train transits, threaded rods bonded with epoxy resin for column base plate anchorage had to be qualified. A fatigue test campaign was carried out at Fischer Laboratories in Denzlingen (Germany) on M20 and M30 (Grade 8.8) threaded rod samples embedded with FIS EM resin.

The main aim was to analyse failures in the medium and high cycle fatigue regime and to obtain design curve related to well-defined probabilities of survival. The results from fatigue tests were found to be very satisfactory as far as the resin performance was concerned. In fact, under tensile loads carried out under a nominal load ratio R=0, all fatigue failures always occurred on the steel rods notwithstanding the embedment length was that suggested in technical manual (i.e. the length relating only to static loading). The new fatigue data, compared also with other data from available for comparable threaded applications recently tested at Fischer laboratories allowed us to assess the fatigue performance of threaded rods bonded with epoxy resin, a matter where there is still poor information in the technical literature [1]. The tests included also threaded rods (M16 and M30, Grade 8.8), obtained from corrugated pipes, embedded in holes with an inner diameter constant and equal to 40 mm. Also these rods were filled with epoxy resin FIS EM. In these cases, too, fatigue failures took systematically place in the threaded rods, under the nut, even when the specimens with a M30 diameter were installed very close to the concrete block edge (70 mm away from it). Finally, all collected data were statistically reanalysed by using a log-normal distribution and the relevant scatterband is provided in the paper together with the most typical fracture surfaces relating to medium and high cycle fatigue regime.

[1] R. Eligehausen, R. Mallèe and J. F. Silva, Anchorage in Concrete Construction, Ernst & Sohn, 2006.

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New Data Reduction Scheme Applied to the ECT Test for Mode III Interlaminar Fracture Characterization of Composites

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The interlaminar fracture characterization of composites under mode III loading was conducted using the Edge Crack Torsion (ECT) test. Experimental tests and numerical analysis were performed. The numerical analysis was executed considering a mixed mode cohesive damage model implemented within finite element simulations. It was verified that non self-similar crack growth occurs, which explains the dependency of the perceived critical strain energy release rate (GIIIc) on the crack length. A new data reduction scheme based on specimen compliance is proposed [1] for accurate GIIIc measurements. This new method only requires the initial compliances of the specimen being tested and the one of an uncracked specimen, as well as the critical displacement corresponding to crack initiation. It does not involve the often employed compliance calibration, which requires several ECT specimens with different crack lengths. Nevertheless, specimens with three different crack lengths (15, 18 and 20 mm) were tested for further assessment of the methodology proposed. In addition, a new lay-up proved to avoid the significant nonlinearity observed before the peak load that hinders a clear identification of the initiation point [2]. Comparisons between numerical and experiments provided consistent results.

[1] de Moura M.F.S.F., Fernandez M.V., Morais A.B. and Campilho R.D.S.G., Eng Fract Mech, 78, 469 (2009).
[2] de Morais AB, Pereira AB, de Moura MFSF, Magalhães AG. Compos Sci Technol, 69, 670 (2009).

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ACEX169
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Numerical Simulation of Crack Propagation in a Degraded Material under Mechanical and Environmental Effects

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We presented a numeric model based in a synthesis of the Fracture Mechanics and of the Continuum Damage Mechanics to treat the problem of the crack propagation in elastic regime, under the effect of a mechanical action and of an environmental action, characterized by the hydrogen, which reduces the fracture toughness of many metals and metallic alloys, most structural steels included. The crack is loaded in tensile opening mode in plane strain state and only two damage types are considered: a mechanical damage produced by a static load and a nonmechanical damage produced by the hydrogen diffusion of the mouth to the crack tip. The crack propagation is considered as the result of the interaction between the balance of forces and the global energy in the crack body-load system and the process of damage accumulation [1]. The equations that describe the evolution of the variables at the crack tip form a non-lineal system of ordinary differential equations that is calculated by means of the 4th order Runge-Kutta method. The obtained results show the influence of the hydrogen concentration in the decrease of the time of growth and crack propagation, what keeps good correlation and consistency with macroscopic observations of the hydrogen embrittlement phenomena. Additionally, the behavior of the curve of evolution of the stress intensity factor with the time, obtained for different load and concentration conditions, shows a similar behavior to the one reported in the scientific literature, allowing a better understanding of the process of beginning and crack propagation in aggressive environments, also demonstrating, the validity of the adopted model in the elastic regime.

[1] V.V. Bolotin and A.A. Shipkov, International Journal of Solids and Structures, 38, 7297–7318 (2001).

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Dynamic crack propagation in composite structures

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During the last few decades many efforts have been made to analyze static and dynamic fracture behavior, giving rise to several studies devoted to predicting crack growth phenomena. However, progress toward a complete understanding of dynamic fracture mechanics has been limited by the intrinsic complexities of the growth phenomena, such as time dependence, high speed crack propagation and multiple cracks with branching mechanisms [1]. In the framework of composite structures, the laminated structures are formed by weak interfaces, in which the interfacial cracks are constrained to propagate between the interfaces suppressing any tendency to branch or kink out of the weak planes. [2]. In the present work, an investigation on the dynamic behaviour of propagating crack in composite structure is proposed. Closed-form expressions in the framework of steady state crack growth for simple cases involving mode I and mode II loading conditions are provided, whereas for schemes concerning mixed mode loading conditions, an analytical procedure to evaluate the ERR and its modal components is proposed by the use of the virtual crack closure technique. Moreover, the analysis is proposed in a non-stationary framework, in which the influence of time dependence and the inertial forces are taken into account more specifically. The structural model is developed by means of a finite element formulation based on 2D continuum model. In order to predict the crack growth phenomena, a combined formulation based on "Moving Mesh Method" and “Remeshing Technique” is developed. An investigation on loading schemes involving mixed mode conditions are proposed and the main features of the dynamic fracture behaviour concerning the energy release rate evaluation, the crack growth and the corresponding limiting tip speeds are evaluated.

[1] Ravi-Chandar K, Dynamic Fracture of Nominally Brittle Materials, International Journal of Fracture 1998; 90(1):83-102.
[2] Rosakis AJ, Intersonic shear cracks and fault ruptures, Advances in Physics 2002; 51(4):1189-1257.

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ACEX234
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A Study on the Leakage of High Pressure Hose Assembly using Finite Element Analysis

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Power steering hoses use to steer a vehicle for supplying hydraulic power generated by hydraulic pump driven by engine. The life of high pressure hose which is to transfer the hydraulic power to steering cylinders were affected by vibrating and heating coming from the engine. Failure mode of power steering high pressure hoses is the leakage which occurred from fitting part and which could be verified by resulting analysis and observation of the cutting the hose assembly which were used to vehicle to check leakage path. Failure mode was verified as an experiment that outer layer rubber of high pressure hose assembly was damaged originating from sharp corners of inner part sleeve during swaging process, although the main reason of the occurred leakage was the characteristic of rubber which is hardened as long as used period. The leakage phenomenon could observe as reappearance of fluorescent material, which was coming from the space between reinforced material and outer rubber. The objectives of this study are the analysis of the stress and strain distribution during the swaging process of high pressure hose assembly to find out where the stress concentrates and the prove on leakage phenomenon of high pressure hose assembly in comparison with results of finite element analysis.

Keywords: High pressure hose assembly, Leakage path, Fluorescent material, Power steering, Failure mode, Finite Element Analysis

[1] Seung-Bum Kwak and Nak-Sam Choi, "Micro-Damage Formation of a Rubber Hose Assembly for Automotive Hydraulic Brakes under a Durability Test" Engineering Failure Analysis, No. 16, pp. 1262~1269 (2009)
[2] C. D. Stewart & D. G. Gorman, "Observation of a Pressurised Hydraulic Hose under Lateral Liquid Impacts", Composite Structures, No. 28, pp. 255~261 (1994)

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Crack Growth Evaluation on Helicopter Fuselage under Spectrum Loading

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Damage Tolerance method for structural integrity evaluation of helicopters fuselages requests a detailed FE analysis validated through a dedicated experimental survey. This approach permits an important maintenance cost reduction and a structural safety improvement of helicopters frames.

The construction of advanced FE models for the stress assessment can be after used for the identification of the most critical area for crack nucleation and growth; these area permits a continuous monitoring of the damage with a sensors network (Comparative Vacuum Monitoring, Optical Fiber Sensors, Crack Propagation Gauges, etc). Moreover the final research aim is to obtain a reliable method to assess the damage accumulated in the fuselage by means of an advanced prognostic models that allow the real time definition of schedule for periodic and special inspections.

Thus an increase in the safety of the aircraft by prognostic and monitoring of the frame is the main objective; in addition, the results achieved will be useful in the cost reductions regards maintenance operations and life extension for aged aircraft.

In this paper, a review of the state-of-the-art concerning the Structural Health Monitoring applied on helicopter fuselages will be described. In particular the review will be focused on the numerical FE models of cracked structures

(Fig. 1) and on residual life evaluation on helicopter fuselage, and the results will be compared with experimental relief (Fig. 2).

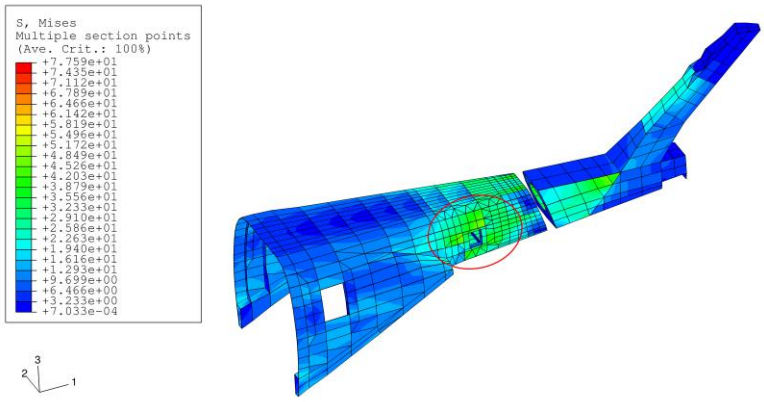

Fig. 1 – FE model of helicopter fuselage with cracked area

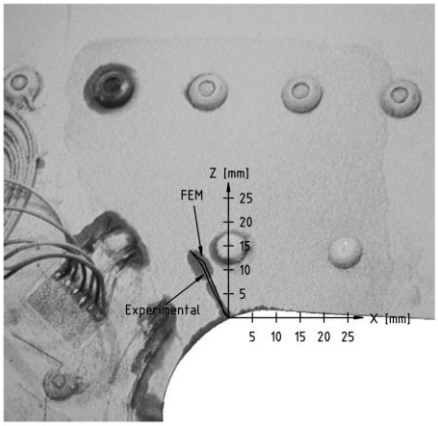

Fig. 2 – Experimental crack growth

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ACEX070
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Mesh Sensitivity in the Simulations of Fatigue Crack Growth by Blunting and Re-Sharpening

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Results of extensive analysis of the mesh-sensitivity of large-deformation near-tip patterns under cyclic loading are summarised in this paper. Notorious mesh sensitivity of solution, which commences at spontaneous shear banding, is evidenced. Observed instabilities seem to have roots in common attribute of inelastic behaviours, which consists in their intrinsic bifurcating performance associated, following Hill and Rice, with the loss of ellipticity of differential equations, and the loss of solution uniqueness as a consequence. Then, revealed mesh sensitivity turns out to be not a numerical artefact, but a consequence of the inherent bifurcating behaviour of the problem solutions.

In published analyses of plain test-pieces such localizations were triggered by intentional local imperfections in otherwise homogeneous and uniformly meshed test-pieces — either geometry alteration or material softening. This latter in effect is done near the crack tip unintentionally through mesh-sensitive alterations of FE element stiffnesses with respect to the "true" material one within chosen mesh and FE technology. Such activators of bifurcation do the same as the mentioned intentional ones. Anyway, generated FE results appear reasonable, e.g., always agree with theoretical slip-line fields.

Nevertheless, the relationship between the continuum problem, of its FE interpolation, and the physical reality, is still an open question. Under solution non-uniqueness, shear banding is a possibility, but not a certainty, for constitutive models lacking intrinsic length scale. On the other hand, shear banding in real materials is set by material-dependent length scales of microscopic slip events. To this end, intrinsically absent in the microstructureless continuum, length scales are present de facto in their FE implementations. Then, it may be tempting to assign the meaning of a material parameter to FE size, and the significance of a material unit to FE itself, which then must be kept constant for a given material. The particular bifurcating solution then can acquire objectivity favoured by a particular microstructure

ACEX222
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Failure Analysis of a Large Bell Tank

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Power transformers are used in industrial applications for transmission and distribution of power. With an increase in their rating and quality requirements, careful attention has to be paid to their structural reliability. The transformer tank has to be designed robust enough to withstand the vacuum loads as per the quality standards. After the fabrication of the tank, it is subjected to the vacuum tests and the deformations under the vacuum loads and the permanent deformations after the release of vacuum are recorded and as per the standards are the criteria for deciding the passing or failure of the tank. However predicting whether a particular design of the tanks will pass or not is quite a complicated task.

In this work, an FEA model is developed to predict the deflections of the tanks thus explaining the failure of a particular tank which had failed at the initial vacuum tests. The causes behind the failure of the initial prediction are assessed. A new FEM model is developed using the commercially available software Ansys to compute the deformations of the tank.thus explaining the failure of the tank.

DYNAMICS

ACEX026
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Protein Dynamics based on Mixed Mass-Spring Model Using Normal Mode Analysis

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It is well known that “elastic network model” (ENM; mass-spring model) has been used for developing the protein dynamic model in the computational biology community. This paper investigates the structural dynamics model and associated model condensation methodology applicable to biomolecular structures for understanding the dynamics and the biologically relevant function of proteins. Furthermore, the ENM with the normal mode analysis (NMA) which provides the dynamics described by the large scale low-frequency modes is outlined. Even though the ENM with NMA has been contributed for analyzing the dynamics and thermal fluctuations of proteins, it frequently encounters with the computational prohibition for identification of biological function due to limitation of protein model. To overcome the conventional computational limitations, the drawback motivates one to develop robust model method. In this sense, our talk presents mixed elastic network model based on Gaussian Network Model (GNM) to observe the dynamics of proteins in a normal mode analysis. In this paper, we addressed mixed model based on GNM to ascertain whether these models are proper to observe the cooperative motion of protein structure. Through the implementation of mixed model, we can save computational time of the large scale molecules without the information omission of interesting parts of proteins. The mixed models consist of several regions which have high and low resolution regime, respectively. Some of the regions are binding sites playing a biological function in molecules and remaining parts excluding functional part. High resolution parts of the system are interesting parts which are to be modeled in refinement using all alpha-carbons, while low resolution parts are constructed from further coarse-grained model, not using all alpha-carbons. Our results demonstrate that the mixed model predicts the low-frequency eigenmodes and thermal fluctuation of proteins accurately, which are highly related to biological function with reducing the computational cost enormously. This scheme may help identify biologically relevant functions for large proteins.

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ACEX030
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Model Experiment and Numerical Modelling of Dynamic Soil-structure Interaction

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Model tests are frequently used to develop new mechanical interface models for dynamic soil-structure interaction during an earthquake [1]. Computer simulation has been implemented based on the model tests results. The dynamic soil-structure interaction is often modelled by introducing soil-springs, applying external forces, introducing traction, or forcing displacements at the boundaries. However, in these models, the soil condition is not modelled although the soil-structure interaction is expected to influence the soil condition around the structure. In reality, the stress-strain state of the soil changes continuously over the soil-structure interactive motion. Soil deformation behavior depends on soil properties and the state of the soil for example the stress history (or stress path). Therefore in order to understand the soil-structure interaction mechanism, the pressure-displacement behaviour caused by the motion needs to be investigated associated with soil properties. In this study, model shaking tests were performed in the laboratory to investigate dynamic pressure-displacement behaviour of different types of soil ground. In the tests, a structure model supported by bearing system was subjected to lateral force only coming from the soil grounds, which is similar to an actual condition of underground structures during earthquake. Based on measured lateral pressure-displacement behaviour of the structure model,

feature of dynamic soil-structure interaction is discussed associated with soil properties. A numerical model of soil-spring for sandy ground is also proposed.

[1] K. Komiya, N. Kodama and K. Shikata, Model Experiments on Dynamic Soil-Structure Interaction, Proc. of International Geotechnical Conference on Development of Urban Areas and Geotechnical Engineering, pp.245-248 (2008).

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ACEX032
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INTEGRATED CONTROL OF ACTIVE SUSPENSION SYSTEM WITH ELECTRICAL POWER STEERING SYSTEM Mohamed M. ElMadany

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Vehicle suspension system performance is typically rated by its ability to provide improved passenger comfort and improved road handling. Current automobile suspension systems using passive elements can only offer a compromise between these two conflicting criteria. Chassis control systems such as active suspension, and rear wheel steering have been proposed and developed in order to realize saferand more comfortable driving.
In this work, a methodology for the design and evaluation of an integrated system consisting of an active control of vehicle suspension and a steering system is developed. The vehicle is assumed to run over curved and randomly uneven roads. Optimal control theory is used to design the integrated controller. The effects of the control strategy on ride comfort and stability of the vehicle are examined in both the time and frequency domain.

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ACEX042
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Numerical Study on the Avalanches Dynamics

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Snow is assumed to be represented by semi-solid and the governing equations have been studied from the concept of continuum approach. In this paper, the avalanche release of snow has been modeled [13].
By using appropriate initial and boundary conditions, the dynamical equations [2] have been solved for three following different zones: (i) starting zone, (ii) uniform zone and (iii) run out zone, furthermore velocity has been computed for the

above zones. Effect of the density (ρ), Eddy viscosity (η), Slope angle (θ), Slab depth (R and H) on the flow parameters have been observed in our work. For computing the non linear differential equations, numerical methods have been employed. The out puts have been compared with results in [1]. One of the most interesting and fundamental innovation in the present studies is getting initial condition for the computation of velocity either by numerical or by analytical approach.
This information of the velocity has obtained through the concept of fracture mechanics applicable to snow. The results on the flow parameters have found to be in qualitative agreement with the published results [1, 3].

[1] C. Sigrist, Ph D Thesis, Swiss Federal Institute of Technology, Switzerland (2006).
[2] S.P. Pudasaini and K. Hutter, Avalanche Dynamics, Ed. (Springer-Verlag Berlin 2007).
[3] J. Schweizer, J.Cold Region Sci.Tech., 30, 43 (1999).

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ACEX049
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Determination of Response Spectrum of a Linear Time Invariant Gyroscopic System to Random Excitations using Finite Element Method

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In this paper, dynamic analysis of a compliant shaft in rotation has been carried out, using the mathematical tool Finite Element Method. This system is linear time invariant gyroscopic system. The governing equations are formulated for the shaft supported at both ends. Both ends of the shaft are supported on bearings. The shaft is modeled using beam elements, with six degrees of freedom at the nodes. At the supports all degrees of freedom, except axial rotations are constrained. The effect of rotation on displacements is analysed by assessing the total kinetic energy and potential energy. In this paper dynamic response of the shaft while rotating, excited by random forces at various points are analysed along with free vibration analysis.

Finite element method is used to analyse the rotating shaft subjected to random excitations, excitations are assumed to be ergodic in nature.. The beam elements used for discretisation are one-dimensional Euler- Bernoulli beam element [1]. The beam element has six degrees of freedom at the nodes- three translations and three rotations. The procedure includes formulation and solving of the fourth order differential equation for shaft bending vibrations with second order equation for axial vibrations and torsional vibrations [2]

Using FEM the equation of motion is formulated as

$$M\,\underset{\sim}{\ddot{u}}(t)+\left(C+G\right)\underset{\sim}{\dot{u}}(t)+\left(K+H\right)\underset{\sim}{u}(t)=Q$$

where [M] is mass matrix, [K] stiffness matrix, [C] damping matrix, [G] gyroscopic matrix and [H] the circulatory matrix. Here the damping is treated as structural damping, where the coefficient of damping c is taken as linear combination of

mass and stiffness parameters. [Q] is the load vector. In this problem the load is ergodic Random excitations. White noise of unit amplitude [3] is considered as the input excitations at selected nodes.

The response spectrum for the ergodic excitations are obtained for the system considered. free vibration analysis has also been carried out. Results are obtained and plotted. As this is a fundamental work, it can be used for applied dynamic analysis.

Reference
1. F. Bellezza , L. Lanari, and G. Ulivi, IEEE Int. Conference, OH, 734, 1990.
2. J. S. Archer, ASCE, Vol. 89, ST4, 161,1972.
3. B. A Akesson,., Int. J. Numerical Methods in Engineering, V 10, 1221, 1976.
4. J. R Banerjee, Int. J. Numerical Methods in Engineering, 28, 1283, 1989.
5. C. W., Lee, and , Y. D. Cho, J Mechanical Systems and Signal Processing V 7(1), 57, 1993
6. L . Meirovitch,. Analytical Methods in Vibrations, Macmillan Book Co., 1967
7. J. N. Reddy, An Introduction to Finite Element Method, McGraw-Hill. 1993.

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ACEX052
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Simulation Study of the Spreading Process via Molecular Dynamics Method

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In this paper, a nanodrop spreading on a substrate is simulated via the molecular dynamics(MD) method. Initially, the nanodrop and the substrate are equilibrated at specific temperatures (equilibration phase). When the simulation starts, the spreading occurs under the attractive atomic forces between the nanodrop and the substrate atoms. The contact angle is calculated at the end of simulation and finally the effects of the nanodrop size and the substrate temperature on the contact angle are studied. The simulation is done with 3 different nanodrop sizes (200, 300 and 400 atoms) and at 3 different substrate tempreatures (10, 200 and 400 K). It is shown that the contact angle decreases as the size of the nanodrop or the tempreature of the substrate increases.

[1] S. S ikalo, C. Tropea, E.N.Ganic, Experimental Thermal and Fluid Science, 29, 795 (2005).
[2] A. B. A. Elyousfi,,1 A. K. Chesters, A. M. Cazabat, and S. Villette, J. Colloid Interface Sci., 207, 30(1998).
[3] M. Voue´ and J. De Coninck, J. Acta mater. 48, 4405 (2000).

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ACEX183
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Free Vibrational Characteristics of the Thermally Loaded Cylindrical Shell

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The variations of the structural vibration characteristics such as the natural frequency, damping, and mode shape can be observed under thermal loading conditions. Therefore, the free vibrational characteristics of the thermally loaded cylindrical shell were analyzed in this study. ABAQUS was used for the analyis and the thermo-elactic experimental modal test was conducted. The configuration of the shell was 5 m. long, 0.4 m. diameter, 0.002m thick and its material was combined by stainless-steel 304 and aluminum 6061. The cylindircal shell was heated by the temperature of 100℃, 200℃ and 400℃ and divided longitudunally by five zones. The theoretical analysis was verified by the experimental modal analysis of the cylindrical shell for the free-free boundary condition and the elevated thermal conditions. The free vibrational analysis of the thermally loaded cylindrical shell was performed according to several thermally loaded conditions.

[1] M.W. Kehoe and H.T. Snyder, NASA Technical Memorandum 101742, (1991).
[2] D. J. Ewins, Modal Testing, Second edition, Research Studies press LTD. England. (2000).

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ACEX213
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Experimental Study of High Copper Alloys Submitted to Vibration Tests

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Our study relates to the electrical contact resistance characterization under dynamic vibrations for a contact between a sphere and plane using different high content copper alloys with no coatings used for automotive connectors. The contact zones were subjected to normal loads and to vibration phases. Only one contact part is subjected to a vibratory movement, the other part is fixed. The contact resistance is continuously measured during the test. An experimental study of the wear prints is undertaken in order to evaluate the influence of mechanical and electrical material properties on the degradation of conduction. The obtained results show that the hardness and the resistivity of the copper alloys used have a large influence on the component lifespan. The main requirement for the connector materials used in electrical contacts and submitted to vibration mode is to maintain very low and stable electrical resistance. Wear and fretting corrosion are a major cause of failure for these mechatronic systems and the main reasons influencing the reliability of the electrical system. The electrical resistance of the connector is related to the contact zone which is imposed by the connector design. Much work [1, 2] has been devoted to understanding the contact zone mechanism

which is a complex process involving the interaction of various physical phenomena between two contact surfaces (friction, wear, adhesion, transfer, etc). The main objective is to establish a correlation between wear, electrical behaviour and vibration stresses for samples with different high copper alloys.

[1] A. Monnier, B. Froidurot, C. Jarrige, R. Meyer and P. Testé. Proceeding of the 51st IEEE Holm Conf, Chicago, USA, p. 224 (2005).
[2] F. Ossard, S. Noël, D. Alamarguy, S. Correia and P. Gendre. Proceeding of the 53rd IEEE Holm Conference on Electrical Contact, Pittsburgh, USA, p.1 (2007).

IMPACT AND CRASH

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Finite Element Analysis of Composite Ballistic Helmet Subjected to High Velocity Impact

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Reduction in weight and an improvement in ballistic resistance has made ballistic helmet made of composite materials more practical compare to ballistic helmet made of steel. Since the cost of conducting experiments of ballistic helmet is very high, plus with the limited data obtained, finite element analysis has become another option in order to characterise the response of composite ballistic helmet.

In this study, finite element software code ABAQUS was used to investigate the response of ballistic helmet when struck at high velocity impact by 9 mm parabellum bullet. The impact velocity varied from 360 m/s up to the ballistic limit for each material studied. As far as the material was concern, Kevlar 29/Phenolic, Kevlar/Polyester, Glass/Polyester and Carbon/Polyester were employed.

The result obtained was validated by comparing with previous researchers and good correlation was observed. From this study, it was found that the ballistic limit of the helmet made from Carbon/Polyester was the highest, followed by Glass/Polyester, Kevlar/Polyester and Kevlar 29/Phenolic with a value of 776.8 m/s, 745.3 m/s, 657 m/s and 575.7 m/s respectively. In addition, the deflection of Kevlar 29/Phenolic was 12.9 mm when impacted at 360 m/s and it was observed to be the highest.

[1] Aare, M. and Kleiven, S. (2007) Evaluation of head response to ballistic helmet impacts using the finite element method. International Journal of Impact Engineering, 34(3), p.596-608.

[2] ABAQUS standard manual version 6.4 (2003). ABAQUS, Inc. U.S.A.

[3] Abrate, S. (1998) Impact on composite structures. Cambridge: Cambridge University Press.

[4] Balandin, D.V., Bolotnik, N.N. and Pilkey, W.D. (2004) Capabilities of helmets for preventing head injuries induced by ballistic impacts. Shock and Vibration 11, p.547-562.

[5] Carey, M.E., Herz, M., Corner, B., McEntire, J., Malabarba, D. Paquette, S. and Sampson, J.B. (2000) Ballistic helmets and aspects of their design. Neurosurgery, 47(3), p.678-689.

[6] Cartič, D.D.R. and Irving, P.E. (2002) Effect of resin and fibre properties on impact and compression after impact of CFRP. Composites Part A: Applied Science and Manufacturing, 33(4), p.483-493.

[7] Chan, S., Fawaz, Z., Behdinan, K. and Amid, R. (2007) Ballistic limit prediction using a numerical model with progressive damage capability. Composite Structures, 77(4), p.466-474.

[8] Cheeseman, B.A. and Bogetti, T.A. (2003) Ballistic impact into fabric and compliant composite laminates. Composite Structures, 61(1). p.161-173.

[9] Datoo, Mahmood Husein (1991) Mechanics of fibrous composite. UK: Elsevier Science Publishers Ltd.

[10] Gellert, E.P., Cimpoeru, S.J. and Woodward, R.L. (2000) A study of the effect of target thickness on the ballistic perforation of glass-fibre-reinforced plastic composites. International Journal of Impact Engineering, 24, p.445-456.

[11] Goldsmith, W., Dharan, C.K.H. and Chang, H. (1995) Quasi-static and ballistic perforation carbon fiber laminates. International Journal of Solids and Structures, 32(1), p.89-103.

[12] Grujicic, M., Pandurangan, B., Koudela, K.L. and Cheeseman, B.A. (2006) A computational analysis of the ballistic performance of light-weight hybrid composite armors. Applied Surface Science, 253, p.730-745.

[13] Gupta, N.K., Iqbal, M.A. and Sekhon, G.S. (2006) Experimental and numerical studies on the behaviour of thin

aluminium plates subjected to impact by blunt- and hemispherical-nosed projectiles. International Journal of Impact Engineering, 32(12), p.1921-1944.
[14] He, T., Wen, H.M. and Qin, Y. (2007) Penetration and perforation of FRP laminates struck transversely by conical-nosed projectiles. Composite Structures, 81(2), p.243-252.
[15] Kaw, A.K. (2006) Mechanics of composite materials. Second edition. New York: Taylor & Francis.
[16] Kostopoulos, V., Markopoulos, Y.P., Giannopoulos, G. and Vlachos, D.E. (2002) Finite element analysis of impact damage response of composite motorcycle safety helmets. Composites: Part B, 33, p.99-107.
[17] Lim, C.T., Shim, V.P.W. and Ng, Y.H. (2003) Finite element modelling of the ballistic impact of fabric armor. International Journal of Impact Engineering, 28, p.13-31.
[18] Mines, R.A.W., Roach, A.M. and Jones, N. (1999) High velocity perforation behaviour of polymer composite laminates. International Journal of Impact Engineering, 22, p.561-588.
[19] Morye, S.S., Hine, P.J., Duckett, R.A., Carr, D.J. and Ward, I.M. (2000) Modelling of the energy absorption by polymer composites upon ballistic impact. Composites Science and Technology, 60, p.2631-2642.
[20] Naik, N.K. and Shrirao, P. (2004) Composite structures under ballistic impact. Composite Structures, 66, p.579-590.
[21] Naik, N.K., Shrirao, P. and Reddy, B.C.K. (2006) Ballistic impact behaviour of woven fabric composites: Formulation. International Journal of Impact Engineering, 32, p.1521-1552.
[22] Nandlall, D., Williams, K. and Vaziri, R. (1998) Numerical simulation of the ballistic response of GRP plates. Composites Science and Technology, 58, p.1463-1469.
[23] National Institute of Justice (1981) NIJ Standard-0106.01. NIJ standard for ballistic helmets. Washington: NIJ.
[24] Nicholas, T. and Recht, R.F. (1992) Introduction to impact phenomena. In: J.A. Zukas, (ed). High velocity impact dynamics. New York: John Wiley & Sons, Inc.
[25] Shuaeib, F.M., Hamouda, A.M.S., Radin Umar, R.S., Hamdan, M.M. and Hashmi, M.S.J. (2002) Motorcycle helmet, Part I. Biomechanics and computational issues. Journal of Materials Processing Technology, 123, p.406-421.
[26] Silva, M.A.G., Cismaşiu, C. and Chiorean, C.G. (2005) Numerical simulation of ballistic impact on composite laminates. International Journal of Impact Engineering, 31, p.289-306.
[27] Sun, C.T. and Potti, S.V. (1996) A simple model to predict residual velocities of thick composite laminates subjected to high velocity impact. International Journal of Impact Engineering, 18, p.339-353.
[28] Tarim, N., Findik, F. and Uzun, H. (2002) Ballistic impact performance of composite structures. Composite Structures, 56, p.13-20.
[29] Tham, C.Y., Tan, V.B.C. and Lee, H.P. (2008) Ballistic impact of a KEVLAR® helmet: Experiment and simulations. International Journal of Impact Engineering, 35(5), p.304-318.
[30] Ulven, C., Vaidya, U.K. and Hosur, M.V. (2003) Effect of projectile shape during ballistic perforation of VARTM carbon/epoxy composite panels. Composite Structures, 61, p.143-150.
[31] van Hoof, J. (1999) Modelling of impact induced delamination in composite materials. Ph.D thesis, Carleton University.
[32] van Hoof, J., Cronin, D.S., Worswick, M.J., Williams, K.V. and Nandlall, D. (2001) Numerical head and composite helmet models to predict blunt trauma. In: Proceedings of 19th International Symposium on Ballistics. 7-11 May 2001. Interlaken: Switzerland.
[33] Walker, J.D. (2001) Ballistic limit of fabrics with resin. In: Proceedings of 19th International Symposium on Ballistics. 7-11 May 2001. Interlaken: Switzerland. p.1409-1414.
[34] Walsh, S.M., Scott, B.R. and Spagnuolo, D.M. (2005) The development of a hybrid thermoplastic ballistic material with application to helmets. U.S. Army Research Laboratory Report. ARL-TR-3700. December 2005.
[35] Wambua, P., Vangrimde, B., Lomov, S. and Verpoest, I. (2007) The response of natural fibre composites to ballistic impact by fragment simulating projectiles. Composite Structures, 77. p.232-240.
[36] Wen, H.M. (2001) Penetration and perforation of thick FRP laminates. Composites Science and Technology, 61. p.1163-1172.
[37] Wu, E. and Tsai, C.Z. (2000) Impact behaviour and analysis of CFRP laminated plates. In: S.R. Reid and G. Zhou, (eds). Impact behaviour of fibre-reinforced composite materials and structures. Cambridge: Woodhead Publishing Limited. p.212.

[38] Yetham, L.A., Godfreg, P.M. and Chinn, P.B. (1994) Materials for motorcycle crash helmets - a finite element parametric study. Plastics, Rubber and Composite Processing Application, 22, p.215-221.
[39] Zhu, G., Goldsmith, W. and Dharan, C.K.H. (1992) Penetration of laminated Kevlar by projectiles-I. Experimental investigation. International Journal of Solids and Structures, 29, p.421-436.
[40] Zukas, J.A. (1982) Impact dynamics. New York: Wiley Interscience.

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The Theoretical, Experimental and Numerical Analysis of a Cylindrical Structure under Internal Explosive Loading

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Predicting the maximum radial deflection of a thin walled cylindrical shell is an important aspect while studying the dynamic-plastic behaviour of cylindrical shells under explosive loading. Considering a fully closed cylindrical shell that its diameter is longer than its length, it can be concluded that the forehead of the shockwave hits the cap of the shell sooner than it hits the walls. On the other hand, since the decaying constant of the exponential pressure-time profile is not definitely known [1], in this paper, the dynamic-plastic behaviour of a cylindrical shell has been studied based on a simplified pressure-time profile. The maximum radial deflection of the shell is then calculated through analysing the dynamic equations of the walls [2], considering three phases of motion. Afterwards, the theoretical calculations are compared to the results of the experimental tests. The problem is also solved via finite element method, using LS-DYNA. In mesh generation process for simulation of explosion, there are three material phases :1-explosive sphere, 2-metal thin-walled shell, 3-medium between explosive and structure. It should be noticed that, the elements surfaces in the outer surface of the explosive and inner surface of the medium should be at the same place and in order to simulate shock wave propagation precisely, the elements volume enlargement path should be radial. Comparing the results of the numerical solution with the theoretical and experimental results shows an acceptable accuracy. The numerical solution is also consistent with the experimental and theoretical results, though, when the explosive charge is assumed to increase in mass, the numerical results diverge from the results of experimental tests.

[1] R.A. Benham, T.A. Duffey, Experimental-Theorical Correlation on the Contaminent of Explosions in Closed Cylindrical Vessels, Int. J. Mech. Sci., Vol.16, p.549-58, (1974).
[2] N. Jones, Structural Impact, (Cambridge University Press, U.K, 1989).

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ACEX230
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An investigation on the effects of various parameters on the basic element behavior under impact loads

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Honeycombs are cellular structures and the cells have different geometries but hexagonal cells are more useful than others (Figure 1.a). Behavior of these structures under various loading conditions is studied by some researchers. The first studies belong to Mc Farland [1]. Wierzbicki has introduced a method for prediction of collapse strength of cellular structures with hexagonal cells [2]. Wierzbicki and Abramowicz have driven formulas for calculation of absorbed energy of angle element [3, 4]. Response of honeycombs under static and impact loads are studied by the other researchers [5, 6].

In this paper the response of the basic element of honeycomb under impact loads is studied and the effects of geometric parameters of it on the energy absorption capacity and the folding wavelength are investigated.

2. Simulation of the basic element behavior

In this section impact loading of the basic element (Figure 1.b) is explained using LSDYNA software and effects of geometric parameters on the energy absorption capacity and the folding wavelength are studied. For simulation the basic element is set on a rigid support and a rigid cubic mass moves toward it vertically and impacted it
(Figure 2).
a b

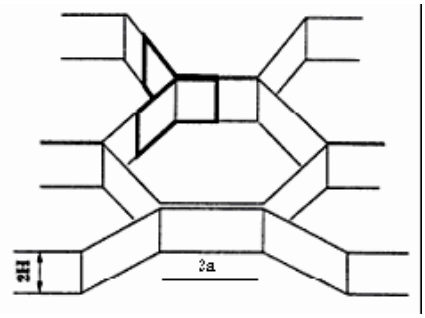

Fig. 1. a) Hexagonal cells honeycomb, b) the basic element.

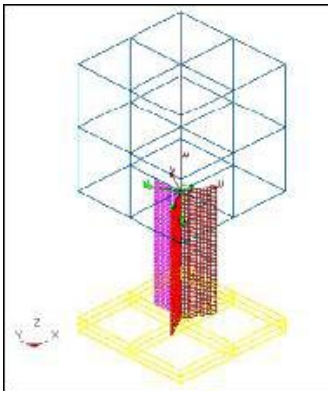

Fig. 2. Finite element model of the basic element

The impactor and the support materials are steel and the basic element is aluminium and their
The impactor and the support materials are steel and the basic element is aluminium and their mechanical properties are obtained from tests. The material model for impactor and support is rigid and for aluminium is plastic_kinematic.
Types of elements for the impactor and the basic element are solid and shell, respectively. Appropriate contact models are defined between the parts and suitable boundary conditions are considered for them. Because of honeycomb configuration the movement of nodes along the web width is prevented. Therefore, two local coordinate systems are defined on the basic ele-ment. The impactor velocity in the vertical direction is 8.5 m/s in correspondence with test apparatus.
The number of samples is 25 with five different thicknesses, five different width for webs and five different angles.

2.1. Simulation results

Variation of the absorbed energy and folds wavelength with the branch angle are shown in Figures 3 and 4.

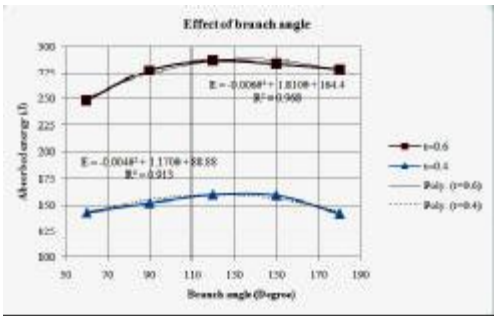

Fig. 3. Absorbed energy vs. the branch angle.

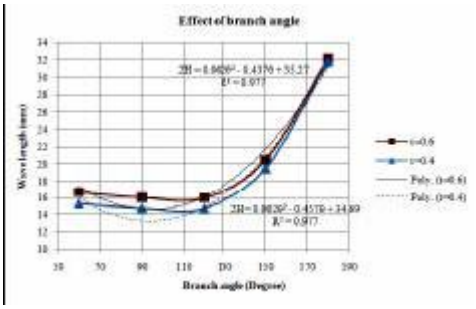

Fig. 4. Folds wavelength vs. the branch angle.

The effect of wall thickness on the absorbed energy and folds wavelength are shown in Figures 5 and 6.

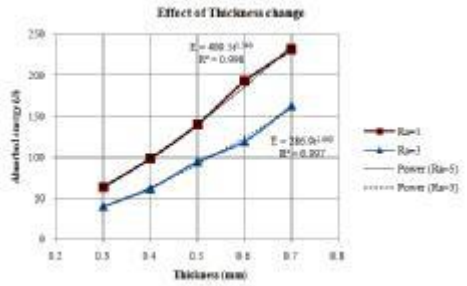

Fig. 5. Absorbed energy vs. the walls thicknesses.

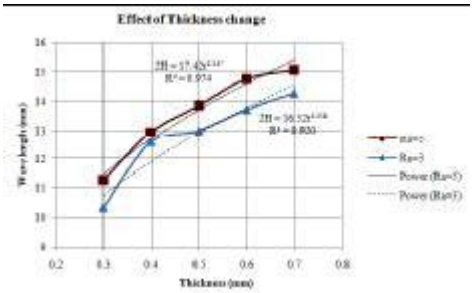

Fig. 6. Folds wavelength vs. the walls thicknesses.

Also variations of the absorbed energy and folds wavelength with the webs widths are shown in Figures 7 and 8.

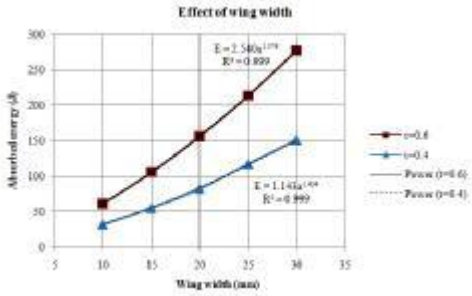

Fig. 7. Absorbed energy vs. the walls thicknesses.

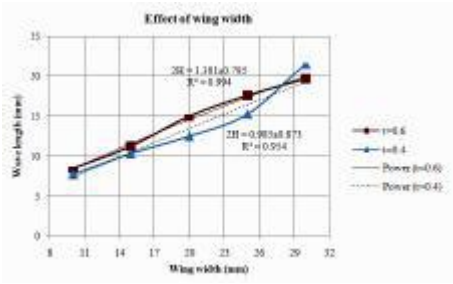

Fig. 8. Folds wavelength vs. the webs widths.

3. Experimental tests

In order to evaluate the simulation results some tests are carried out using Drop Hammer apparatus. The samples are made from Al-1235-H19 material and yield strength and ultimate strength of this material are obtained 172 and 205.6 MPa, respectively using standard tension test. Impactor is released from a predetermined height so that the impact velocity is equal to 8.5 m/s. The results of tests and simulations for all of parameters are compared and good agreement between them shows that the simulations predict correct behaviour of the structure.

4. Conclusions

In this paper the effects of the basic element parameters on the energy absorption capacity and the folds wavelength are studied both numerically and experimentally. Results show that the absorbed energy of the basic element and honeycombs is maximum at 120 degrees branch angle; unlike the theoretical predictions the folds wavelength in thick

web is greater than those of thin webs; the effect of webs widths on energy absorption capacity is very larger than the theoretical predictions; the effect of glue on deformations of the basic element is considerable and finally separation of two walls of thick web in honeycombs with smaller walls thicknesses rarely occurs.

References

[1] McFarland R K. Hexagonal cell structures under post-buckling axial load. AIAA Journal 1963; 1(6): 1380-1385.
[2] Wierzbicki T. Crushing analysis of metal honeycomb. International Journal of Impact Engineering 1983; 1(2): 157-174.
[3] Wierzbicki T, Abramowicz W. On the crushing mechanics of thin-walled structures. Journal of Applied Mechanics 1983; 50: 727-734.
[4] Abramowicz W, Wierzbicki T. Axial crushing of multicorner sheet metal columns. Journal of Applied Mechanics 1989; 56: 113-120.
[5] Zhao H, Gary G. Crushing behavior of aluminum honeycombs under impact loading. International Journal of Impact Engineering 1998; 21(10): 827-836.
[6] Kim T H, Reid S R. Bending collapse of thin-walled rectangular section columns. Journal of Computer & Structures 2001; 79:1897-1911.

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Analysis of the Mechanical Behaviour of Thermoplastic Materials at High Strain-Rates – An Approach by Using Invariant Theory

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For a Finite Element Simulation close to reality for parts made from thermoplastics a deeper knowledge about the material behaviour at different load cases and environmental influences are necessary. Also there have to be mathematical models to describe these influences according to the simulation problem.
The material models developed in the past are mostly based on the extensions of models originally made for other material classes like metals and the calculation of the static behaviour [1]. By using these models several phenomena of the polymers could not be explained [2]. For example models based on the Von-Mises plasticity don't differ on the behaviour of tension, compression or shear. Also the compressible nature of the thermoplastic cannot be calculated by these models. There are other mathematical approaches like the DSGZ model [3] that are capable to calculate the behaviour of the two uniaxial load cases, tension and compression, in dependence of strain,

strain rate and temperature but no combination of loads are calculable. With the newest approach, the SAMP-1 model [4], the behaviour of thermoplastics can be calculated very close to reality at all multiaxial stress states.
The aim of the new model developed is to describe the multiaxial behaviour of thermoplastics including all specific phenomena in a parametric way. Therefore a uniaxial description of the yield stress and a potential law based on the invariant theory are combined by an associated yield law. For the description of the uniaxial stress-strain relation in dependence of strain, strain rate and temperature a modified model of G'Sell-Jonas is used [5,6]. The potential law for the multiaxial extension will be of third order according to Kolupaev [7].
For the determination of the parameters needed for the simulation high speed tests at several strain rates and stress states (tension, compression and shear) are performed.

References:
[1] JOHNSON, G. R. ; COOK, W. H.: Fracture characteristics of three metals subjected to various strains, strain rates, temperatures and pressure. In: International Journal of Engineering Fracture Mechanics 21 (1985), S. 31–48
[2] BARDENHEIER, Reinhard: Mechanisches Versagen von Polymerwerkstoffen. Carl Hanser Verlag, München, 1982
[3] DUAN, Y. ; SAIGAL, A. ; GREIF, R. ; ZIMMERMAN, M. A.: Modeling multiaxial impact behavior of a glassy polymer. In: Materials Research Innovations 7 (2003), Februar, Nr. 1, S. 10-18
[4] KOLLING, S.; HAUFE, A.; FEUCHT, M. & DU BOIS, P: A semi-analytical model for the simulation of polymers. 4th LS-DYNA Forum, Bamberg, 2005
[5] G'SELL, C. & JONAS, J.: Determination of the plastic behaviour of solid polymers at constant true strain rat. In: Journal of Materials Science 14 (1979), S. 583-591
[6] G'SELL, C.; ALY-HELAL, N. A.; JONAS, J. J.: Effect of stress triaxiality on neck propagation during the tensile stretching of solid polymers. In: Journal of Materials Science 18 (1983), S. 1731-1742
[7] KOLUPAEV, V. A.: Dreidimensionales Kriechverhalten von Bauteilen aus unverstärkten Thermoplasten. Halle (Saale), Martin-Luther Universität Halle/Wittenberg, Diss., 2005

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Crashworthiness of Thin-Walled Circular and Rectangular Tubes with Ribs Subjected to Axial Impact

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Safety is a vital issue in the design of modern vehicles. Generally when a vehicle collides with another object, its structure collapses to absorb the impact energy for the safety of the passengers. Several researchers have investigated the crushing phenomena of thin-walled structures. Numerical analyses that show thin-walled circular and rectangular tubes with ribs can be used as a structural element to improve or adjust energy absorption characteristics. We

conducted impact crushing tests using circular and rectangular tubes with and without ribs. The results showed that the axisymmetric and non-axisymmetric crushing modes were dependent on the distances between the ribs. A critical distance between the ribs was found to exist for generating axisymmetric and non-asxisymmetric crushing modes.
The peak crushing forces of the tubes which are subjected with ribs are shifted and occurred later than those of without ribs. Ribs appropriately spaced in a circular and rectangular tubes were found to be effective in absorbing a large amount of energy with a short crushing deformation with mitigating the amount of peak value of force, especially in the circular tube.

References

[1] A.A.A. Alghamdi, J. Thin-Walled Struct., 39, 89, (2001).
[2] A.A. Singace, H. El-Sobky, M. Petsios, J. Thin-Walled Struct., 39, 415, (2001).
[3] A.A.A. Alghamdi, A.A.N. Aljawi, TM-N. Abu-Mansour, Int J Mech Sci., 44, 1145 (2002).
[4] V.M. Karbhari, X.Chaoling, Int J Crashworthiness, 8, 471, (2003).
[5] G.M. Nagel, D.P. Thambiratnam, Int J Mech Sci., 46, 201, (2004).
[6] G.L.E. Easwara Prasad, N.K. Gupta, Int J Impact Eng., 32, 400, (2005).

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Food Processing Using Underwater Shock Wave

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The shock wave is defined as the discontinuous pressure wave that appears by the spread of the pressure disturbance generated when energy is accumulated in very short course and it is momentarily transmitted exceeding speed of sound. Explosion, electric discharge, high-velocity phase change, a collision and high-velocity deformation are generation methods [1]. The research is advanced by using the underwater shock wave generated by the detonation of explosive in the present study. The detonating fuse (Made by Nippon Kayaku Ltd. and detonation speed: about 6,300m/s) and preprocessed food are fixed to the cage for shock wave processing and after sinking under water, it detonates with the sixth electric detonator (made of Asahi Chemical Industrial Co., Ltd.). Shock wave takes an oblique direction from the detonating fuse; we adjust strength of the shock wave by the distance from the detonating fuse to the food sample. It is possible to process it by the pressure strength of 10 to 350MPa by adjusting the distance from the detonating fuse to the sample. In this research, we used apples, coffee beans, and more foods as food sample. There is another method of a generation of underwater shock wave by using the high voltage electrical discharge. The underwater shock wave can be generated by discharging the electricity that accumulates in the capacitor. We are presently developing the food processor that is electricity-based. It is clear that we obtained the effect of softening apple by electricity-based shock wave and the power is slightly weaker compared with explosive-based underwater shock wave. A further direction of this study will be to control the direction and strength of underwater shock wave and develop the highly impact-proof processor.

[1] K. Takayama, shock wave handbook, p.3, K. Takayama, Ed. (Springer-Verlag Tokyo, Japan, 1995)

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ACEX131
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Characteristics of Simple Structures Impact on Rigid Surface Using Finite Element Technique

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In recent years public become increasingly concerned about safety and the demand for better protection against injury from vehicles undergoing collision. Thus, a comprehensive understanding of crashworthiness is discussed and presented. The structural response to impact has important and widespread application. Therefore, mitigating or reducing collision damage and redressing its consequences is essential and a matter of widespread interest. The purpose of this work is to present the knowledge or information about aspects of the mechanics of vehicular impact, of the plastic deformation processes which result, and the consequences for passengers; how these destructive consequences can be reduced or minimized when a collision occurs.
In this work, these issues and others will be addressed and the work will be concentrated on the investigation of impact response of cylindrical structures, both theoretically and experimentally. A particular emphasis will be made on modeling of the impact process by finite element method.

Series of cylindrical sections made of steel, brass, and PVC are loaded dynamically in the longitedunal direction. These materials are typical of the many materials used in the automobile industry. Thus, these experiments are utilized to obtain the impact characteristics of these simple structures, which simulate the vehicle basic geometry. The experimental results are found to be in a very good agreement with the FE results.

[1] C.B. Pedersen, Topology Optimization of 2D-Frame Structures with Path Dependent Response, International Journal for Numerical Methods in Engineering, 57, p.1471, 2003.
[2] C.B. Pedersen, Crashworthiness Design of Transient Frame Structures using Topology Optimization, Computer Methods in Applied Mechanics and Engineering, 193 (6-8), p.653 (2004)
[3] P. Prasad, and J. E. Belwafa, Vehical Crashworthiness and Occupant Protection, American Iron and Steel Institute, Southfield, Michigan, USA (2004)
[4] A. G. Hanssen, A. Artelius, and M. Langseth, Validation of the simplified super folding element theory applied for axial crushing of complex aluminum extrusions, International Journal of Crashworthiness, Vol. 12 (6), 2007, p.591 (2007)
[5] Y. Liu and M. L. Day, Development of simplified thin-walled beam models for crashworthiness analyses, International Journal of Crashworthiness, Vol. 12 (6), p. 597 (2007)
[6] Y. Liu; M. L. Day Development of simplified finite element models for straight thin-walled tubes with octagonal cross section, International Journal of Crashworthiness, Vol. 12 (5), p.503 (2007)
[7] M. F. Horstemeyer, J. Siervogel, L. Kwasniewski, J. Wekezer, B. Christiana, and G. Roufa, Material and structural crashworthiness characterization of paratransit buses, International Journal of Crashworthiness, Vol. 12 (5), p.509 (2007)

[8] Y. Liu, Design optimization of tapered thin-walled square tubes, International Journal of Crashworthiness, Vol. 13 (5), p.543 (2008)
[9] R. Krivachy, W. Riedel, S. Weyer, and K. Thoma, Characterization and modeling of short fiber reinforced polymers for numerical simulation of a crash, International Journal of Crashworthiness, Vol. 13 (5), p.559 (2008)
[10] S. Tabacu and N. Pandrea, Numerical (analytical-based) model for the study of vehicle frontal collision, International Journal of Crashworthiness, Vol. 13 (4), p.387 (2008)
[11] K. Tamura, Y. Nakazawa, T. Kusaka, and M. Hojo, A study on introduction of notch into thin-walled polygonal shell member to control plastic buckling behaviour in axial collapse, International Journal of Crashworthiness, Vol. 14 (1), p.25 (2009)

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ACEX149
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Design Optimization of Reinforced Concrete Barrier under Five Car Train Impact Loading

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A Concrete barrier of external facilities in safety-related structures such as protective walls. Impact load may causes damage to the concrete barrier and serious economical damage. Therefore, concrete barrier were required to be designed to withstand the effect of impact load. The considered impact load of concrete barrier was five car trains with 13.4 m/s. In this paper, model of concrete used the Karagozian & Case (K&c) concrete model [1]. The Karagozian & Case (K&c) concrete model was three-invariant model, uses three shear failure sufaces, includes damage and strain-rate effects and has origins based on the Pseudo-TENSOR model[1]. The impact simulation using LS-DYNA was carried out. The impact analysis is performed by applying material properties of ground which obtained througth the standard penetration test. The shape optimization of concrete barrier using ANSYS was carried out. This study focuses on the design optimization of a concrete barrier under five car train impact load to minimize stress.

[1] LS-DYNA KEYWORD USER MANUAL(Ver. 971), Livemore Software Technology Coporation. (2006)

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ACEX151.1
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A Study on the Performance Optimization of the tail bumper for a helicopter

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Tail bumper is equipment to protect tail rotor of the helicopter body. The helicopter was fitted with tail bumper which is to prevent impact and damage between the tail rotor and ground. The tail bumper consists of the skid and shock absorber. When the skid comes into collision with a ground, the skid plays a plate spring role. The skid absorbs first impact and then, the shock absorber also absorbs and reduces second impact. Through the working of a mechanism, a moving body of the helicopter has to be transmitted to minimum impact force in order to protect the tail rotor. To determine design important performance variable of the shock absorber, prediction of a reaction force between the tail bumper and ground. The impact loads of the tail bumper are estimated through a study on a modeling of the impact Resistance and dynamic analysis for the tail bumper system. In this study, used modeling simplifies tail part of the Eurocopter (AS-532) to analyze the impact loads. All parts of simulation were modeled with CATIA V5 R17 and analyzed dynamic analysis for the protective system of a tail rotor with ADAMS Aircraft Module. Based on the results, characteristics of impact dynamic behaviors of the protective system of a tail rotor are practically investigated. The design variables are gas curve and damping curve of shock absorber, and maximizing the performance by shock absorber is used as an object function in the optimization. In conclusion, the end of the goal is performance optimization of the shock absorber.

[1] Ladislao Pazmany, “Landing Gear Design for Light Aircraft”, Vol 1, Pazmany Aircraft Corp, ISBN-10: 0961677708, 1986
[2] Rob Langlois, Zheng H. Zhu, Michael LaRosa,“Modelling and simulation of skid-equipped shipboard rotorcraft”, Proceedings of the 2008 Spring simulation multiconference, Ottawa, Canada, April 14-17, pp. 709～719, 2008

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ACEX165
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Crashworthiness of Thin-Walled Circular and Rectangular Tubes with Ribs Subjected to Axial Impact

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Safety is a vital issue in the design of modern vehicles. Generally when a vehicle collides with another object, its structure collapses to absorb the impact energy for the safety of the passengers. Several researchers have investigated the crushing phenomena of thin-walled structures. Numerical analyses that show thin-walled circular and rectangular tubes with ribs can be used as a structural element to improve or adjust energy absorption characteristics. We conducted impact crushing tests using circular and rectangular tubes with and without ribs. The results showed that the

axisymmetric and non-axisymmetric crushing modes were dependent on the distances between the ribs. A critical distance between the ribs was found to exist for generating axisymmetric and non-asxisymmetric crushing modes.

The peak crushing forces of the tubes which are subjected with ribs are shifted and occurred later than those of without ribs. Ribs appropriately spaced in a circular and rectangular tubes were found to be effective in absorbing a large amount of energy with a short crushing deformation with mitigating the amount of peak value of force, especially in the circular tube.

References

[1] A.A.A. Alghamdi, J. Thin-Walled Struct., 39, 89, (2001).
[2] A.A. Singace, H. El-Sobky, M. Petsios, J. Thin-Walled Struct., 39, 415, (2001).
[3] A.A.A. Alghamdi, A.A.N. Aljawi, TM-N. Abu-Mansour, Int J Mech Sci., 44, 1145 (2002).
[4] V.M. Karbhari, X.Chaoling, Int J Crashworthiness, 8, 471, (2003).
[5] G.M. Nagel, D.P. Thambiratnam, Int J Mech Sci., 46, 201, (2004).
[6] G.L.E. Easwara Prasad, N.K. Gupta, Int J Impact Eng., 32, 400, (2005).

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ACEX207
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A methodological approach to the crashworthiness of trains

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The explicit finite element (FE) and multibody (MB) methods are extensively adopted to study many types of impact and crash phenomena. It is widely acknowledged today the need of a more systematic approach to the crashworthiness of trains [1] such as to allow to manage the huge energies involved in the impact phenomenon. The goal is to improve the passive safety performance of a vehicle and to decrease as much as possible the values of biomechanical indexes. In the present work an hybrid numerical procedure is presented, which is based on FE and MB methodologies and which aims to assess biomechanical indexes and safety performance of the interior of a rail vehicle. Ls-Dyna code has been used to develop the FE simulations, while Madymo code has been used to carry out the MB simulations. The biomechanical performances have been evaluated considering the biomechanical damage criteria generally adopted in the automobile field [1].
The steps followed to develop the presented activity are as follows:
1. The acceleration profile (pulse) of the selected interiors of the vehicle has been obtained, as it is required to initialize the multibody analysis [2];
2. A preliminary MB analysis has been performed by considering rigid interior surfaces, in order to investigate the kinematics of dummies;
3. The contact stiffness of the interiors have been obtained by means of local explicit FE analyses, which have been used to characterize and calibrate the surfaces in the multibody model;

4. The secondary impacts in the multibody environment have been simulated in order to quickly investigate on different design solutions such as to improve the passive safety index.

[1] EN15227 Railway applications - Crashworthiness requirements for railway vehicle bodies.
[2] ECE R94 Uniform provisions concerning the approval of vehicles with regard the protection of the occupants in the event of a frontal collision.

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ACEX042
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Computing Stability Index and Critical Length under detonation

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In present model, the stability analysis of snow slab which is under detonation has studied. Furthermore, by using the basic concepts of non-detonation model and concepts of underwater explosions with appropriate modifications our model has been studied.
The studies have also been extended to account the effect of critical length variations at the time of detonation and its effects on various material parameters through the concepts of fracture mechanics. The results indicate that the stability and critical length values are lower for the detonation values in comparison with the non-detonated values.

[1] H. Tada, P.C. Paris and G.R. Irwin, The stress analysis of cracks handbook, Ed. (Paris Productions, MO, Saint Louis, 2000).
[2] S.P. Pudasaini and K. Hutter, Avalanche Dynamics, Ed. (Springer-Verlag Berlin 2007).
[3] J. Schweizer, J.Cold Region Sci.Tech., 30, 43 (1999)
[4] D. Albert: Reduction of blast noise by a snow cover, Primary subject classification: 21.3.4; Secondary subject classification: 72.8, (2002).

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ACEX116
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Impact analysis of fabric reinforced composites

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Electromagnetic and mechanical properties of composites, as manifestations at the external changes, have to be averaged manifestations of the components. This is just an approach viewed as a starting point both for further studies and decision making in forming a composite with certain properties. It is extremely difficult to mathematically describe a multi-component composite even if there are various models for bi-component composites [1]. The aim of this study, based on intuition, is to present some empirical results in order to help the manufacturers in decision making of forming a special composite.

For the case in which the filled polymers are used in order to obtain laminate or pseudo-laminate composites it is necessary to know the behavior of filled polymers, there are interaction between reinforcement and matrix not only from the mechanical point of view but also from the electrical or thermal point of view [3]. In the case of use of mixed fabric (kevlar and carbon fiber) there is some instability during the electrical measurement because of the multitude of capacitors which appears in the composite's structure. On another hand the use of such fabric ensures the in-plane electric conductivity due to the carbon fibers and the strength due to the kevlar fiber.
Using various arrangements of reinforcement sheets and filled epoxy it is possible to design also the impact and fire resistance of formed composites. Plates of composites were realized using various arrangements of carbon fiber fabric and carbon and kevlar fiber fabric and filled epoxy as matrix. Ferrite and CNT in various concentrations were used as fillers. Also clay was used to avoid the clusterization of ferrite particles or CNT.

[1] S. Torquato, International Journal of Solids and Structures, 37, 411 (2000).
[2]A.N. Lagarkov, S.M. Matytsin, K.N. Rozanov, A.K. Sarychev, J. Appl. Phys., 84, 3806 (1998).
[3] D. P. N. Vlasveld, W. Daud, H. E. N. Bersee, S. J. Picken, Composites: Part A, 38, 730 (2007).

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Mechanical Behavior Analysis of Rechargeable Battery through the Impact Simulation and Test

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Rechargeable batteries are energy storage device which is converted chemical energy into electric energy so call secondary batteries. The kind of secondary batteries are NiCd, NiMH, Li-polymer and Li-ion battery etc., in which the Li-ion secondary battery has the best efficiency in same space. The Li-ion secondary battery includes an active material of cathode and anode, separator, electrolyte contained LiPF6 and safety devices such as can, vent, current interrupt device(CID), positive temperature control(PTC), gasket etc.. But though all of this battery has each safety device, it is still unstable under abuse condition because of lithium-ion. This abuse condition means a sudden rise of temperature (so call thermal damage) by mechanical damage like impact, crush and drop tests and chemical damage like overcharge, short circuit and nail penetration tests. So, the Li-ion battery needs to be verified the safety under this abuse condition.
In this paper, impact condition which is belonged to mechanical damage that one of the abuse conditions was investigated. To mechanical behaviour analysis for impact test that one of the abuse test defined by Underwriters

Laboratories Inc. (UL), the impact simulation using ANSYS Workbench was carried out. Also, the impact test by UL1642 documentation [1] was carried out. From the simulation and test results, it could predict and check the damage location.

[1] UL Standard for Safety for Lithium Batteries, UL 1642, Fourth Edition, Dated August 9, 2007.

MATERIAL MODELLING AND CONSTITUTIVE RETATIONSHIPS

ACEX045
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Numerical Investigation of Combined Cold Expansion and Internal

Torsion of Fastener Holes

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This study investigates a process which combines cold expansion and internal torsion of a fastener hole for accumulating strain around the hole surface under high hydrostatic pressure. It is proposed to use sticking friction at the interface of an expandable mandrel and the hole for deformation of the hole surface. In order to avoid developing residual stress gradient along the hole thickness in the vicinity of the hole, simultaneous radial expansion in axial direction followed by the internal twist are applied to the hole surface to carry out the process. For estimating the optimum process parameters such as diametral interference and the cold formability of the material, a coupled numerical analysis of both the mandrel and the hole is carried out by nonlinear finite element analysis. A sequence of numerical analysis steps with mixed boundary conditions are set to solve the coupled problem. The analysis also predicts the onset of slippage between the mandrel and the work-piece. The distributions of accumulated strain in both radial and tangential directions are studied. Dissection of the nature of the resultant stresses in the periphery of the hole is also carried out. The conditions for postponing slippage before reaching a pre-determined level of deformation are predicted. This is accomplished in an inversed solution fashion by changing diametral interference and the constitutive parameters inside a pseudo light metal flow model. Finally a range of process parameters including adequate diametral interference and constitutive parameters for the proposed flow model is recommended to ensure that the process can create a minimum amount of deformation at the surface of the fastener hole.

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ACEX046
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Finite Element Modelin, Simulation and Analysis of Cold Updet Forging of Pure Aluminium

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The main objective of any manufacturing process is economical production of a consistent quality. The FEA can provide detailed information for forming designers such as forming force, defects predictions, flow pattern, and stress concentration in the dies. Therefore, part fabrication design can modified to improve tool's life or to enhance the formability conditions, and the new designs can be checked with repeated finite element simulations before experimental tests.

In this study, the application of commercial general finite element software - ANSYS - has been applied to model a forming operation. Models have been developed to simulate the ring compression test and to simulate a basic forming operation (upsetting) that is applied in most of the cold forging parts sequences. The basic data required for analysis of upsetting process are true stress- true strain behaviour and friction factor. The true stress- true strain data was obtained

from upsetting test performed with frictionless dies and aspect ratio of 1.0 on 100T computerized servo hydraulically controlled UTM. No lubricant was used during the test. The friction factor was determined from ring compression test.
Finite element analysis of deformation behaviour of cold upsetting process was carried out for pure aluminium in both dry and lubricated conditions with aspect ratios of 1.0 and 1.5. Rigid-flexible contact analysis was performed for the forming process. The billet geometry was meshed with 10-node tetrahedral elements (solid 92 in ANSYS Library). Element size was selected on the basis of convergence criteria and computational time. The program was continued to perform equilibrium iterations until the convergence criteria were satisfied. Material models selected were based on the properties of the tooling and billet materials. Due to high structural rigidity of the tooling, only the following elastic properties of tooling (H13 steel) were assigned assuming the material to be isotropic. Young's Modulus E = 220 GPa and Poisson's ratio υ = 0.30.
For billet material model selected is isotropic Mises plasticity with E = 110 GPa, υ = 0.343 and plastic properties obtained from Hollomon power law equation. As the nature of loading is non-cyclic, Bauschinger effect could be neglected and the non-linear data was approximated to piecewise multi linear with 10 data points. The material was assumed to follow the Isotropic hardening flow rule. Suitable elastic properties were also assigned for the material chosen for analysis. As the experiments were conducted at room temperature, the material behavior was assumed to be insensitive to rate of deformation.
A 3-D, 8-noded, higher-order quadrilateral element CONTA 174 (of ANSYS library) that can be located on the 3-D solid or shell elements with mid side nodes is used. Contact surface was meshed with CONTA 174. TARGE 170 (of ANSYS library) is used to represent various 3-D target surfaces for the associated contact elements. The contact elements themselves overlay the solid elements describing the boundary of a deformable body that is potentially in contact with the rigid target surface, defined by TARGE 170. Hence a target is simply a geometric entity in space that senses and responds when one or more contact elements move into a target segment element.
The variation in the values of radial diameter at 50% deformation obtained from finite element analysis and calculated values from volume constancy condition is 0.7%. This small variation may be neglected in non linear finite element analysis such as in large deformation / metal forming applications. Hence the analysis procedure adopted is validated. This fact was proved for all the samples considered. The FEA results were also compared with the analytical results of various stresses from the experimental measurements of axial, circumferential strains and found to be in good agreement.

Key Words: Friction, Upsetting, Vision System, Finite Element Analysis

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VIP-ACEX003
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A Model for Creep of POM and PBT

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For description of the time-dependent material behaviour of non-reinforced thermoplastics such as polyoxymethylene (POM) and polybutylene terephthalate (PBT) a simple model is proposed. In the one-dimensional case it encompasses the classical time-hardening and the total strain theories. The transition between these two classical models is controlled by a single parameter $\alpha \in [0; 1]$

$$\dot{\varepsilon}^{gem} = \sigma^n \frac{d\lambda(t)}{dt} + \alpha n \frac{d\sigma}{dt} \sigma^{n-1} \lambda(t) + \frac{1}{E} \frac{d\sigma}{dt}. \qquad (1)$$

A three-dimensional generalisation can be built up analogous to the one-dimensional case by introduction of the plastic potential $\Phi(\sigma)$ and of the tensor

$$R_{ij} = \frac{\partial \Phi}{\partial \sigma_{ij}} / \frac{\partial \Phi}{\partial \sigma_{11}} \Bigg|_{\sigma_{ij}=0,\ \sigma_{11}=\sigma_{eq}}$$

as it follows

$$\dot{\varepsilon}_{ij}^{cr} = \dot{\lambda}(t)\ f(\sigma_{eq}) R_{ij} + \alpha \lambda(t)\, \dot{f}(\sigma_{eq})\, R_{ij} + \beta \lambda(t)\, f(\sigma_{eq})\, \dot{R}_{ij} \qquad (2)$$

In order to fit the model the following tests were carried out: ramp loading (loading with a constant strain rate), standard creep test, creep test with a "jump" in loading.

The knowledge of the strain rate is required to fit the model (1) or (2), however strain only is measured directly. Hence, a computational procedure is needed in order to obtain the strain rate. This procedure is based upon the well-known SAVITZKY-GOLAY filter.

An additional verification of the models is the POISSON's ratio. It cannot be measured with sufficient precision and hence cannot be used for fitting directly. However, it is rather helpful in order to obtain some qualitative estimation.

[1] Kolupaev, V.A., Bolchoun, A., Forschung im Ingenieurwesen, 72(4), 209-232, (2008).

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Modification of structural stiffness and geometric stiffness matrices for shifting natural frequencies and buckling loads of plates simultaneously

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The inverse engineering design or behavior modification of a system may be defined as finding the necessary changes in physical or geometrical properties of a structure in order to achieve predefined shifts in structural responses such as natural frequencies or buckling loads. The traditional method for performing such modification is the error and trial method wherein the structural responses are iteratively calculated for different values of design variables till the answer converges to the desired value. This procedure faces with more conflicts when simultaneous modification of two parameters is needed. For structural responses that are formulated in eigenvalue form (such as free vibration and linear buckling) the time consuming iterative methods may be replaced by an inverse eigenvalue problem. Aryana et. al. [1] and Mirzaeifar et. al. [2] presented an inverse approximate eigenvalue method based on eigen-derivatives for modification of free vibration behavior of FGM and laminated composite plates. This work presents an inverse non-iterative formulation for simultaneous modification of natural frequencies and buckling loads. The inverse eigenvalue problem is transformed to solving a system of algebraic equations with considering the desired changes in natural frequencies and buckling loads as known terms and the design parameters as unknowns. The proposed algorithm is applied to a plate with different boundary conditions and the results are compared with those obtained by implementing the finite element method directly.

[1] F. Aryana, H. Bahai, R. Mirzaeifar, A. Yeilaghi. Int. J for Numer. Meth. Engng 70(12) 1409-1429 (2007)
[2] R. Mirzaeifar, H. Bahai, F. Aryana, A. Yeilaghi. J of Composite Materials 41(26): 3091-3108 (2007)

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ACEX240
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Optimization of Electrode Grids dimensions For ITO-free Organic Photovoltaic Devices

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The study of organic semiconducting materials has emerged over the last few decades as a field rich in fundamental science concerning unique electronic phenomena and photophysics. The development of organic photovoltaic devices is just one application of this fundamental work. Plastic photovoltaic devices offer the possibility of low-cost fabrication of large-area solar cells for harvesting energy from sunlight [1].
Solar cells based on conjugated polymer-fullerene composites are a promising potential source of renewable energy. [2-4].
The most efficient conjugated polymer based solar cell consists of blends of light absorbing superconducting polymer and a soluble derivate of the Buckminster fullerene C60. Recent polymer based bulk heterojunction solar cells show power conversion efficiency of close to 5% [5-6]. The series resistance can severely affect the performance of photovoltaic cells as solar energy converters [7].
The aim of this work is to present an optimized model of metallic micro grid used as anode electrode in organic photovoltaic devices excluding the use of expensive ITO (Indium Tin Oxide). We propose a grid design whose pattern is circular. In order to optimize the collecting grid dimensions one must choose a compromise between the resistive losses, represented by the series resistance Rs, and the shadowing loss; i.e. the minimization of the series resistance must not be done on the detriment of the shadowing loss. Therefore, in order to find the best geometry of the grid, a comparative study has been done between the linear geometry and the circular one of the grid. Our results show clearly that the efficiency is enhanced when using the circular geometry.

[1] C.Brabec, V.Dyakonov, J.Parisi, N.S.Sariciftci, Organic Photovoltaics “Concepts and Realization”, Springer edition (2003).
[2] G. Yu, J. Gao, J. C. Hummelen, F. Wudl, A. J. Heeger, Polymer photovoltaic cells: enhanced efficiencies via a network of internal donor-acceptor heterojunctions,
Science, Vol: 270, pp. 1789-1791, 1995.
[3] S. E. Shaheen, C. J. Brabec, N. S. Sariciftci, C. J. Brabec, N. S. Sariciftci, F. Padinger, T. Fromherz, J. C. Hummelen, 2.5% efficient organic plastic solar cells,
Appl. Phys. Lett, Vol: 78, pp. 841-843, 2001.
[4] C. J. Brabec, N. S. Sariciftci, J. C. Hummelen, Plastic solar cells, Adv. Funct. Mater, Vol: 11, pp. 15-26, 2001.
[5] Kristofer Tvingstedt and Olle Ingan_s, Electrode Grids for ITO-free Organic Photovoltaic Devices, Advanced Materials, 2007, vol. 19, no19, pp. 2893-2897.
[6] J. Y. Kim, S. H. Kim, H. H. Lee, K. Lee, W. L. Ma, X. Gong, A J. Heeger, Adv. Mater. 2006, 18, 572.
[7] MARTIN WOLF and HANS RAUSCHENBACH, SERIES RESISTANCE EFFECTS ON SOLAR CELL MEASUREMENTS, Advanced

Energy Conversion. Vol. 3, pp. 455-479. Pergamon Press, 1963.

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ACEX054
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Numerical Simulation of Powder Bed Consolidation for Beam Based Additive Manufacturing Processes

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Melting and resolidification of a random packing powder bed under the irradiation of a Gaussian beam is numerically investigated with a 2D single phase lattice Boltzmann model (LBM). An increase in heat source intensity or powder bed packing density will changes the melt pool depth, melt pool shape and liquid phase shrinkage.
Simulation results are compared with experimental finding during Electron Beam melting (EBM). EBM is a novel technique, where metal powders are selectively molten with the help of an electron beam layer by layer.
Comparison of experiment and simulation show that this model is cable of prediction of melt pool characteristics.

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ACEX055
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Interval analysis applied to dielectric spectroscopy : A guaranteed parameter estimation

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Dielectric spectroscopy (DES) is widely applied in the characterization of polymers, insulating liquids and ceramics because this is an extremely effective method for characterizing the molecular dynamics over a large range of time scales .In the measurement, the complex dielectric function is measured at constant temperature. This function is called the dielectric spectrum and can be fit by a sum of relaxation processes, but the choice of a reasonable physical model for the relaxator is critical. Most of the usual models result from phenomenological considerations providing limited physical foundation, and even after the model choice, these analyses are often difficult since the common software algorithms and line shape functions do not always provide unambiguous data for the fitted parameters. In this presentation, software, based on a global optimization algorithm which uses interval analysis, is presented. Taking into

account the experimental error of each data point in the measured dielectric spectrum, the software provides a confidence interval for every parameter of the dielectric function implemented in the software. This is demonstrated for an epoxy monomer with a sum of Debye relaxators as dielectric line shape function. This software is also able to deliver and guarantee the number of relaxation processes even if they are in part masked by other phenomena like conductivity or electrode polarization. Then, with the correct model and calculus, it is possible to determine important characteristics of the data, such as the number of relaxations, their frequency position and intensity.

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ACEX058
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Computer Aided Design System for Riser Design in Casting Employing Shape Recognition Techniques

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Casting is one of the most complex engineering areas which involve number of technical and scientific disciplines. Since, computers became widely available in industry; researchers have been working on the development of programs to simulate the solidification of castings. Many computer simulation programs now exist, but some require computers of a power not generally available to practical foundry men, while others take an unacceptably long time to obtain meaningful results. There are certain differences among individual programs and packages, but in general they all address the same basic problems and dealing with one casting geometry at a time. The currently available casting solidification simulation software's, mostly based on finite difference method (FDM), finite element method (FEM), and boundary element method (BEM), are very tedious. Normally simulation is done for simple shape castings particularly cylindrical and of slab type. Very limited complicated shape castings of real engineering components have been considered and yet not applied all constraints and complete boundary conditions. Basically, casting solidification simulation software program performs firstly, the solid modeling (i.e. using the casting drawing, determine model scale and element size), consecutively, the thermal analysis and solidification simulation.

In this work a computer aided design (CAD) system for riser systems is developed. The system is simple and general in nature and can deal with any casting geometry. A geometrical methodology to recognize the casting geometry is adopted. The Casting is represented by top and front views in different layers using the boundary representation (B-Rep) method in 2-D to model the part drawing, whose, Data Exchange Format (DXF) file include the basic entities (lines and arcs) of the Casting under consideration. A Visual Basic (VB) code is developed to recognize the casting geometrical properties, which is essential in the design of risers and the success of the casting process. A simple automatic method for feeder design in casting processes is presented. Three well known approaches namely; Chvirnove, Cain and Navel Research Laboratory (NRL) are utilized to design the feeders in the presented system. Illustrative examples are presented to demonstrate the capability of the developed system.

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ACEX101
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Modeling of the Cutting Forces in Machining AISI 4140 Steel Using Intelligent Techniques

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Even though modeling of the metal cutting process has been a subject of investigation for a large number of researchers all around the world, no general model, which describes this process exactly, has been established to date. Data acquisition and modeling of the experimentally obtained data, in different cutting conditions and with different cutting regimes, is the most often way of the process representation. Data modeling, using the means of classic mathematical tools is fairly restricted, especially because of impossibility of comprehending all the relevant factors, and all the correlations which occur among them. Cutting forces are one of the most important quantitative-qualitative parameters of the metal cutting process. In the first part of this work relevant data about cutting forces, which occurs during turning of the AISI 4140 steel, were collected, presented and analyzed. Relationship among input parameters, i.e. cutting regimes, and corresponding cutting forces, as well as trends of cutting forces changing was established. In the next step, modeling of the cutting force was performed using the artificial intelligence techniques, i.e. artificial neural networks, and hybrid, adaptive neuro-fuzzy systems. The comparative analysis of the created models, considering the error and the capability of generalization, is shown. Obtained models can be used for prediction cutting forces purposes and metal cutting process optimization, in order of increasing the productivity and reducing the manufacturing costs.

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ACEX132
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Homogenisation of a Microcellular Integral Sandwich Structure Using Virtual Representative Models

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Advanced foaming technologies were employed to fabricate tailored LDPE integral cellular sandwiches. These structures were composed of a microcellular core with a medium relative density and two denser faces made of the same bulk material. Monitored three point bending tests have been carried out with the aim of determining the flexural rigidity and failure mode of these structures.
In parallel, representative volume element (RVE) virtual models were developed for medium-high density cellular material based on a random sequential absorption algorithm. These micromechanical models closely imitate real structures and they were successfully employed for the prediction of mechanical properties of real foams under compressive loads. Once they had demonstrated their high predictive capability, these cell-level models were utilized to simulate more complex tests which are required to adjust constitutive models (crushable foam, Deshpande-Fleck) and

multiaxial yield behavior. Simulated tests were carried out by applying prescribed deformations with appropriate periodic boundary conditions to finite element RVE models. This homogenisation methodology was useful to compute the macroscopic stress-strain behavior of an equivalent continuum under multiple load conditions. The studied methodology was employed for the determination of the yield surface on the deviatoric-hydrostatic stress plane avoiding the performance of rather complicate real tests such as hydrostatic compression or biaxial tension. From the derived yield surfaces equivalent constitutive models were adjusted for different high density foams. The macroscopic finite element analysis of a real LDPE integral cellular sandwich subjected to three points bending test was simulated by assigning the corresponding constitutive models to the core and faces. The comparative response of the macroscopic bending simulation and real test was discussed.

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ACEX150
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A Statistical Study on Stress-strain Relation of AISI 304 Stainless Steel under Elevated Temperatures

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This study describes the tensile test results of AISI 304 under room and elevated temperatures. The tensile tests for AISI 304 are performed according to ASTM standard. Normal probability plot was used to evaluate A and B basis value for tensile strengths. It is described implicit and explicit modified Ramberg-Osgood relation of AISI 304 stainless steel under normal and elevated temperatures. The validity of relations is testes by experimental data. The tests show that the expressions are consistent with experimental data qualitatively and quantitatively. After room and elevated temperature tensile tests, the surface of fractured specimens was observes by SEM images and EDX.

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ACEX155
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Crystal Plasticity Simulation of Free Bulge Test of Polycrystalline Aluminum Tubes

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In this study, a three-dimensional crystal plasticity model for the tube hydroforming of initially-textured polycrystalline materials was used to investigate the stress state and burst failure of the SS304 tube. A rate-dependent crystal plasticity finite element model, where each material point in the tube is considered to be a polycrystalline aggregate of a large number of grains, was implemented into the user-subroutine UMAT of a finite element program ABAQUS. Deformation

responses and burst failures of the weld-line in the tube were modeled by using the cohesive zone model. The initial orientation distribution was measured by the electron back-scattered diffraction (EBSD) and orientation imaging microscopy (OIM) and given to the finite element program as input data. The strain distributions were measured by using the digital image correlation method and final textures were also measured after free bulge test. Finite element simulations show a good agreement with the experimental results for the strain distribution, burst failure and the evolution of the crystallographic textures during hydroforming processes.

[1] Y. Guan, F. Pourboghrat and F. Barlat, Int. J. Plasticity, 22, 2366 (2006). [1] P. Tugcu, K.W. Neale, P.D. Wu, K. Inal, Int. J. Plasticity, 20, 1603 (2004). [2] Z. Zou and S.R. Reid, Int. J. Solid Struct, 42, 4519 (2005).

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ACEX156
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Aerodynamic Analysis of Helicopter Rotor using the Time-domain Panel Method

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Recently, aerodynamic analysis of the helicopter rotor using computational fluid dynamics (CFD) is widely carried out with high accuracy. But, it is very difficult only using the wake simulation of the helicopter rotor using CFD analysis. In this research the time-domain panel method, which uses a numerical technique based on the piecewise constant source and doublet singularities, is applied to the analysis and prediction of the unsteady aerodynamic characteristics of helicopter rotor in a potential flow. And the time-marching free wake model is used for wake simulation. The results of present method are compared with the experimental data of a helicopter rotor in hover and in forward flight.

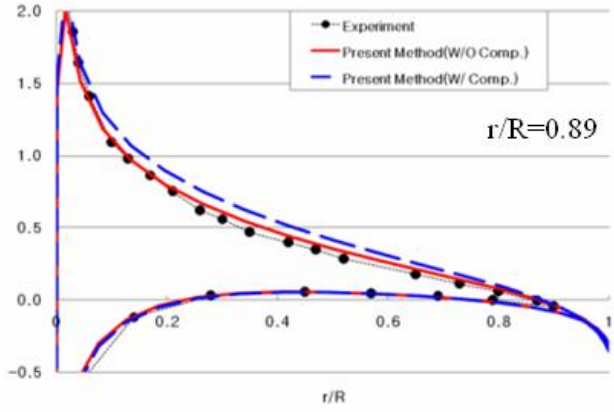

Fig. 1 Pressure distribution of blade

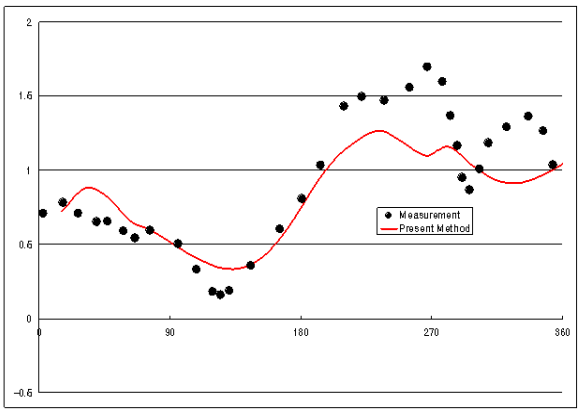

Fig. 2 Blade section lift

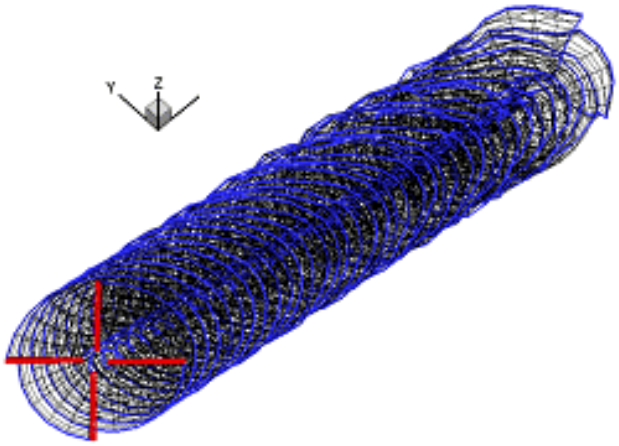

Fig. 3 Wake simulation in forward flight

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ACEX166
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Methods of estimation of influence of creep processes on bearing ability of bridge constructions

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Necessity of the account of the phenomenon of creep of metals has arisen for the first time in power mechanical engineering at designing of steam and gas turbines. But also in building the account of processes of creep has sometimes fatal value. The train of the failures which have occurred recently on transport (Moscow, Russia 08.02; California, USA 04.07; Cologne, Germany 08.04) puts before us a problem of more detailed studying of processes of creep in metal structures, in particular in bridge beams. These examples tell about necessity of a numerical estimation of influence of sharp growth of temperature on strength properties of bridge beams. Feature of these failures is prompt growth of temperature up to 1000°C that conducts to change of the Young's modulus and other characteristics of a material of a beam. Therefore growth of deformations is got by nonlinear character and a structure can waste bearing ability for very short time. At use modern program complexes the forecasting problem total influences of processes of creep and plasticity leaves the category not solved and there is a possibility to receive the decision with the minimum error.

In work theoretical and practical methods of plotting of creep for a metal beam are compared; the analysis of curves of creep from the point of view of an estimation of bearing ability of a design is resulted. Making experiments at a temperature and loading preset value “critical time” was defined – time at which there comes loss of stability of a structure. It is given the chance forecasting of time during which there will come full or partial destruction of a construction.

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ACEX174
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Model of Large Displacements in Static Analysis of Shell

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A model of geometric non-linearity in static analysis of a shell, which includes the effects of large displacements and small deformations, is presented. A non-linear problem was solved using the updated Lagrange procedure. External load was applied in increments. An iterative solution procedure was carried out for each load increment until a vector of residual forces became arbitrary small. At the end of the each iteration step states of variables were updated in comparison to their states at the end of the previous iteration step. Impact of large displacements was included by transformation of variables between the global and local coordinate systems. The shell was simulated by 8 and 9 node curved degenerated finite elements, free of membrane and shear locking. A layered model along the shell thickness was used. Presented numerical model was verified on the results of three experimentally tested very slender steel cantilever beams, with elastic behaviour of material for all applied loads. Cantilever beams were loaded by eccentric force at their ends. Example 1 shows the cantilever beam placed horizontally and loaded by bending. In Example 2, cantilever beam was placed vertically and loaded by longitudinal compressive force (Fig. 1). In Example 3, cantilever beam was placed horizontally and loaded by bending and torsion.

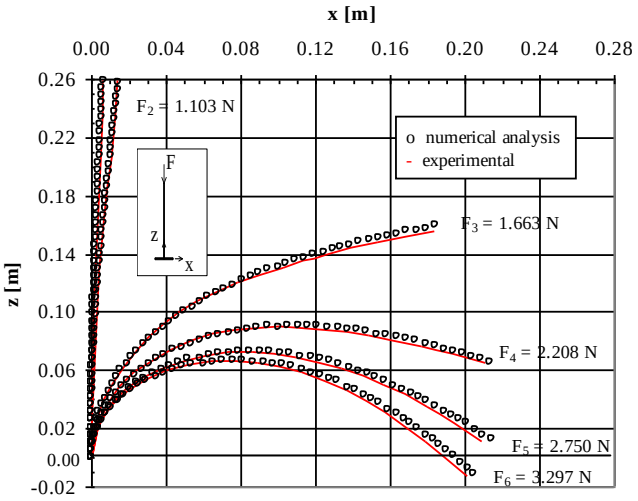

Fig. 1 Deflection of the cantilever beam described in Example 2

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ACEX174.1
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Nonlinear Time-dependent Analysis of Prestressed Concrete Shells

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The model for the numerical analysis of prestressed concrete plates and shells under the short-term and long-term static loads was presented. The material and geometric structure nonlinearities were modelled. It is possible to simulate the dominant nonlinear effects of concrete: the creep, shrinkage, aging, the development of cracks in tension and yielding in compression, as well as the changes in the tensile and shear stiffness of cracked concrete. Reinforcing steel is modelled as a separate layer with anisotropic material properties, with a possibility to transfer the stresses in the reinforcement bars direction only. Prestressing tendon is simulated by 1-D curved finite element embedded in the shells finite element. The numerical procedures, which describe the prestressing contributions and time-dependent analyses, are discussed. The numerical model simulates the prestressing losses that occur during and after the prestressing. A distinction has to be made between pre-tensioned and post-tensioned structures, in order to take into consideration the immediate prestressing losses. The numerical model is verified by results of the experimentally tested prestressed concrete shells (see Fig.1).

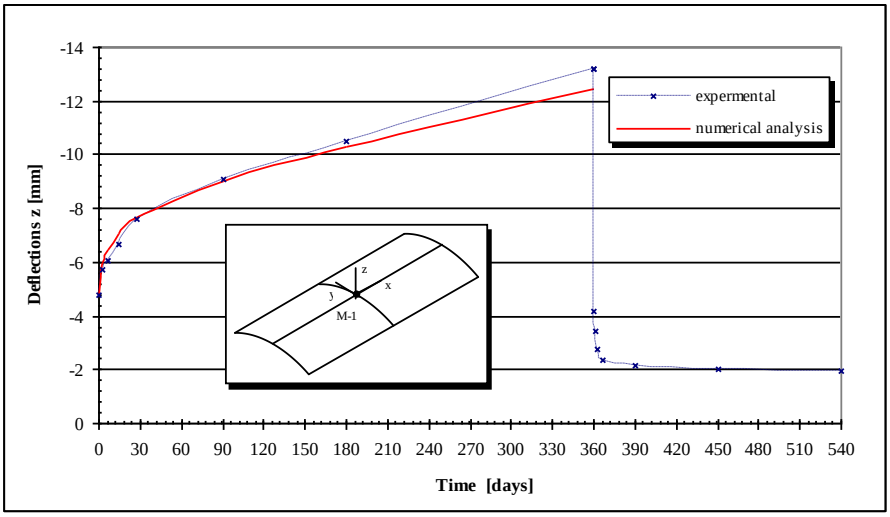

Fig.1 Long-term deflection at shell centre (measuring point M-1)

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VIP-ACEX003
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Advanced Creep Equations for Structural Analysis Applications

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The classical creep mechanics is based on Norton's creep law since it is very simple and one need only two material parameters. In addition, it can be easily extended to the three-dimensional case. However, it is limited to the stationary creep, to the isotropic material behaviour, and to the isothermal case.
One possible extension of the classical approach is necessary since many materials exhibit stress range dependent creep behaviour. The power-law creep observed for a certain stress range changes to the viscous type creep if the stress value decreases. Experimental data for advanced heat resistant steels indicates that the high creep exponent (in the range 5-12 for the power-law behaviour) may decrease to the low value of approximately 1 within the stress range relevant for engineering structures. An advanced constitutive model for the minimum creep rate is introduced to consider both the linear and the power law creep ranges.
The first extension is applicable only to the stationary creep. For practical purposes the constitutive equation for the secondary creep should refined to account for hardening, softening and the damage processes. The suggested equations are based on an extended power law to characterize the minimum creep rate as well as appropriate state variables. The tertiary creep rate is assumed to be controlled by the softening associated with subgrain coarsening as well as damage due to voids and microcracks. Both processes can be dominant depending again on the level of the acting stresses.
Based on the academic example of the thick-walled pipe under inner pressure it will be demonstrated that the stress range dependent creep may alter both the magnitude of the stresses and the kind of the stress redistribution in a structure.

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ACEX073
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Effects of friction on microstructural evolution in a deformed low alloy steel

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In metal forming processes, friction plays a significant role in determining the life of the tool, the formability of the work material and the quality of the finished product such as, surface finish, internal structure, and product life. Friction can increase the inhomogeneity of deformation, leading to defects in the finished products. Friction can also be used beneficially to manipulate the material flow to achieve the desired end product with a minimum effort [1-3]. In order to study the workability and effects of friction on dynamic recrystallization in a deformed low alloy steel, the compressive deformation behavior of 42CrMo steel was investigated at the temperatures from 850 to 1150℃ and strain rates from 0.01 to 50 s-1 on Gleeble-1500 thermo-simulation machine. Based on experimental results, the dynamic recrystallization mathematica1 models of 42CrMo steel were derived. Then, the thermo-mechanica1 coupled finite element model was developed to investigate the effects of friction on dynamic recrystallization in a deformed 42CrMo steel during hot upsetting were investigated by integrating the thermo-mechanica1 coupled finite element method with the derived microstructural evolution models. The results show that the distributions of strain/stress in the deformed block are inhomogeneous, and the degree of the deformation inhomogeneity changes with the frictions between workpiece and dies. The distribution of dynamic recrystallization volume fraction and dynamic recrystallization grain size, which change with the fritions, are also inhomogeneous in the deformed workpiece.

[1] F. Fereshteh-Saniee, M. Jaafari and Analytical, J. Mater. Process. Technol., 125/126, 334 (2002).

[2] J. Beddoes, M.J. Bibby, Principles of Metal Manufacturing Processes, Arnold, 1999.
[3] M. Bakhshi-Jooybari, J. Mater. Process. Technol., 125/126, 369 (2002).

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ACEX058
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A CAPP/CAD Expert System for Sheet Metal Dies of Deep Drawing Process

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Deep drawing process is one of the important sheet metal forming processes in today's industrial production world. It is widely used in various industries such as automobiles, electronic appliances, airplanes, and military applications. Axisymmetric deep drawing is a process by which the circular blank is formed into a cylindrical, conical or complex round shell by means of axisymmetric deep drawing die. Deep drawing dies have wide application forms in the sheet metal industrial world. However, there is no complete research work in the area, in which an integration of CAD/ CAPP/ CAM are included, which is capable to solve this problem in the real industrial world.

In this work an intelligent and integrated expert system for sheet metal deep drawing dies design is developed. The system consists of two mean modules; the first module is Computer Aided process planning (CAPP) for deep drawing parts. This includes the calculation of the blank dimensions of the drawn part, determination of the number of stages of deep drawing needed to produce the required part, geometry calculations of the part and tooling after each stage, determination of the need of the drawn part for annealing after each stage. While the second module is a Computer Aided Design and Drafting for deep drawing dies. In this module the data of the required deep drawing stages is received from the CAPP module, the geometry of the each stages are defined, then the fully and automated 3D modeling design and drafting of the deep drawing dies in each stage could be constructed parametrically.

The developed system is coded using Visual Basic (VB) to report the load and tooling requirements and is interfaced with AutoCAD to plot the shape of the drawn shell and its drawing die in each stage of the deep drawing process. Illustrative examples are presented to demonstrate the capabilities of the developed system.

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ACEX069
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Computational Model of Laser- Micromachining Based on Finite Element Method

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Computational model was developed based on finite element method to virtually carry out laser-micromachining. Model geometry considered was micro-bridge found in MEMS devices and created as 2D. The element types were plate elements. Material was PMMA and phase change material model was incorporated into the computational model. Material properties were taken from published report. Heat flux propagation and temperature plots generated during virtual laser-micromachining were compared and discussed. The important parameters to obtain the realistic results from the virtual work were highlighted. Experimental laser-micromachining of PMMA was carried out using the same set of machining parameters predicted by computational model. The computational results were qualitatively agreeable with the laser-micromachining mechanism found in the experiment. This computational technique is promising to provide the important information leading to the possibility of replacing the conventional method of fabricating MEMS components.

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ACEX220
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STUDY ON THE CHROM INFLUENCE ON THE MECHANICAL PROPERTIES AND MICROSTRUCTURE OF THE TUNGSTEN BASED ALLOYS

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Faculty of Materials Science and Engineering

In this paper we have presented the studies and the researches done by the authors on the crom addition effect on the mechanical properties and microstructure of the heavy alloys from the W-Ni-Fe system. The experimental results have shown that the chrom addition up to 3 wt. % in the W-Ni-Fe system, have influenced the density, elongation and the yield limit of the sintered samples. These results could be explained by the segregation observed on the interphase boundaries between the W based matrix and the chromium compounds with the Ni, Fe and O elements. Also, an interphase corrosion is produced from where is explained the lowering of the mechanical properties analyzed.

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ACEX220
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Mechanical alloying of Fe80Cu20

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This paper present the milling time influence on ball-milled Fe80Cu20 (wt. %) powders. After 16 hour of milling it has been concluded that true alloying at atomic level occurs during milling. The average grain size depends by milling time.

Varying the milling time changes the powder morphology, their size and structure. We found that the complete bcc Fe – Cu solid solution is formed when the grain size of Cu-fcc reaches a value about 13 nm, because at this value of crystallite the free energy for interface become less than interfaces energy. The milling duration have a strongly influence on solid solubility and phases form in Fe-Cu system. The phase formation for Fe80Cu70 (wt. %) has been investigated by X-ray diffraction (XRD), scanning electron microscopy (SEM).

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ACEX218
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A New Modified Austempering to Increase Strength and Ductility Simultaneously for UHS Steels

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2University of Tehran, Tehran, Iran.

In this paper, a modified up-quenching heat treatment method to the ASSAB 705M steel (ultra high strength steel) is proposed.

A low alloy steel (0.33%C), was used to study the effect of isothermal austempering, successive austempering and modified up-quenching austempering heat treatment on the mechanical properties. The specimens, were cut from a bar with 25mm diameter and after achieving the best temperature and time of austenitizing, austenitized at for 60 min and followed by quenching at for the high austempering temperature to achieve the upper bainite morphology and at for the lower austempering temperature to achieve the lower bainite morphology.

In the case of successive austempering, the specimens were first austempered at for different periods (500sec. and 60sec.) and then austempered at for 1000 sec to achieve the mixed structure of upper bainite and lower bainite morphology.

The specimens selected for up-quenching, after austenitization were quenched to below ( ) for 120 sec. followed by heating at to achieve the mixed structure of tempered martensite and lower bainite and to achieve the mixed structure of tempered martensite and upper bainite for 1000 sec.

The all of processes were performed in the salt bath furnaces. Experimental results are presented and the advantages of the modified method are discussed.

As well, it is shown that the best combination of strength and ductility can be achieved by the proposed heat treatment method. This modified method, can offer techniques that simultaneously improve not only strength 12 %(compare with results of strength after other heat treatment methods), but also ductility 38 %(compare with results of ductility after other heat treatment methods). While, conventional heat treatment of ultra high strength steels (UHSS) cannot always meet the strict engineering requirements for improved strength and ductility simultaneously. It has been shown that the mixed structure of tempered martensite and lower bainite that has been suggested in this investigation offers a good combination of strength and ductility.

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ACEX220
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MATHEMATIC MODELING OF THE OSPREY PROCESS

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Spray forming is a flexible process which can be used to manufacture a wide range of materials that are difficult to be produced by other methods, such as: metal matrix composites (MMCs), Al-Si alloys or high speed steels with a relatively fine-scale microstructure in large cross-sections. The potential benefits of the process had impulsioned many researchers to study the phenomens involved in the process and to improve the capability of the industrial production of the strips, tubes, rings, clad bars and other products related to Osprey technology.
In that respect, this paper is focused on the mathematical modeling of the phenomens involved in Osprey process, treated in a cursive manner, as the process timeline is evolving. First, the melt flow rate is analyzed as a function of the melt delivery nozzle geometry vs. the height of liquid head in crucible, then the analysis of the atomization process predicting the droplets size and velocities vs. initial conditions and finally the thermal history of the droplets are investigated.

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ACEX247
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Torsional buckling of a double-walled carbon nanotube embedded on Winkler and Pasternak foundations using nonlocal cylindrical shell theory

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Based on theory of nonlocal elasticity, small scale effect on torsional buckling of a double-walled carbon nanotube embedded on Winkler and Pasternak foundations investigated in this work. The effects of the surrounding elastic medium such as linear and nonlinear parts of foundations called Winkler and Pasternak models, and van der Waals forces between the inner and outer nanotubes are taken into account. The effect of small length scale is incorporated in the formulation. It is concluded that the nonlocal torsional buckling load for a carbon nanotube could be overestimated by the local shell model due to ignoring the small scale effect. Finally, based on theory of nonlocal elasticity and using continuum models, an elastic double-shell model is presented for the nonlocal torsional buckling load of a double-walled carbon nanotube. The nonlocal critical torsional buckling load has been obtained at the different states such as the effect of the surrounding elastic medium, small scale effect and the van der Waals force of pre-buckling. Also, a simplified analysis is carried out to estimate the nonlocal critical torque for the torsional buckling of a double-walled carbon nanotube.

[1] A. C. Eringen, J. Appl. Phys., 54, 4703 (1983).
[2] Q. Han, G. Lu, Eur. J. Mech. A/Solids, 22, 875 (2003).
[3] A. R. Ranjbartoreh, A. Ghorbanpour, B. Soltani, Physica E, 39, 230 (2007).

MATHEMATICAL FOUNDATIONS

ACEX060
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FORK -512: Motivate a New Hash Function

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This paper describes the study of cryptographic hash functions, one of the most important classes of primitives used in recent techniques in cryptography. The main aim is the development of recent crypt analysis hash function. We present different approaches to defining security properties more formally and present basic attack on hash function. We recall Merkle-Damgard security properties of iterated hash function. The Main aim of this paper is the development of recent techniques applicable to crypt Analysis hash function, mainly from SHA family. Recent proposed attacks an MD5 & SHA motivate a new hash function design. It is designed not only to have higher security but also to be faster than SHA-256. The performance of the new hash function is at least 30% better than that of SHA-256 in software. And it is secure against any known cryptographic attacks on hash functions.

REFERENCE

[1]. E. Biham and R. Chen, “Near-Collisions of SHA-0,” Advances in Cryptology
CRYPTO 2004, LNCS 3152, Springer-Verlag, pp. 290–305, 2004.
[2]. E. Biham, R. Chen, A. Joux, P. Carribault, C. Lemuet and W. Jalby, “Collisions of
SHA-0 and Reduced SHA-1,” Advances in Cryptology – EUROCRYPT 2005,
LNCS 3494, Springer-Verlag, pp. 36–57, 2005.

[3]. B. den Boer and A. Bosselaers, “An Attack on the Last Two Rounds of MD4,” Advances in Cryptology – CRYPTO’91, LNCS 576, Springer-Verlag, pp. 194–203, 1992.
[4]. B. den Boer and A. Bosselaers, “Collisions for the Compression Function of MD5,” Advances in Cryptology – CRYPTO’93, LNCS 765, Springer-Verlag, pp. 293–304, 1994.
[5]. F. Chabaud and A. Joux, “Differential Collisions in SHA-0,” Advances in Cryptology – CRYPTO’98, LNCS 1462, Springer-Verlag, pp. 56–71, 1998.
[6.] I. Damg°ard, “A Design Priciple for Hash Functions,” Advances in Cryptology CRYPTO’89, LNCS 435, Springer-Verlag, pp. 416–427, 1989.
[7.] H. Dobbertin, “RIPEMD with Two-Round Compress Function is Not Collision-Free,” Journal of Cryptology 10:1, pp. 51–70, 1997.
[8]. H. Dobbertin, “Cryptanalysis of MD4,” Journal of Cryptology 11:4, pp. 253–271, 1998.

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ACEX084
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Engine Room Distance Alarm System Based on Computer Vision Monitoring

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Hard working conditions in engine room are cause for investigating better ways of monitoring and control aboard ships. Additional problem is constant reduction of crew, because of costs reduction and lack of ship's engineers. Natural way of improving working conditions and reduce necessary crew number is implementation of distance alarm system . Such systems can be local, concentrating on one problem [1], or global. Proposed system is global. It monitors engine room indicators and informs the crew, which is not necessary positioned in the engine room, about possible alarms. To track indicators, it is important to compensate for camera vibrations and to use higher vision aspects for understanding is there a possible alarm. Except monitoring of different indicators, engine parts can be also monitored for structural damages and degradation processes. It is especially important to detect possible corrosion. Depending on number and position of monitoring cameras, it is possible to deal with some or all of mentioned problems. Since the vibrations of the camera, because of the engines operation, causes virtual motion (parts of the scene are captured at different location of the acquired image), this effect causes false alarms. Therefore it is important to reduce or eliminate these false alarms. Reduction of such virtual motion is performed using spatio-temporal discrete wavelet transform [2, 3].

[1] I. Kuzmanić, J. Šoda, R. Antonić, I. Vujović, S. Beroš, Mat.-wiss. u. Werkstofftech., 40, 98 (2009).
[2] I. Selesnick, R. G. Baraniuk, N. G. Kingsbury, IEEE Sig. Proc. Mag. 22, 123 (2005).
[3] A. Mertins, Signal Analysis: Wavelets, Filter Banks, Time-Frequency Transforms and Applications, John Wiley & Sons Ltd. (1999).

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ACEX094
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Geometry Optimization with limited changes in Attachment Geometry and Cost saving in Manufacturing Processes for a Steering Knuckle

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Key words: Steering Knuckle, Forged steel, Attachment Geometry

The purpose of the paper is to reduce weight and manufacturing cost of the forged steel steering knuckle while maintaining or improving its fatigue strength. It is attempted to have a more general look at the optimization. Therefore reducing the mass of the component, reducing manufacturing costs, and improving fatigue performance are focused simultaneously. Manufacturing costs and fatigue strength of a steering knuckle depend on service conditions, geometry, material and manufacturing processes. Therefore, geometry, material and manufacturing parameters are attempted in this study as design variables. The modifications are approached in two stages; first without changing the component's attachment geometry and focusing on steering knuckle's body; and second, with limited change in attachment geometry and focusing on the spindle as well as the body. The paper discusses for the second stage.
The material alternatives search in this paper is considered replacing the current material with materials of superior fatigue performance, and subsequently, reducing dimensions and weight. Manufacturing parameter modifications to improve fatigue performance or reduce manufacturing costs included precision forging instead of conventional forging, warm forging instead of hot forging, reducing manufacturing steps, and surface enhancement.

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ACEX194
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Developing an Expert System For Powder Technology

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The need for a complete expert system for powder technology is a technical and economic necessity to increase this industry efficiency and productivity as well as profitability and competitiveness in a modern ever increasing industry. The importance of this study stems from the fact that, the expert system which is structured on intelligent technology and engineering knowledge, is believed to be the backbone of the suggested Computer Integrated Manufacturing for Powder Technology (CIMPT). Particularly, with the development of greater number of new engineering materials and manufacturing processes that are now available and growing lag of expertise in this filed.

The objective of this research is to build a complete expert system for powder technology using an expert system. A functional prototype expert system will be developed using a rule-based knowledge representation model. The system will be designed to acquire knowledge from the user then give recommendations on powder production method which satisfies the specified powder requirements for a specific application.

In the powder technology it is believed that, there are three main areas of work, which are interacting and heavily interdependent on each other. The number of variables involved and the amount of information as well as the databases of the material properties and powder production processes are huge. Thus, to seek a complete integrated approach is very demanding and extremely difficult. Therefore, it is suggested to divide the problem into stages, which will be tackled separately. Later, an attempt will be made to integrate these stages and form a complete computer integrated manufacturing system for powder technology (CIMPT), where most of powder technology activities are to be integrated. This envisaged powder technology expert system consists of various parts. Thus, in this paper, an expert system that deals with the powder selection according to predetermined recommended or required material properties, and specific powder characteristics will be selected. Then, determining the most common powder production method, which satisfies the specified powder requirements for a specific application. For this purpose a detailed functional prototype expert system will be developed using a rule-based knowledge representation model. The expert system is designed to acquire knowledge from the user then give recommendations. The forward and backward chain techniques are utilized, thus the reverse process is also be possible. The proposed expert system will be flexible, easy to be implemented, modified and extended.

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ACEX042

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Graph Theory for Color Reconstruction and Image Segmentation

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Fuzzy sets defined on the Hue, Saturation and Value components of the HSV color space, provide a fuzzy logic model that aims to follow the human intuition of color classification.

In this paper we describe a human perception based approach to pixel color segmentation which applied in color reconstruction by numerical method associated with graph-theoretic image processing algorithm, typically in grayscale. The proposed model introduces an improvement over some other basic color classification techniques which are considered more challenging to color segmentation methods. In color vision systems require a first step of classifying pixels in a given image into a discrete set of color classes.

[1] R. Benavente, M. Vanrell and R. Baldrich, Color Res.Appl., 31, 46 (2006).
[2] C.E. Brodley and P.E. Utgoff, Machine Learning 19, 45 (1995).
[3] M.R. Darafsheh and A. Moghani, Italian J. Pure and Appl. Math. (In press)
[4] A. Moghani, IMID/IDMC/ASIA DISPLAY '08 DIGEST, 943 (2008).

NANOMATERIALS

ACEX109
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Graphene Sheet as a Multifunctional Mass Sensor

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In traditional mass sensors for mass detection of any nanoparticle in dynamic mode of operation of sensors, it is essential to specify position of mass or assumption that it be evenly distributed over the surface[1], and consequently sensor must be functionalize in one specific site. In addition to, achieving the ability to determine mass and position would make it possible to design an artificial nose using only a single sensor by having several areas on it coated for sensing of specific and different target molecules. Recently, single-layer graphene sheet capability as mass sensors was considered. In this paper a theoretical study for investigation the possibility of graphene sheet as a mass and position sensor is considered. This multifunction mass sensor (used for denote mass sensors by capability of determine of added mass position) able to have multi functionalized site for different particles and simultaneously specify amount of mass in any site. It is shown that the use of higher bending modes grants the capability of mass and position sensing. Modeling is based on molecular dynamics simulation of defect free single-layer graphene sheet (SLGS). Three first frequencies and corresponding mode shapes of these nanostructures are calculated. The equivalent structural beam is employed to model interatomic forces of the covalently bonded carbon atoms. The results also compared with equivalent continuum sheet model. It is perceived that there exists a good agreement between the continuum and molecular dynamics modeling. The results show that the frequencies are highly sensitive to added masses and their positions.

[1] A. Sakhaee-Poura, M.T. Ahmadiana, A. Vafaib, Solid State Communications 145 (2008)168–172.
[2] Harold Craighead, nature nanotechnology, VOL 2, JANUARY 2007, p18-19.

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ACEX190
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Synthesis and Characterization of Ferromagnetic Nanoparticles (Fe3O4) — Vinyl ester resin -Based Nanocomposites and Study of Superparamagnetism

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The synthesis and characterization of ferromagnetic nanoparticles is part of a project whose goal is to study the control of viscosity and the cure in polymers by a magnetic field. Some of the resin properties (ex: viscosity) are locally controllable and modify by imposing magnetic fields [1]. So, the main target in this case; is to obtain ferromagnetic nanoparticles that could have superparamagnetic behaviour and can be used as resin additives (vinyl ester resin). As a first step the influence of ferromagnetic nanoparticles on the cure of vinyl ester was observed. However, the data provided by the DSC did not allow us to get to a valid conclusion. Anyway a linear relationship between polymerization time and the time it takes to the beginning of the reaction with the temperature of cure was defined. Taking into account the influence of nanoparticles in the kinetic of the cure of the vinyl ester resin, it is pretended to insert these nanoparticles in a homogenous way into a polymer matrix. Magnetic nanoparticles have been synthesised in water by co-precipitation using various carries fluids and surfactants to define which one of them is more efficient to prepared ferrofluid samples [2]. As surfactants were used oleic acid and 25% aqueous solution of tetramethyl ammonium hydroxide and as carriers fluids were used alcohol and kerosene [3]. Properties and behaviour of the magnetic emulsion are currently under research, comparison and debate processes.

[1] A. Valea, M.L. Gonzales, I. Mondragon, J. of Appl. Polym.Sci., Vol. 71, pp.21-28, (1999).
[2] S. W. CHARLES, The preparation of magnetic fluids, in: S. ODENBACH (Editor), Ferrofluids: Magnetically controllable fluids and their applications, Lecture Notes in Physics, Springer-Verlag, pp.3-18, (2002). See also: S. W. CHARLES, Preparation and magnetic properties of magnetic fluids, Rom. Repts. Phys. vol.47 (1995).
[3] S.W. Charles, The preparation of magnetic fluids, in: S. Odenbach (Ed.), Ferrofluids. Magnetically controllable fluids and their applications, Lecture Notes in Physics, SpringerVerlag Berlin, Heidelberg, New York, vol. 594, pp.3–18, (2002).

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ACEX198
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High Cycle Fatigue Behaviour of Au Thin Films

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Mechanical properties of the Au thin film, which is often used in various electrical applications and microelectromechanical system(MEMS), is an essential properties for evaluating their reliability. The grain size of the Au thin film deposited on the substrate is varied with deposition thickness of the film and the tensile properties of the film are also varied with the thickness. In this study, fatigue behaviour of the Au thin films with different thicknesses was investigated. The micro-fatigue specimens 2mm long and 100 μm wide were fabricated by electromachining process using the films, deposited on the silicon by sputtering technique, with different thickness of 0.2, 0.5 and 1. 0 μm , respectively. To apply the cyclic fatigue loads to the thin film specimen with 40 Hz at stress ratio of 0.1, a PZT-actuated fatigue machine with load capacity of 50 mN was developed. From the experiments, S-N curves of the thin films with different thicknesses were determined. Furthermore, the fatigue-fractured surfaces of the films were observed through SEM. The fracture aspect was dependent on the fatigue life and grain size of the films.

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ACEX217
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Elastoplastic deformation behaviour and cutting Mechanism During Nano Scratch using Tribo Indenter for Cu and Ni coatings

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Electroplated coating plays a prominent role in the manufacturing of micro components for electronic devices. Characterisation of machining parameters on a coated substrate is important. This paper studies the elastoplastic behaviour and wear mechanism of two commonly used coated materials (copper and nickel). Tribo Indenter was used for nano scratching and in situ observation of the scratched surfaces irrespective of the crystal orientation of the coatings. The coated surface could be considered as a specimen due to its comparatively larger thickness compared to the maximum depth of cut used. It was found that for a given depth of cut, the normal force during the machining process varied with the hardness of the material.

This study showed that the elastic recovery was higher for Ni compared to Cu. Consequently, the plastic deformation rate and wear rate were higher for Cu than Ni. It was found that the wear rate increased with an increase in the depth of cut. Moreover, it was shown that only the plastic deformation process was responsible for the generation of the machined groove at nano level when the tip radius was greater than the depth of cut.

NUMERICAL & EXPERIMENTAL METHODS

ACEX025
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Evaporation and Condensation in Presence of an Extremly Thin Binary Liquid Film in a Vertical Channel

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The problem of evaporation-condensation by mixed convection in a vertical channel has been numerically analyzed for an air-water/ethylene glycol system. One plate of the channel is covered by an extremely thin binary film and the other is dry. The two plates are maintained at different temperatures. The governing equations of conservation of mass, momentum, energy and species were written in their parabolic form and solved using a marching finite difference method. Results presented in terms of temperature and concentration profiles as well as axial variation of the evaporation rates show the effect of changing the humid plate temperature. It is observed that the nature of the phase change (condensation or evaporation) is directly dependent on the values of the wall temperatures.

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ACEX131
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Computer Aided Manufacturing System for Riser Design Automation in Casting

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Casting is an important industrial process for manufacturing near net-shaped products. It is one of the most complex engineering areas which involve number of technical and scientific disciplines. Generally, production of cast parts has two design stages: product design and process design. Riser design is one of the main parts of the casting process design. It is needed to eradicate and eliminate the casting solidification defects like shrinkage, porosity and hot tears. This can be predicted and designed by means of computer simulation of casting solidification. Huge numbers of different scientific and commercial computer softwares dealing with issues related to casting are available. Unfortunately, most if not all of these programs are tedious, not friendly to use, and deal only with one product geometry at a time.

The primary objective of this work is the automation design of risers for any casting. A complete simple Computer Aided Manufacture (CAM) procedure using an integrated methodology for designing risers using three methods is developed and presented. The methods are: Chvorinov's Rule, Caine rule and Naval Research Laboratory (NRL) method .The theoretical data and empirical, charts and values relevant are collected and presented in the appropriate formats. However, when designing risers for a given application, an infinite numbers of solutions are possible. Thus, certain limitations are imposed on the values, of the riser dimensions (e.g. diameter, height for cylinder or length for cube).

In general, the CAM program developed and constructed is fully automated, flexible, extendable, interactive and friendly to use. The programming language used is Visual Basic.6. The feasibility of the presented method is supported with illustrative examples

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[1] R. Tavakoli, P. Davami," Automatic optimal feeder design in steel casting process" , Comput. Methods Appl. Mech. Engrg. 197 (2008) 921–932
[2] L.C. Kumruoglu, A. O¨ zer, " Investigation of critical liquid fraction factor in nodular iron castings by computer simulation", journal of materials processing technology 197 (2008) 182–188
[3] R. Tavakoli, CartGen: robust, efficient and easy to implement uniform/ octree/embedded boundary cartesian grid generator, Int. J. Numer. Meth. Fluid (2007), p1685.
[4] R. Tavakoli, P. Davami, A fast method for numerical simulation of casting solidification, Commun. Numer. Meth. Engrg. (2007),
[5] R. Tavakoli, P. Davami, Unconditionally stable fully explicit finite difference solution of solidification problems, Metall. Mater. Trans. B 38 (1) (2007) 121–142.
[6] L. Yatziv, A. Bartesaghi, G. Sapiro, O(N) implementation of the fast marching algorithm, J. Comput. Phys. 212 (2006) 393–399.
[7] R.S. Ransing, M.P. Sood, W.K.S. Pao, Computer implementation of Heuvers' circle method for thermal optimisation in castings, Int. J. Cast. Met. Res. 18 (2) (2005) 119–128.
[8] B. Ravi, Metal Casting: Computer Aided Design and Analysis, Prentice Hall of India, India, 2005.
[9] M. Bellet, O. Jaouen, I. Poitrault, An ALE-FEM approach to the thermomechanics of solidification processes with application to the prediction of pipe shrinkage, Int. J. Numer. Meth. Heat Fluid Flow 15 (2) (2005) 120–142.
[10] J. Campbell, Castings Practice, The 10 Rules of Casting, Elsevier Butterworth-Heinemann, 2004.
[11] R.W. Lewis, R.S. Ransing, W.K.S. Pao, K. Kulasegaram, J. Bonet, Alternative techniques for casting process simulation,

Int. J. Numer. Meth. Heat Fluid Flow 14 (2) (2004) 145–166.
[12] Q. Li, G.P. Steven, Y.M. Xie, O.M. Querin, Evolutionary topology optimization for temperature reduction of heat conducting fields, Int. J. Heat Mass Trans. 47 (23) (2004) 5071–5083.
[13] M. Bellet, V.D. Fachinotti, ALE method for solidification modelling, Comput. Methods Appl. Mech. Engrg. 193 (39) (2004) 4355–4381.
[14] J. Campbell, Castings, Butterworth-Heinemann, 2003.
[15] D.P.K. Singh, G.D. Mallinson, S.M. Panton, Applications of optimization and inverse modeling to alloy wheel casting, Numer. Heat Trans. A 41 (6) (2002) 741–756.
[16] R.W. Lewis, M.T. Manzari, D.T. Gethin, Thermal optimization in the sand casting process, Engrg. Comput. 18 (3/4) (2001) 392– 417.
[17] R.W. Lewis, K. Ravindran, Finite element simulation of metal casting, Int. J. Numer. Meth. Engrg. 47 (2000) 29–59.
[18] M.T. Manzari, D.T. Gethin, R.W. Lewis, Optimisation of heat transfer between casting and mould, Int. J. Cast. Met. Res. 13 (4) (2000) 199–206.

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ACEX248
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Numerical Simulation of Heat Transfer in Friction Stir Welding of 7075-T6 Aluminum Alloy and High Carbon Steel using ALE Technique

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There are various methods in the simulation of processes having severe plastic deformation. Finite Elements Method is used as an appropriate and precise method in the simulation of such processes. This method is used and completed with Eulerian and Lagrangian formulation. In the present work the combination of these two methods namely Arbitrary Lagrangian Eulerian (ALE) has been found to be the best way of simulating events involving severe plastic deformation. The purpose of this article is to analyze the heat transfer process in friction stir welding using ANSYS software and compare obtained data with experimental results.
In this research, palates made of 7075-T6 Aluminum alloy and a high carbon steel were welded and temperature measurement in the main sections was carried out by an accurate and special method during welding. Heat variation measurement was also carried out based on the time the tool operated.

the process of heat transfer in friction stir welding of the selected alloys were then simulated , a comparison between simulation and experimental data shows a reasonable conformity between numerical and experimental results.

[1] W.M.Thomas, E.D.Nicholas, J.C.Needham, M.G.Murch, P.Templesmith, ,G.B Paterit Application No. 9125978.8 (December 1991).
[2] C. Dawes,W. Thomas, TWI Bulletin 6 (November/December) (1995) 124.

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ACEX038

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Simulation of Inhomogeneous Models Using the Finite Cloud Method

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The field of computational engineering and experimentation relies very heavily on methods of advanced and accurate model simulation of partial differential equations as found in heat flow, the wave equation and electromagnetics. A majority of these methods use techniques such as Finite Difference or Finite Elements that require the meshing of the geometric region and knowledge of the connectivity and relationships between each segment. A newly proposed method the Finite Cloud Method (FCM) removes the need for the onerous and sometimes difficult task of computing this mesh, instead using shaping functions and a discretized set of partial differential equations based only on the placement of nodes [1]. The ability of the FCM to allow for the distribution of solution points to areas of complexity in a completely free manner could enable faster more accurate simulations. However, initial work has focused on materially homogenous problems and the extension of the technique to models composed of different materials with varying physical properties is needed for practical problems.

This study presents a method of formulating the FCM equations such that they allow for the specification of varying materials and applies this to several equations; including the heat transfer equation, the wave equation and the telegrapher's equation. Results from the work have shown an ability to accurately model complex structures in 3-dimensions for both transient and steady-state solutions. An example is shown below with the heat transfer equation modelling heat distribution through a heat sink.

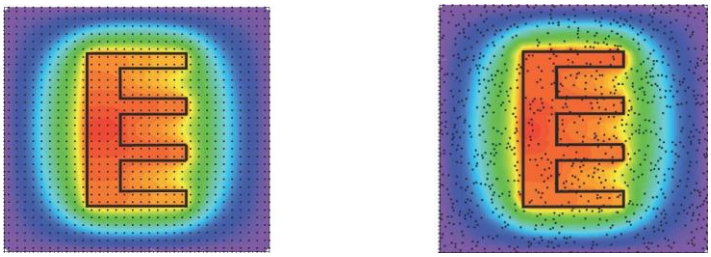

Fig 1. The temperature distribution in a heat sink. a) Regular mesh. b) Irregular mesh

[1] X. Jin, G. Li and N.R. Aluru, Computers and Structures, 83, 1366 (2005).

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ACEX107
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Transient Performance of Stand Alone Induction Generator under Different Operating Conditions

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Gradual increase in the oil prices and the expectation of loosing oil sources within the next 50 years forced electrical utilities to focus their attention to green power generation as an alternative source [1]. Induction generators either grid connected or self excited become very important because of its suitability for various applications in the area of green power generation [2-4]. The generated power from self excited induction generators are generally employed for lighting or cooking to reduce firewood or fuels in the villages where high power quality is not required. Induction generator has its inherent advantages such as brushless construction with squirrel-cage rotor, reduced sized, absence of DC power supply for excitation, reduce maintenance cost, better transient performance and low cost compared with synchronous generator[3-5].

Traditionally, the models used to analyze SEIG have been classified into two major categories. One is the per-phase equivalent circuit approach which includes the loop impedance and the nodal admittance methods [5-6]. This model can only be used to investigate the steady state performance of the SEIG under balance condition. The other is the d-q axis model based on the generalized machine theory [6-8]. D-q model can be used to investigate the SEIG transient performance under balanced condition. Steady state operation of the SEIG under single phase load, variable capacitance in one phase of the delta connected capacitor has been analyzed using two phase generalized machine model [9]. Symmetrical component technique has been considered in analyzing the steady state operation of the SEIG under general unbalance load and excitation conditions [10]. References [11-13] have used phase sequence equivalent circuit to study the performance of the SEIG under unbalanced conditions. In general symmetrical component and phase sequence equivalent circuit are suitable only in steady state analysis.

The major contribution of this paper is to derive a general model for the SEIG together with its excitation capacitors and load. This model is derived in the direct phase quantities in order to make it able to analyze the machine under different balanced or unbalanced conditions. Furthermore, it permits studying the generator transient performance under different modes of operations, such as constant speed, power and torque.

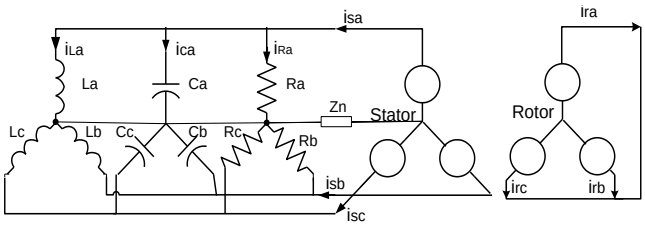

Fig.1 System under study

Analysis

Fig. 1 shows the system under study including the SEIG with its excitation capacitors and loads. The stator and rotor windings of the induction generator, the excitation capacitors, the pure resistive load and the pure inductive load are all star connected. The rotor windings terminals are shorted together. The neutral points of the stator windings, the excitation capacitors and loads can be connected or disconnected in the derived model.

Generator equations

The stator and rotor flux linkage can be written in the following matrix form:

$$[\lambda_s]_{abc} = [L_s][i_s]_{abc} + [L_{sr}][i_r]_{abc}$$

$$[\lambda_r]_{abc} = [L_{sr}]^t [i_s]_{abc} + [L_r][i_r]_{abc}$$

The three phase stator and rotor voltage equation can be expressed by the following equations:

$$[v_s]_{abc} = [R_s][i_s]_{abc} + p[\lambda_s]_{abc}$$
$$[v_r]_{abc} = [R_r][i_r]_{abc} + p[\lambda_r]_{abc}$$

Magnetizing Current

Stable operation of SEIG can only occur with a reasonable degree of saturation in its magnetic circuit. Estimation of equivalent instantaneous magnetizing current is achieved by projecting stator and rotor phase currents into stationary orthogonal d-q axes with d-axis coinciding with phase as-axis, hence:

$$i_m = \frac{1}{\sqrt{2}}\sqrt{(i_{ds} + i_{dr})^2 + (i_{qs} + i_{qr})^2}$$

Mechanical System Equations

$$2Hp(\omega_r) = T_m + T_e$$
$$p(\theta_r) = \omega_r$$
$$T_e = (\frac{P}{2})[i_s]^t_{abc} \frac{\partial}{\partial \theta_r}[L_{sr}][i_r]_{abc}$$

System state variables are given by:

$$[i_{sa}\ \ i_{sb}\ \ i_{sc}\ \ i_{ra}\ \ i_{rb}\ \ i_{al}\ \ i_{bl}\ \ i_{cl}\ \ v_{o1}\ \ v_{o2}\ \ v_{o3}\ \ \theta_r\ \ \omega_r]$$

To test the validity of the proposed model, a certain three phase induction machine was tested. The machine was investigated under different balanced and unbalanced conditions. These results will be shown

References

[1] D. B. Watson, J Amlaga and T. Densem, "Controllable d.c. Power Supply from Wind-Driven Self-Excited Induction Machines", IEE Proceedings, vol. 126, no. 12, 1979, pp. 1245-1248.

[2] J. B. Patton and D. Curtice, "Analysis of Utility Protection Problems Associated with Small Wind Turbine Interconnections", IEEE Trans. Power Apparatus and Systems, vol. 101, no. 10, 1982, pp. 3957.

[3] G. Raina and O. P. Malik, "Wind Energy Conversion Using a Self-Excited Induction Generator", IEEE Trans. Power Apparatus and Systems, vol. 102, no. 12, 1983, pp. 3933-3936.

[4] P. Freere, "Electronic Load/ Excitation Controller for a Self Excited Squirrel Cage Generator Micro-Hydro Scheme", Fifth International Conference on Electrical Machines and Drives, Publication no. 341, 1990, pp. 266-270.

[5] N. Elsonbaty, P. G. Holmes, M. Salama, N. P. A Smith and A. A. Williams, "VSCF Induction Generation in Stand-alone Micro-hydro Generating Systems", International Conference on Renewable Energy-Clean Power 2001, 1993, Conference Publication No. 385, pp. 89-94.

[6] E. D. Basset and F. M. Potter, "Capacitive Excitation of Induction Generators", AIEE Trans., vol. 54, 1935, pp. 540-545.

[7] S. S. Murthy, O. P. Malik and A. K. Tandon, "Analysis of Self Excited Induction Generators", IEE Proceedings, vol. 129, Part C, no. 6, 1982, pp. 260-265.

[8] N. H. Malik and A. H. Al-Bahrani, "Influence of the Terminal Capacitor on the Performance Characteristics of a Self Excited Induction Generator", IEE Proceedings, vol. 137, Part C, no. 2, 1990, pp. 168-173.

[9] L. Quazene and G. McPherson, Jr., "Analysis of the Isolated Induction Generator", IEEE Trans. Power Apparatus and Systems, vol. 102, no. 8, 1983, pp. 2793-2798.

[10] A. K. Tandon, S. S. Murthy and G. J. Berg, "Steady State Analysis of Capacitor Self Excited Induction Generators", IEEE Trans. Power Apparatus and Systems, vol. 103, no. 3, 1984, pp. 612-618.

[11] A. H. Al-Bahrani and N. H. Malik, "Steady State Analysis and Performance Characteristics of a Three Phase Induction Generator Self Excited with a Single Capacitor", IEEE Trans. Energy Conversion, vol. 5, no. 4, 1990, pp. 725-723.

[12] A. H. Al-Bahrani, "Analysis of Self Excited Induction Generators under Unbalanced Conditions", Electric Machine and Power Systems, vol. 24, 1996, pp. 117-129.

[13] Y. H. A. Rahim, "Excitation of Isolated Three Phase Induction Generator by a Single Capacitor", IEE Proceedings, Part B, vol. 140, no. 1, 1993, pp. 44-50.

[14] S. K. Jain, J. D. Sharma and S. P. Singh " Transient performance of three-phase self excited induction generator during balanced and unbalanced faults" IEE, Proc.-Gener. Trnas., Vol. 149, No. 1, 2002.

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DBEM and FEM Analysis of an Extrusion Press Fatigue Failure

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This paper illustrates an application of the Dual Boundary Element Method (DBEM) [1] to the simulation of a fatigue crack propagation affecting the main cylinder of an extrusion press for aluminum sections. The crack initiates at the inner

surface of the cylinder and propagates through the thickness causing a leakage of the pressurized oil and consequently a production stop. The fatigue load is induced by the pressure variation inside the cylinder as needed to push each section through the extrusion hole. The aim of the simulation is to assess the most probable initial crack dimensions that, after the recorded in service fatigue cycles, lead to the final crack scenario. This was requested in order to assess if, originally, there was a detectable (by NDI technique) rogue flaw, introduced by the manufacturing process. The analysis, in addition to the cylinder pressure, takes into account the normal load on the crack faces caused by the oil pressure.

In the DBEM simulation, the crack propagation direction is based on the minimum strain energy density criterion by Sih. For validation purposes, the DBEM Stress Intensity Factors (SIFs), in the initial cracked configuration, are compared with the corresponding results obtained by the Finite Element Method (FEM). SIFs are calculated by both J-integral and crack opening displacement (COD) approaches, using the FEM code ANSYS and the DBEM code BEASY.

References

[1] Y. Mi, M.H. Aliabadi, Engineering Analysis with Boundary Elements, 10, 161-171, (1992).

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ACEX243
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Molecular Dynamics Simulation of Carbon Nanotubes in Aluminium Melt

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Carbon nanotubes (CNTs) have attracted wide attention of the scientific community, due to their unique structural properties and applications. The interaction between carbon nanotubes and the matrix especially in metal-based nanocomposites is an important factor affecting the properties of the composite. Aluminium is a good choice for composites with carbon nanotubes as the reinforcement because of the high specific strength of the final product. With regard to the above points, this research was performed to investigate the interaction between carbon nanotubes and aluminium melt. In this research, Molecular Dynamics (MD) simulations of CNTs in aluminium melt has been performed in order to examine the possible reactions of CNT reinforcement and the aluminium matrix. The results demonstrate the survival criterion of CNTs under high temperature conditions in aluminum melt.

[1] Lijie Ci , Zhenyu Ryu, Neng Yun Jin-Phillipp, Manfred Rühle, Acta Mater., 54, 5367–5375 (2006).
[2] C.F. Deng, D.Z. Wang, X.X. Zhang, A.B. Li, Mater. Sci. Eng. A, 444, 138–145 (2007).
[3] R. George, K.T. Kashyap, R. Rahul, S. Yamdagni, Scripta Mater., 53, 1159–1163 (2005).

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Mechanical properties Study of Copper Nanowires under Uniaxial Loading with Molecular Dynamics Simulation

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In this paper, the mechanical properties of copper nanowire at different cases of loading and unloading are studied using molecular dynamics (MD) simulations[1,2]. The interatomic interactions are represented by employing embedded atom potential model [3]. At first, an energy minimization (free relaxation) process in order to arrive an equilibrium position of nanowire is performed and the effect of free surfaces on mechanical properties of nanowire is described[4]. In the case of uniaxial loading, the stress–strain curve at different strain rates is simulated. The effects of cross-sectional size, volume/surface ratio and temperature on mechanical properties of copper nanowire are discussed[5]. In particular, the loading-unloading process is modeled and the effect of unloading process on the stress-strain curve in the plastic region is investigated. Furthermore the mechanical characterization in compression loading is carried out and the results of compression modeling show that the obtained yield stress is lower than the computed tensile yield stress. Finally Bauschinger effect phenomena on copper nanowire is studied, at this stage the tension-followed-by-compression process is applied to the specimen and it is observed that the resulted yield strength in the reloading or reverse loading is substantially lower than the compressive yield stress in the original direction

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Applied Computer Analysis the Service Life Criteria to Special Transport Elements

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A characteristic feature of new trends in development of new aggregates of mobile machinery is a continuous increase in manufacturing and operating costs. Simultaneously, transmitted outputs are also higher and a sufficient reliability has to be maintained. There is a tendency towards a higher use of materials, i.e. a relatively higher stress on particular parts of the aggregate. At the same time, a real safety of operation against the maximum admissible stress decreases. This all requires a further improvement of the method of designing and strength checking of a construction. The problem of fatigue strength and service-life, as the most important phenomena of strength reliability under those conditions, is connected more or less with a certain degree of uncertainity. The method described in this paper are the way to reach the solution goal by mean of a characteristic curve of reliability with the maximum use of computer technology.

[1] Kopecky, M., Peslova.: Assessment Metholdology of Elements and Constructions reliability criteria for mobile machines and equipment. In: ISTLI special publication 2: Teaching and Education in Fracture and Fatigue, Imprint: E & FN SPON , London, England, (1996) 325-330
[2] Cuth, V., Tvaruzek, J. Vavro, J., Husar, S., Varkolyova, B.: The Stress Analysis and the Service Life Prediction on the Low-power Motocycle. In: 4th Mini Conf. on Vehicle System Dynamics, Identification and Anomalies, Budapest, Hungary, (1994) 171-177
[3] Vavro, J.: Optimization of the Design of Cross-Sectional Quantities in Transport Machines and Equipments. In: Studia i materialy, Technika, Zelena Gora, Poland, (1998) 187-194
[4] Weibull, W.: A Statistical Distribution Function of Wide Applicability. In: Journal of Appl. Mechanics, No.3, (1951).

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ACEX064
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A 3D Perfectly Matched Layer Non-Re Ecting Boundary Conditions for The Linearized Euler Equations

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A 3D Perfectly Matched Layer, Non-Reecting Boundary Conditions For The Linearized Euler Equations

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No matter how much computaiton resources are available to us nowadays, our computa- tional domains will always be a small fraction of the physical domain. If the physical domain extends too far without physical boundaries, then, at some point, the computational domain has to be terminated with an open boundary. Most likely than not, the variables that don't vanish by the time they hit the open boundary reect o_ the boundary and become a source of instability. Therefore the development of non-reecting open boundary conditions is a necessity to allow outgoing solution to leave the computation domain and hence preserve the solution in the interior from contamination. Such boundaries are an essential part of modern CFD. The perfectly matched layer (PML) is a method of constructing a non-reecting boundary conditions. It employs the selective absorption of outgoing variables through the modi_cation of the governing equations and the introduction of damping coe_cients that are developed in the frequency space[1]. The developed boundaries are based on the unsplit Perfectly Matched Layer (PML) formulation of Hu[2]. The e_ectiveness of the developed non-reecting bounaries is veri_ed with a simple example problem. In the example problem, a simple monopole harmonic source is omitting energy in the middle of a cubic computational domain with open boundaries all around. The solution is carried out using the newly developed boundaries and compared to the analytical solution. In addition, the developed boundaries is compared to the widely used 1D characteristic nonreecting boundaries of Thompson[3].

References

[1] K. AlSalem. Hybrid drp-bem method for plume acoustics. PhD Dessertation, SUNY at Bu_alo, 2005.
[2] F. Q. Hu. A stable perfectly matched layer for linearized euler equations in unsplit physical variables. Journal of Computational Physics, 173:455{480, 2001.
[3] K. W. Thompson. Time-dependent boundary conditions for hyperbolic systems. Journal of Computational Physics, 89:439{461, 1990.

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Modeling and Simulation of the Perforated Clay Bricks Drying Including Shrikage and Hygrothermal Stress

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Ceramic processing has traditionally been discussed in term of the material formulation and industrial arts used in the production of commercial products that are very different in size, shape, detail, complexity, material composition, structure, and cost. Products obtained by plastic forming and casting must be dried, in order, to removal of the moisture prior for further processing and/or firing. The magnitude of the stresses will depend on the shape, thermo-physical and elastic properties, and contraction and expansion coefficients of the material. Depending on the drying conditions, structures of the material and geometry of the product, this phenomenon can cause cranks, deformations and even fracture inside the solid.
In this sense, this paper presents a three-dimensional mathematical modelling to predict heat and mass transport inside the holed ceramics bricks during the drying including shrinkage and hygrothermalelastic stress analysis. Results of the temperature, moisture content and stress distributions, and drying and heating kinetics are shown and analyzed. It was verified that the largest temperature, moisture content and stress gradients are located in the intern and external vertexes of the brick. These regions are more favorable to hygro-thermo-mechanical stress, that can cause cracks and deformations, and consequently to reduce the quality of the product in the end of the process.

[1] Y. Itaya, and M. Hasatani. Drying Tech. 14, 6, 1301-1313 (1996). [2] Y. Itaya, T. Kobayashi and K. Hayakawa, Int. J. Heat Mass Transfer, 38, 7, 1173-1185 (1995)
[3] A. Sander, D. Skanki, and B. Nenad. Ceramics Int., 29, 641-643 (2003).
[4] S. Su, Appl. Clay Sci. 12, 189-207 (1997).

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Weld-Bonded Metal Joints Modeling Using Finite Element Method

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Weld-bonded joints are used for a variety of applications in different industries such as automobile, aerospace, home appliances etc. Getting the representative model of weld-bonded metals is very important for further design of joining. In this work, finite element method will be used to get a representative model and fit the load displacement curve with the experimental data to evaluate the model's accuracy. Detailed material properties of each zone of resistance spot welding (nugget, heat affected zone, and base metal) are essential to accurately simulate the model. Reverse engineering analysis will be introduced to get those material properties by modeling the indentation process using finite element software, and conduct some iteration of models until the load-displacement curve of indentation agree with the experimental curve.

[1] B. Bouyousfi, T.Sahraoui, S.Guessasma, and K.T.Chaoch, Effect of process parameter on the physical characteristic of spot weld joints, J Mater and Design, 28, p.414 (2007).
[2] K. Furukawa, M. Katoh, K. Nishio, and T. Yamaguchi, Influence of electrode pressure and welding conditions on the maximum tensile shear load, Q. J of the Japan Welding Society, p.10, 2006.
[3] P.K. Ghosh and Vivek, Weldbonding of stainless steel, ISIJ International, 43, p.85, (2003).
[4] B. Chang, Y. Shi, and L. Lu, Studies on the stress distribution and fatigue behavior of weld-bonded lap shear joints, J of Mater Process Tech, 108, p.307 (2001).
[5] Al-Samhan and S.M. Darwish, Finite element modeling of weld-bonded joints, J of Mater Process Tech, 142, p.587 (2003).
[6] M. N. Cavalli, M.D. Thouless, and Q.D. Yang, Cohesive modeling of deformation and fracture of weld-bonded joints, AWS (2003).
[7] X. Kong, Q. Yang, B. Li, G. Rothwell, R. English, and H. J. Ren, Numerical Study of spot-welded joints of steel, J Mater and Design, 29, p.1554 (2008).
[8] T.A Venkatesh, K. J. Van Vliet, A. E. Giannakopoulos, and S. Suresh, Determination of elasto-plastic properties by instrumented sharp indentation: guidelines for property extraction, Scripta Mateialia, 42, p.833 (2000).
[9] M. Dao, N. Chollacoop, K. J. Van Vliet, T. A. Venkatesh, and S. Suresh, Computational modeling of forward and reverse problems in instrumented sharp indentation, Acta Materialia, 49, p.3899 (2001).
[10] Q.D. Yang, M.D. Thouless, and S.M. Ward, Elastic-plastic mode II fracture of adhesive joints, International Journal of Solid Structure, 38, p3251 (2001).
[11] S. Li, M.D. Thouless, A.M. Waas, J.A. Schoeder, and P.D. Zavattieri, Use of Mode I cohesive zone models to describe the fracture of an adhesively-bonded polymer-matrix composite, Composite Science and Technology, 65, p.281 (2005).

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ACEX212
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Multi Sensor Data Fusion using Kalman Filter Techniques

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In this paper multi sensor data fusion is carried out using three different techniques of Kalman Filtering namely AKF, ACKF and ADKF. Kalman filtering techniques are modeled and the effectiveness of their application in multi sensor data fusion is compared with each other. All of the kalman filter models have been simulated in MATLAB and simulation environment.

Keywords: Kalman filtering - Data fusion - Multi sensor data fusion -Adaptive Kalman Filter - AKF – ADKF – ACKF

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Performance of CBN tool and PCBN Tool on Machining of Hard

AISI 440C Matensitic Stainless Steel

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In this study, the formation of flank wear by CBN tool and PCBN tool on cutting forces were studied. The CBN tool and PCBN tools were used. Turning tests were carried out using five cutting speeds 100, 125, 150, 175 and 200 m/min with feed rates of 0.10, 0.20 and 0.30 mm /rev and constant depth of cut of 1.00 mm. The performances of cutting tools were evaluated based on the flank wear and cutting forces. The wears formed were measured by scanning electron microscope and the cutting forces measured by Kistler dynamometer. There is clear relationship between flank wear and cutting forces while turning hard martensitic stainless steel by CBN and PCBN tools. The lower the cutting force leads to low flank wear formation and low cutting force provides good geometry of the work material including the surface roughness. Flank wear formation was more by abrasion and less by adhesion. The built up edge formed had reduced the cutting force and also the heat generated at tool tip – work surface interface. It was unclear about the high cutting force recorded and unable to find reasons. It may be due to heat and flank wear combinations. Flank wear and cratering on the rake face and hard metal deposition on the cutting tool surface are the damage that takes place during turning process.

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A Computational Method of Space Robot Path for Target Capturing

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This study deals with a computational method for space robot path generation in target capturing operation. For the future space robot application it is mandatory to capture the free flying target in autonomous operation by the robotic arm, which is mounted on the spacecraft main body. It is also required to move the arm from the initial posture to the final posture without collisions withthe target. The configuration space and artificial potential methods are often applied to the usual robot operational planning. Khatib [1] proposed a motion planning method, in which between each link of the robot and the obstacle the repulsive potential is defined and between the end-effector of robot arm and the goal the attractive potential is defined. By summing both of the potentials and using gradient of the potential field the path of the robot is generated.

However there may be points at which the repulsive and attractive forces are equal and thisleads to the so-called eadlock phenomenon. In order to resolve this issue the solution of Laplace equation is utilized and in this study some improvements on shaping of the path from zigzag path to smooth one and on the reduction of the computational load have been obtained by applying an interpolation technique. A few numerical simulations were carried out and its applicability is demonstrated.

[1]Katib, International Journal of Robotics Research, Vol.5 No.1,1986

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Laser Drilling Simulation Considering Multiple Reflection of Laser, Evaporation and Melt flow

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Laser drilling was analyzed by considering multiple reflections and evaporation of material. In the keyhole formation process, the variation of the hole shape and the variation of the absorption of the laser power distribution in the wall were examined. The flow velocity distribution of the molten metal was also examined. Moreover, the effect of material on the hole shape was examined. The main results obtained are as follows: (1) at the stage where the depth of the hole is comparatively shallow, the power at the bottom of hole increases by the effect of multiple reflection. (2) When the hole becomes deep, the effect of multiple reflections becomes remarkable and the absorption factor increases. The absorptance increases due to multiple reflections to a value of about 0.75. (3) When the hole becomes deep, the flow field shows circulation of molten metal that rises near the walls of the keyhole and by surface tension, moves away from the keyhole at the surface, forming an eddy. (4) Because the thermal diffusivity of aluminum is larger than iron, the energy lost by thermal diffusivity increases, and the energy used to evaporate decreases. Therefore, in case of aluminum, the molten pool broadens and the hole becomes narrow.

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The Laser Welding Simulation of the thin Sheet Metal

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The laser welding became the main means to produce the industrial products by various industries. It is said the main reason is that the laser can weld the metal at high speed with low deformation. Though a lot of researches of laser welding have been performed, there are few data of deformation theoretically treated. Most of data concerning the deformation are measured results of the experiment on an actual site. The thermal deformation of the thin metal is very important factor for the laser welding technology. For a highly precise welding with sheet metal by the laser, it is necessary to understand the accurate quantities of distortion caused by thermal processing to a highly accurate welding. At first, to clarify the deformation values quantitatively when the laser welding of sheet metal, "bead-on-plate" by the moving heat source with continuous wave oscillations on the plate was done. Bead-on-plate that assumes the butt welding without gap means the state of ideal in the butt welding. It is considered the criterion to understand the deformation by the thermal stress of laser heat source. Therefore, the first stage of this study of the welding model was assumed as a bead-on-plate. By using these experimental data, the amounts of the deformation were measured. At the same time, the calculation by computer simulation was done to confirm the experimental results.

However, there is a gap in the actual welding by all means. Therefore, it is necessary to consider this for a calculation. The correct method of calculation is not yet established now. To clarify these, the influence of the gap on the welding deformation was examined when an actual butt welding was done. In the butt welding with a gap, the positions of focal point and energy distributions to each portion on the material are relating respectively.The deformation in the butt welding is related to not only thermal stress, but also thermal expansion of the metal in melting zone. As a result, the phenomena of deformation behavior that had happened by the laser welding were clarified.

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ACEX231

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Optimal Design of Rear Chassis Components for Automobile Lightweight using Design of Experiment

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With the growing public concerns over the rising price of fossil fuel and the greenhouse gas emissions, the automotive industry is once again faced with an increased demand to develop more fuel-efficient vehicles. Savings in weight using lightweight materials such as aluminum can lead to increased fuel economy and reduction in pollution. Aluminum material has a weak point than steel material in strength for life cycle. In study, to design a lighter and more reliable chassis component using aluminum material as compared with existing steel chassis components, new shape of link were suggested by adding vertical ribs to existing I-beam type link and to investigate how each design parameter makes an effect on reliability and weight of component, the design of experiment (DOE) was performed with nine design

parameters and two levels. Through the DOE analysis, three parameters which were the most effective on weight were selected. And then the design of experiment (DOE) was performed with three levels to find out optimal dimensions. The weight of aluminum link was 50% of steel link. The stiffness and strength of aluminum link were 101 and 145% of steel link, respectively.

[1] L. Sun, "Optimum Design of road-friendly vehicle suspension systems subjected to rough pavement surfaces", Applied mathematical modeling 26:5 635-652 (2002).
[2] W. Beak, "A Study on durability test method of vehicle suspension systems", Journal of KIIS 10: 2 24-31 (1995).

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ACEX233
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ACS Based Optimization Technique for SVC Control

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The objective of this work is to introduce an economic cooperative agent based algorithm oriented on Ant Colony System (ACS), for achieving optimized switching of Static Var Compensators (SVCs) to inject or withdraw the reactive power required to reach a desired power factor (p.f). This device is operational from an embedded system operating on BF533 DSP Microcontroller. It should be kept in mind that the optimization process should be implemented cheaply, quickly using less memory. Optimizing Parameters include p.f, Voltage profile, frequency and the health and state of capacitors and also the instant of switching. The smart device incorporating this algorithm is to be used for traction substations, rolling mills, cold storages and furnaces with dynamic load pattern. Execution of this ACS based algorithm from this device will make it smart and intelligent and sensitive to load profile changes and take action on the banks accordingly. Also this device will reduce the penalty charged to the consumers and also decrease loading of cables and other electrical apparatus connected to the system.

ACS promises better result compared to other heuristics because it possesses several advantages including: i) Distributed Computation due to a large amount of parallelism offered by the presence of several agents. ii) Positive Feedback, as the search proceeds new population of ants who contribute to a higher fitness value in terms of rich pheromone (organic deposition from ants) trail overpowers the one having a weaker pheromone trail. iii) Robustness which enables the colony to find a solution for problems which are dynamically evolving. The ACS algorithm is built on the foundation that there exist multiple food sources. Fitness is evaluated as a function of the proximity of a food source from the nest and this criterion helps the algorithm to select the fittest capacitor bank combination to meet the desired Var demand at prevailing condition. Results of this optimization algorithm together with required signal processing applied to a traction substation of 1320 kVar at 25 kV employing ACS technique and operational from the DSP based hardware took 112 msec. for finding one combination. Whereas the same hardware applied to the same problem using Genetic Algorithm (GA) optimization technique took 3 min. 34 sec. Therefore the suitability of this type of ACS based optimization technique for combination selection is most appropriate for such application.

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ACEX239
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Effect of Sensor Location on the Solution of Parabolic Inverse Problems

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Parabolic inverse problems have an important role in many branches of science and technology.The aim of this research work is to solve these class of equations using a high order compact finite difference scheme. We consider the following inverse problem for finding u(x,t) and p(t) governed by $u_t = u_{xx} + p(t)u + \varphi(x,t)$ with $u(x,0) = f(x)$ as initial condition and $u(0,t) = g_0(t),\ u(1,t) = g_1(t),\ u(x^*,t) = E(t),\ 0 \le t \le T$ where $\varphi(x,t), f(x), g_0(t), g_1(t)$ and $E(t)$ as boundary and overspecified conditions over $0 < x < 1$ and $0 < t \le T$.
Due to importance and the applications of inverse parabolic problems in various fields of science and engineering, these kind of problems have been studied by several researchers. Cannon and Lin [1]-[2] formulated a backward Euler Finite difference scheme via a transformation. Dehghan [3]-[5] presented several finite difference formulae with an integral over-specified condition. In this study, Spatial derivatives are approximated using central difference and for the time advancement of the simulation a ”Third order Runge-Kutta method ” is used. A numerical example is used for validity of our analysis. The accuracy of the results are better than the previous works demonstrated in the literature. Also the effect of sensor location (x*) is investigated and observed that when the location is near x=0.5 we have more accurate results and the accuracy is decreased when the sensor location becomes far from x=0.5.

[1] Cannon, J. R , Lin, Y.L. Numerical procedures for the determination of an unknown coefficient in semi-linear parabolic differential equations, Inverse Probl. 10 (1994)227-243.
[2] Cannon, J. R , Lin, Y.L. An inverse problem of finding a parameter in a semi-linear heat equation, J. Math. Anal. Appl, 45 (2) (1990) 470-484.
[3] Dehghan,M. Finding a control parameter in one-dimensional parabolic equations , Appl. Math. Comput 135(2003) 91-503.
[4] Dehghan, M. Numerical solution of one-dimensional parabolic inverse problem, Appl. Math. Comput 136 (2003) 333-344.
[5] Dehghan, M. Parameter determination in apartial differential equation from the overspecified data, Math. Comput. Modell. 41(2005) 197-213.

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ACEX241
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Parametric Model for Evaluating the Performance of Threaded Pipe Connections

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Threaded pipe connections are used to join pipes when welding is undesirable and in applications where pipes should be frequently disassembled. The connections consist of a male and female part, referred to as pin and box each having conical surfaces with helical threads machined on them. This enables them to be preloaded to maintain a sealed and secure connection while being subjected to variable loads. During service a multi-axial stress distribution appears over the connection due to the combined preload and external loads [1]. Additionally, stress concentrations introduced by the thread geometry can initiate fatigue cracks under variable loads [2]. In this study a parametric finite element model is presented and the results for an API Line Pipe threaded connection are discussed. Simulations are carried out on 2D axisymmetric models to evaluate the influence of different geometrical parameters on the behaviour of the connection. For this purpose a performance factor was defined combining parameters for sealability and strength of the connection. The influence of pin and box wall thickness, pin length and box recess length on this performance factor was investigated. Simulations showed that increasing the box wall thickness had no significant influence on the connection's performance relative to the standard Line Pipe connection. However a performance increase was found for a connection with decreased nbox recess length. Also increasing the pin length and wall thickness had a positive effect on the connection's performance.

[1] E.N. Dvorkin and R.G. Toscano, Computers and Structures, 81, 575 (2003).
[2] J.C. Ribeiro Plácido et. al., Materials Research, 8, 409 (2005).

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ACEX108
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Prediction of Plastic Collapse of Cylinder-truncated Cone Shell Intersection under Internal Pressure

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Conical shells and their intersections are of interests in many engineering branches. These shells are usually exerted by pressure. For instance, in civil engineering applications, structures like silos, pressure vessels, tanks, cooling towers and chimneys involve conical shells in their constructions. In such examples conical shells and their intersections are modeled as a shell under internal pressure. One of the static failure reasons of such structure, which is within the scope of this article, is the collapse due to formation of plastic hinges. This type of the failure has been studied by Jones [1] in various plates and shells vastly.
Conical shell and its intersection to the cylindrical shell as a model of silos have been studied by Teng [2]. He presented a complete literature review paper in possible static failures of conical-cylindrical intersection shell. The plastic collapse of cylinder-truncated cone shell intersection under internal pressure has not been investigated analytically yet. Thus, by means of common rectangular yielding curve, plastic limit of such structure has been studied analytically. Rigid rings in both ends are considered as boundary conditions. In this study, various cases for collapse of the cylinder-truncated cone shell such as conical shell collapse, collapse with two hinges and collapse with three hinges are investigated. In addition, in some graphs the regions which each of modes of the stucture collapse takes place are depicted in terms of geometrical specifications of the cylinder-truncated cone shell.

[1] N. Jones, Structural impact, Vol.2, University of Cambridge (1989).
[2] J. Teng, Prog. Struct. Eng. Mater., 2, 459 (2000).

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Numerical Evaluation of the CMOD of Defects in Pipeline Girth Welds under Remote Plastic Deformation

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Welded pipelines can be subjected to significant plastic deformations during installation and operation. Example causes of these deformations are ground settlements and earthquakes in the case of on-shore pipelines, and bending during installation in the case of off-shore pipelines [1]. Because welds regularly contain defects (eg. porosities or lack of fusion), it is important to evaluate their influence on the plastic straining capacity of the pipeline.
This study presents a parametric finite element model of a cracked Curved Wide Plate (CWP) test. A CWP test is a tensile test on a large-scale sample from a pipe weldment, and can be considered as the most representative economically acceptable means to investigate pipe weld integrity under tensile conditions. The numerical model uses coordinate transformations on a simple geometry, which can be meshed using standard meshing techniques. Parameters that can be changed are pipe and weld geometry, crack dimensions and material properties. As a result, the crack mouth opening displacement (CMOD) is extracted, which can be used as a measure of the crack driving force [2]. The analysis of CMOD as a function of the remotely applied strain has been investigated to study the influence of the parameters mentioned above on the behaviour of weld defects under plastic conditions. The numerical results have also been compared to experimental results to assess the validity of the model.

[1] K.R. Jayadevan, E. Østby and C. Thaulow, Int. J. of Press. Vess. and Piping, 81, 771 (2004).
[2] W. De Waele, Materials Science Forum, 475-479, 2659 (2005)

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ACEX091
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The Experimental Analysis of the Influence of Using Media in Explosive Forming of Tublar Structures

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Explosive forming is a sort of metal forming in which, the energy, required for the deformation is produced by the detonation of an explosive and transferred to the work-piece by an energy-conveying medium. For instance, many parts of the Apollo spacecraft are produced by using the explosive forming method [1]. In this paper, the effects of air and water as the energy-conveying medium, on explosive forming process, and also their differences, will be illustrated. Hence, a large number of explosive forming tests have been conducted on two sizes of thin walled cylindrical shells, using air and water as the working medium. Comparative diagrams of the maximum radial deflection of work-pieces of the same size, as a function of the scaled distance, show that for the points with the same values of scaled distance, the maximum radial deformation caused by the under water explosive loading is 4 to 5 times more than the deflection of the shells under explosive forming, while using air. Results of this experimental research have also been compared with other studies which show that using water as the energy conveying media increases the efficiency up to 4.8 times [2]. The effect of the media on failure modes of the shells, and the necking mechanism of the walls of the specimens, while being explosively loaded, are aslo discussed in this issue. Measuring the tested specimens shows that, the increase in the internal volume has been accompanied by necking of the walls, which finally results in the radial rupture of the structure.

[1] D.J. Mynors, B. Zhang, Applications and Capabilities of Explosive Forming, Journal of Materials Processing Technology, (2002).
[2] E.M. Murr, Shock Waves for Industrial Applications, p.157, (Noyes Publications, USA; 1988).

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ACEX091
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Calculation of the Maximum Transverse Deformation of a Cylindrical Shell under Blast Loading

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Internal explosive loading of cylindrical shells is the subject of many applicable researches. For example, Explosive forming of cylindrical shells, due to its special charactaristics, has become an interesting feild of study. Controlling the energy, which is suddenly set free to make the desired shape, in a way that the unconsumed energy does not damage the specimen, is one of the most crucial problems during explosive forming process?
In this study, the explosive forming, effective parameters, energy distribution principles during an explosive forming process and the energetic efficiency will be introduced. Afterwards, a new method, called the Energy Theory will be offered to calculate the maximum radial deformation of cylindrical shells, under internal blast loading. Considering that the plastic collapse of this structure occurs by the formation of three ring plastic hinges at the top, middle and the bottom and also by the hoop stretching between the hinges [1], and only a small portion of the explosive energy is used to deform the work-piece [2], the theory is derived, based on the equality of the internal plastic work for the assumed deflection, to that portion of the explosive energy that is utilized to deform the cylindrical structure. Comparing the maximum radial deformation of the cylindrical shells which have been tested in this research, with the theoretical results shows that the accuracy of the theory is more than 84.5%.

[1] W. Johnson, Impact Strength of Materials, p.206, (Arnild Publishers Ltd., UK; 1972).
[2] E.M. Murr, Shock Waves for Industrial Applications, p.157, (Noyes Publications, USA; 1988).

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Influence of Fabrication and Width of Specimen on Mechanical Properties of NiCo Thin Film

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This paper represents the results of a tensile test of NiCo thin films, to investigate the effect of size and fabrication on tensile properties. An axial loading tensile tester developed by the authors was used to measure the mechanical characteristics of thin film materials. The tester has a load cell with a maximum capacity of 0.5 N and a non-contact position measuring system based on the principle of capacitance micrometry. A “dog-bone” type specimen was designed and was fabricated using electro-plating process and MEMS processes. The tensile stress-strain curves for the films were determined by measuring tensile strains during tensile loading by means of two mechanisms: a capacitance sensor and a CCD camera. The elastic moduli of the NiCo thin films are about 180 GPa for 50 mm width and 148 GPa for 150 mm width. The 50 mm width samples were located in the top of the wafer and the 150 mm width samples were located in the center of the wafer. There is little difference in the elastic modulus according to wafer. The samples have the yield strength of 1930~2013 MPa and the ultimate tensile strength of 2318~2431 MPa. Differences in the yield strength and ultimate tensile strength according to wafer and width are negligible.

[1] Nix W. D. (1989) Mechanical properties of thin films, Metal. Trans. A, 20A: 2217-2245.
[2] Connolley T., Mchugh P. E. and Bruzzi M. (2005) A review of deformation and fatigue of metals at small size scale, Fatigue Fracture Engineering Material Structure, 28: 1119-1152.

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ACEX118
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Water Absorption in Unsaturated Polyester Composites Reinforced With Caroá Fiber Fabrics: Modeling and Simulation

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Studies on composites reinforced with natural fibers show that are sensitive to influences from environmental agents such as water [1-2]. The moisture causes degradation of mechanical properties of natural fiber reinforced composites to a larger extent when compared to synthetic fiber reinforced composites, as a consequence of the higher moisture sorption, and the organic nature of the natural fibers. In this sense the purpose of this work is to study water absorption in unsaturated polyester composites reinforced with caroá fiber at 25, 50 and 70ºC. The composites had weight compositions 30% caroá/70% unsaturated polyester with dimensions of 20x20x3 mm3 and 20x20x6 mm3. Water absorption tests were conducted by immersing specimens in a distilled water bath and water uptake was followed gravimetrically for different elapsed time.
A three-dimensional mathematical model was developed to predict mass transfer during water absorption in paralelelpiped solids. Results of moisture content distribution inside these composites are shown and analyzed. The knowledge of this moisture distribution allows verifying more favorable areas to presents delamination problems due to the weakness of the fiber-matrix interface and consequently reduction in the mechanical properties. It was verified that moisture induced degradation of composite samples was significant at elevated temperature.

[1] L.R. Bao and A.F. Yee, Composites Science and Technology, 62, 2099-2110 (2002). [2] H.S. Choi, K.J. Ahn, J.D. Nan and H.J. Chun, Composites PartA, 32, 709-720 (2001).

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Analytical and Numerical Investigation on First Order Quadrilateral Elements for Axisymmetric FE Analyses: Comparison Between Ansys and Abaqus Codes

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The four-node quadrilateral element (4QUAD) is known to suffer from some drawbacks such as parasitic or false shear phenomenon. In the literature many works have been devoted to the development of high performance elements of this kind; for instance, such drawbacks have been faced by adding incompatible terms to the standard shape functions [1], or by using the mixed formulation [2] or alternative integration methods, such as the B-bar [3]. However some limitations still remain for the axisymmetric condition, which complicates significantly the formulation of low-order elements. In commercial FE codes, different element formulations are implemented and some spurious phenomenon, can be introduced leading to not negligible errors, not easily recognizable for a common FE user.
This study investigates the 4QUAD element for linear elastic and hyperelastic axisymmetric analysis of a pressurized vessel, implemented in two finite element commercial codes, Ansys® and Abaqus®. Moving from numerical simulations, an in depth analytical investigation has been carried out to support the comprehension of FE results. Differences in the element shape functions and in the integration methods produce significant discrepancy in results even in a very simple case as a pressurized steel pipe. As results it is interesting to underline that, for liner elastic problems, although four elements in the thickness suffice to obtain displacements with an error lower than 0.02%, about thirty elements are required to reduce the error on the radial stress to 2%.

[1] R.L. Taylor, P.J. Beresford and E.L. Wilson, Int. J. Num. Meth. Eng., 10,1211 (1976). [2] E.P. Kasper and R.L. Taylor, Int. J. Num. Meth. Engng., 53, 2061 (2002).
[3] T.J.R. Hughes, Int. J. Num. Meth. Eng., 15, 1413 (1980).

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ACEX154
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CFD vs. Wind-Tunnel for an ACC Sailing yacht: a Turbulence Modelling and Grid Resolution Study

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In the lasts few decades, the development of computational techniques in fluid dynamics (CFD), together with the increasing performances of hardware and software have allowed engineers to routinely solve problems in a virtual environment, to understand the role of geometrical and mechanical factors in external aerodynamics and to reveal the interplay of turbulence scales and geometrical design that were hardly tractable in the past. Very recently the larger realistic CFD model (up to one billion cell) obtained from a physical model (wind-tunnel tests) of an American's Cup sailing yacht has been studied using massive parallel processes on up to 512 CPUs [1]. Following this first study a more wide range analysis testing the most common turbulence models used in literature has been performed on the same geometry model using coarser grids. In particular a comparison between physical model results and CFD modelling results for global forces acting on the mainsail, performing a sensitivity analysis with the respect to both the grid size and the turbulence models. The results confirms the reliability of CFD modelling in order to perform AC sailing yachts aerodynamics study and design suggesting that in the near future CFD can became a concrete complementary experimental tool in this cutting edge research field. On the other hand, the differences between the achieve results performed with different turbulent models and grid size put in evidence the required care to perform a reliable and trustable
CFD [1].

[1] Viola I.M., 2008. Numerical and Experimental Fluid Dynamics applied to Sailing Yacht Dynamics. Ph.D. Thesis, Politecnico di Milano, Milan, Italy.

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VIP-ACEX033
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Analysis and comparison of the strength of Simple and

Hybrid Structural Joints

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Hybrid joints means in this case in the simultaneous use of two different joining techniques, one of them being adhesive bonding. Hybrid joints bring together the benefits of adhesive joints and fastened or spot-welded joints [1-3]. In this work, simple adhesively bonded (AB), resistance spot welded (RSW), clinched (C), riveted (R), self piercing riveted (SPR) joint and the corresponding hybrid-bonded joints were analyzed concerning the quasi-static strength, stiffness and energy absorption. The performances were evaluated for different material, geometrical and environmental factors (adherend material and thickness, fastener/spot-weld pitch, temperature and ageing). In order to reduce the number of experiments, a factorial analysis based on DoE techniques was applied [4]. The global analysis was split into two groups: a first named “homogeneous” involving joints where the adherends are of the same material and a second group named “heterogeneous”, characterized by adherends of different materials. For the first group, only AB and RSW were considered, while for the second one, AB, C, R, and SPR were evaluated. Further remarks allowed to reduce the number of experiment (temperature does not affect the performances of RSW joints, pitch cannot be evaluated for AB joints). The influence of the material, geometrical factors and environment was evaluated through the analysis of variance (ANOVA) of the experimental results, in order to compare the performances of hybrid joints with respect to joints on a wide range of conditions. An overall improvement of strength and stiffness was found for "homogeneous" hybrid joints, while for "heterogeneous" joints, the performances are predominantly related to the adhesive. The large benefit found in the case of hybrid RSW-AB joints can be related to the presence of the adhesive that drives failure from the weld nugget to the weld crown, with a neat increase of energy absorption.

REFERENCES

1. G. Kelly, Load transfer in hybrid (bonded/bolted) composite single lap joints - Compos. Struct. 69, 35, (2005).
2. I.O. Santos, W. Zhang, V.W. Goncalves, N. Bay, P.A.F. Martins – Weld bonding of stainless steel, Int. J. Mach. Tools Manuf. 44, 1431 (2004)
3. B. Chang, Y. Shi, S. Dong – Comparative studies on stresses in weld-bonded, spot-welded and adhesive bonded joints, J. Mater. Process. Technol. 87, 230 (1999).
4. Douglas C. Montgomery - Design and analysis of experiments, John Wiley & Sons (New York, 2001).

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ACEX131

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Computer Aided Manufacturing System for Riser Design Automation in Casting

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Casting is an important industrial process for manufacturing near net-shaped products. It is one of the most complex engineering areas which involve number of technical and scientific disciplines. Generally, production of cast parts has two design stages: product design and process design. Riser design is one of the main parts of the casting process design. It is needed to eradicate and eliminate the casting solidification defects like shrinkage, porosity and hot tears. This can be predicted and designed by means of computer simulation of casting solidification. Huge numbers of different scientific

and commercial computer softwares dealing with issues related to casting are available. Unfortunately, most if not all of these programs are tedious, not friendly to use, and deal only with one product geometry at a time.

The primary objective of this work is the automation design of risers for any casting. A complete simple Computer Aided Manufacture (CAM) procedure using an integrated methodology for designing risers using three methods is developed and presented. The methods are: Chvorinov's Rule, Caine rule and Naval Research Laboratory (NRL) method .The theoretical data and empirical, charts and values relevant are collected and presented in the appropriate formats. However, when designing risers for a given application, an infinite numbers of solutions are possible. Thus, certain limitations are imposed on the values, of the riser dimensions (e.g. diameter, height for cylinder or length for cube).
In general, the CAM program developed and constructed is fully automated, flexible, extendable, interactive and friendly to use. The programming language used is Visual Basic.6. The feasibility of the presented method is supported with illustrative examples.

[1] R. Tavakoli, P. Davami," Automatic optimal feeder design in steel casting process" , Comput. Methods Appl. Mech. Engrg. 197 (2008) 921–932
[2] L.C. Kumruoglu, A. O¨ zer, " Investigation of critical liquid fraction factor in nodular iron castings by computer simulation", journal of materials processing technology 197 (2008) 182–188
[3] R. Tavakoli, CartGen: robust, efficient and easy to implement uniform/ octree/embedded boundary cartesian grid generator, Int. J. Numer. Meth. Fluid (2007), p1685.
[4] R. Tavakoli, P. Davami, A fast method for numerical simulation of casting solidification, Commun. Numer. Meth. Engrg. (2007),
[5] R. Tavakoli, P. Davami, Unconditionally stable fully explicit finite difference solution of solidification problems, Metall. Mater. Trans. B 38 (1) (2007) 121–142.
[6] L. Yatziv, A. Bartesaghi, G. Sapiro, O(N) implementation of the fast marching algorithm, J. Comput. Phys. 212 (2006) 393–399.
[7] R.S. Ransing, M.P. Sood, W.K.S. Pao, Computer implementation of Heuvers' circle method for thermal optimisation in castings, Int. J. Cast. Met. Res. 18 (2) (2005) 119–128.
[8] B. Ravi, Metal Casting: Computer Aided Design and Analysis, Prentice Hall of India, India, 2005.
[9] M. Bellet, O. Jaouen, I. Poitrault, An ALE-FEM approach to the thermomechanics of solidification processes with application to the prediction of pipe shrinkage, Int. J. Numer. Meth. Heat Fluid Flow 15 (2) (2005) 120–142.
[10] J. Campbell, Castings Practice, The 10 Rules of Casting, Elsevier Butterworth-Heinemann, 2004.
[11] R.W. Lewis, R.S. Ransing, W.K.S. Pao, K. Kulasegaram, J. Bonet, Alternative techniques for casting process simulation, Int. J. Numer. Meth. Heat Fluid Flow 14 (2) (2004) 145–166.
[12] Q. Li, G.P. Steven, Y.M. Xie, O.M. Querin, Evolutionary topology optimization for temperature reduction of heat conducting fields, Int. J. Heat Mass Trans. 47 (23) (2004) 5071–5083.
[13] M. Bellet, V.D. Fachinotti, ALE method for solidification modelling, Comput. Methods Appl. Mech. Engrg. 193 (39) (2004) 4355–4381.
[14] J. Campbell, Castings, Butterworth-Heinemann, 2003.
[15] D.P.K. Singh, G.D. Mallinson, S.M. Panton, Applications of optimization and inverse modeling to alloy wheel casting, Numer. Heat Trans. A 41 (6) (2002) 741–756.
[16] R.W. Lewis, M.T. Manzari, D.T. Gethin, Thermal optimization in the sand casting process, Engrg. Comput. 18 (3/4) (2001) 392– 417.
[17] R.W. Lewis, K. Ravindran, Finite element simulation of metal casting, Int. J. Numer. Meth. Engrg. 47 (2000) 29–59.
[18] M.T. Manzari, D.T. Gethin, R.W. Lewis, Optimisation of heat transfer between casting and mould, Int. J. Cast. Met. Res. 13 (4) (2000) 199–206.

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ACEX131
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Reassessment of the Diametral Compression Test Using Finite Element Analysis

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The diametral compression test, also called the indirect tensile test or Brazilian test, has been used to measure the tensile properties of brittle materials such as concrete, rock, coal, polymers, cemented carbides, pharmaceuticals and ceramics. In this test, a circular cylindrical disc specimen is subjected to a compressive load through two diametrally opposite rigid platens. Thus, for an elastic material these loading conditions, besides inducing compression, produce a nearly uniform tensile stress over a significant portion of the diametral plane containing the applied load. These maximum tensile stresses grow perpendicularly to the loading direction and are proportional to the applied load. However, the most important thing to note about diametral disc testing is that fracture must be initiated by tensile stresses if the test is to yield useful results. Unfortunately, as the test and loading continued some deformation started to take place at the loading interfaces. Hence, the loading conditions changes from point loading (i.e. concentrated) to distributed loading. Consequenly, the stress paterns and distributions tends to deviate from the recommended ideal tensile stresses at the center to more complex combined stresses. This is reflected in the large scutter found in the values of the tensile strength and the variations in the results obtained from this test by the various investigators. In fact, the strength values obtained in diametral compression testing are always different and much lower than for other uniaxial tests, such as three-and four-point bending. Therefore, a reassessment of the diametral compression test is essential. Also, the results of this test should be treated with more caution and some correction measures should be included in the formulae used.

The main objectives of this work are to address these issues and to analyze in detail the theoretical basis of the data interpretation of the diametral compression test using finite element techniques. Also, improvements in both the measurements and in the interpretation of the test data are essential. Thus, the present work is directed to investigate the validity of the diametral disc test with a small flat ground. The stress distribution is determined by finite element method for a range of loading conditions. The results show that for the case of a point load, the failure is due to shear and compressive stresses at the loading point. Application of the diametral disc test for a ground flat was proposed and tested. It is found that, to obtain accurate tensile strength from this test, the width of the flattened area should be less than 0.25 times the diameter of the disc. It is expected that the results presented in this investigation will stimulate efforts towards establishing accurate experimental methods and guidelines for evaluating the exact properties of materials.

[1] C. Thornton, M.T. Ciomocos, M.J. Adams, Numerical simulations of diametrical compression tests on agglomerates, Powder Technol,3, 140, (2004), 258-267
[2] A.T. Procopio, A. Zavaliangos, J.C. Cunningham, Analysis of the diametrical compression test and the applicability to plastically deforming materials, J Mater Sci, 17, 38, (2003), 3629-3639
[3] U. Soltesz, G.Bernauer, R. Schaefer, Diametral compression test for determining the tensile strength of brittle materials, CFI Ceram Forum Int Ber DKG, 9, 72, (1995), 553
[4] S. P. Mates, R. Rhorer, S. Banovic, E.Whitenton, R. Fields, Tensile strength measurements of frangible bullets using the diametral compression test, Int J Impact Eng, 6, 35, (2008), 511-520
[5] P. Jons, H. ggblad, K. Sommer, Tensile strength and fracture energy of pressed metal powder by diametral compression test, Powder Technol., 2-3, 176, (2007), 148-155
[6] T. R. Paulsen, O. Lindtjorn, G. Hogstedt, Avian gut passage reduces seed exit costs in Sorbus aucuparia (Rosaceae) as measured by a diametral compression test, Funct. Plant Biol., 6, 33, (2006), 611-617

[7] P. Chen, H. Xie, F. Huang, T. Huang, Y. Ding, Deformation and failure of polymer bonded explosives under diametric compression test, Polym. Test, 3, 25, (2006), 333-341
[8] M. Khanal, W. Schubert, J. Tomas, DEM simulation of diametrical compression test on particle compounds, Granular Matter, 2-3,7, (2005),83-90

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ACEX215
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Three Dimensional Finite Elements Modeling of Human Knee in Response to External loads

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The knee is one of the most commonly injured joints in the human body. 3D FE modeling is a useful tool for understanding of the stress – strain distributions within articular cartilage in response to external loads and investigating both the prevention of injury and the pathological degeneration of the joints. This paper propose 3-D dynamic finite element (3-DDFE) model based on the digital data set from the human Knee section. The analysis was constructed to demonstrate the effectiveness of the 3-DDFE model as a potential Knee fracture investigatory technique. The fresh Computerized Topography (CT) scans were used for the Kneel analysis and the Magnetic Resonance Imaging (MRI) images for the brain model. The 3-DDFE analysis of human Knee would allow the assessment of the injurious effects of different impact conditions and enable the development of enhanced Knee fracture and protection criteria for human Knee.

Objective
The objective of this paper is to develop an anatomically based model of 3-D dynamic finite element of the human Knee, which can be used to predict injury in response to external loads.

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ACEX171
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An Innovative Method for Measuring Young's Modulus of Multi-Layered Materials Using Postbuckling Behavior

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In recent years, flexible multi-layered materials with very high performance are used in wide and diverse industrial applications to establish cost-effective processing with regard to long-term performance and reliability and large deformation analysis is becoming increasingly more important in both analytical and technological interests of structural design (mechanical springs, various thin walled structures). A new bending test method (Compression Column Method) is

proposed with the nonlinear large deformation theory. Exact analytical solutions are obtained in terms of elliptic integrals. By using this method, the Young's modulus of each layer in a thin and long flexible multi-layered material can be easily obtained by just measuring the horizontal displacement(λ), the vertical displacement(δ) and the deflection angle(θB) (see Fig.1).
In order to assess the applicability of the proposed method, several experiments were carried out using a two-layered material (PVC: a high-polymer material + SUS: a stainless steel material) (see Fig.2). As a result, the new method was found to be suitable for flexible multi-layered materials. Furthermore, the proposed new method is applicable to Young's modulus measurement in a thin multi-layer formed by PVD (Physical Vapor Deposition), CVD (Chemical Vapor Deposition), Electrodeposition, Coating (Graphite, Metal Oxide), Paint (Lacquer), Cladding, Lamination, etc.
Fig.1 Schematic configuration of multi-layered column subjected to compressive forces.
Specimen(:column)
Besides the Compression Column Method for a flexible multi-layered material studied here, the Cantilever Method [1], the Circular Ring Method [2],[3] and the Compression Column Method [4],[5] for a flexible single-layered material have already been developed and reported, based on the nonlinear large deformation theory.

References
[1] A.Ohtsuki, Proc. 4th Int. Conf. Adv. Exp. Mec h., 3-4, 53 (2005).
[2] A.Ohtsuki and H. Takada, Trans. JSSR, 47, 27 (2002).
[3] A.Ohtsuki, Proc. 2005 SEM Ann. Conf. & Expo. Exp. Appl. Mech, 72, 113(2005).
[4] A.Ohtsuki, 4th Int. Conf. Thin-Walled Struct., 233 (2004).
[5] A.Ohtsuki, Proc. 2005 SEM Ann. Conf. & Expo. Exp. Appl. Mech, 78, 78(2006).
LM-Block

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ON THE IDENTIFICATION OF THE PARAMETERS OF A VEHICLE PASSENGER/SEAT MODEL FOR RIDE COMFORT ASSESSMENT

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The paper deals with the identification of the parameters of a passenger/seat model that can be used for ride comfort assessments. The final aim is to produce a comprehensive framework for enabling vehicle seat designers to develop comfortable (and healthy) seats, especially for those people who spend their lives working on vehicles. In previous papers a model of the seated passenger was derived and validated. Such a model needed as input the seat parameters (stiffness and damping). Such parameters had to be measured by means of a time consuming experimental process. A more quick way to obtain such parameters is to identify them, by seating a proper dummy (the Marco dummy developed at the Politecnico di Milano) on a car while running on actual roads. Such a procedure involves the estimation of the error that can be introduced by the identification of the relevant seat parameters.
In the paper, an in-depth theoretical analysis has been performed on the signal processing of data coming from records of random phenomena. A proper experimental and theoretical analysis has been performed to assess the error related to the estimation of the mean-square densities (power spectral densities).
The result is that, it is possible to identify the passenger/seat parameters provided that the records of the random excitation of the passenger/seat vibrations are sufficiently long and properly processed.

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ACEX130
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Numerical and Experimental Analyses for the Aerodynamic Design of High Performance Counter-Rotating Axial Flow Fans

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A study was done on the numerical and experimental analyses for the aerodynamic design of high performance of counter rotating axial fans. Front rotor and rear rotor blades of a counter rotating axial fan are designed by using the simplified meridional flow analysis method with the radial equilibrium equation and the free vortex design condition, according to design requirements. The through-flow fields and the aerodynamic characteristics of the designed rotor blades are analyzed by using the matrix method and the frequency domain panel method[1]. Fan performance curves are measured by following the standard fan testing method, KS B 6311. Three-dimensional steady/unsteady flow fields in the counter-rotating axial flow fan are analyzed by using the prism type five-hole probe and the inclined hot-wire probe[2]. Performance characteristics of a counter rotating axial flow fan are estimated for the variation of design parameters such as the hub to tip ratio, the taper ratio and the solidity. The effect of the hub to tip ratio on the fan efficiency is significant compared with the effects of other design parameters such as the taper ratio and the solidity. The magnitudes of the meridional and relative velocities on the front and rear rotors are increased with the radial direction from hub to tip. This results in the reverse pressure gradient at the blade leading edges of both the front rotor and the rear rotor.

[1] J.S. Cho, “Frequency Domain Aerodynamic Analysis of Interacting Rotating Systems,” Ph.D. Thesis, Purdue University(1988).
[2] B. Lakshminarayana and A. Poncet, “A Method of Measuring Three-Dimensional Wakes in Turbomachinery,” Journal of Fluids Engineering, Trans. ASME, Vol. 96, No. 2, p. 87-91(1974).

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ACEX138
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Effect of Support Conditions on the Rod Motion in a Nuclear Fuel Fretting Simulator

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The primary failure mechanism of a nuclear fuel rod is known as grid-to-rod fretting that is generated by a flow-induced vibration. One of the key factors determining the resistance to fretting wear is the contact condition between the fuel rod and the grid springs. Although the fretting failures have significantly decreased by introducing advanced grid spring

designs, it is necessary to examine the correlation between the fuel rod motions for different grid spring shapes and the fretting wear damages. In this study, fretting wear tests of nuclear fuel rods have been performed by using two kinds of spacer grid springs with a concave and a convex shape in room temperature air with a specially designed 1x1 cell unit test rig. The objectives are to examine the fuel rod behavior for different support conditions under a simulated flow-induced vibration condition and to determine its effect on the fretting wear behavior. The result indicated that when the fuel rod was vibrated with a circular motion, its motion at grid-to-rod contact regions was dramatically changed with spring shapes (i.e. convex and concave) and support conditions (i.e. positive force, just contact and open gap). Based on the test results, the relationship between the grid-to-rod contact behavior of each support condition and the variation of fretting wear mechanism were discussed in detail.

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ACEX140
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Experimental Study on the Unsteady Wake Characteristics of the Propulsive Ducted Fan using a Hot-wire Anemometry

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The experimental study on the wake characteristics of turbomachineries is essential, when developing the turbomachineries such as pumps, fans, compressors, turbines. Various sources of losses are analyzed by studying the wake characteristics of turbomachineries. For more accurate analysis, various types of experimental equipments are used. Because of the high frequency response characteristics, the hot-wire anemometry was widely used to measure the wake characteristics of the turbomachinery. In this research, the flow fields of the small ducted fan as a propulsion device of small R/C aircraft were measured using a hot-wire anemometry at inlet and outlet to analyze the wake characteristics. Because the ducted fan is able to be disturbed by cross wind in operation, It is necessary to study the wake of the ducted fan with cross wind. To considering the cross wind, the ducted fan was installed perpendicular to the flow direction of the wind tunnel. As a result, the wake has very complicated characteristics from steady state without the cross wind. The difference between axial velocities at advancing and retreating side was induced by the difference between the inflow speed of rotor according to the cross wind. The difference between axial velocities at forward and backward area relative to the cross wind was induced by the blockage effect of the duct and motor hub.

(a) Inlet (b) Outlet

Fig. 1 Axial velocity distribution at inlet and outlet

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ACEX146
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Procedural Terrain Generation at GPU Level with Isosurface Extraction

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This work presents a method to create procedural terrains using the GPU (Graphic Processing Unit) using an isosurface extraction approach. This provides a flexible way to generate, in real-time, intricate topographies by manipulating the different parameters in the procedural model. The isosurface is extracted using a variation of the Marching Cubes algorithm [1] implemented totally on the GPU based on the Histogram Pyramids approach [2], providing a faster and smoother extraction.
The terrain is generated by using a procedural function, such as Perlin Noise combined with some fractal iteration like the turbulence function, to create a 3D scalar field. The Marching Cubes algorithm is used to extract the isosurface representing the terrain. All algorithms were implemented in a GPU resulting in high performance generation rates.
Although the main focus of this work is to generate procedural terrains, the fast visualization of surfaces reconstructed from scalar fields can be useful for the analysis of seismic data, prospecting for oil, among other applications. The real-time visualization of the drilling process for oil tunnels is also an interesting topic that can help to avoid problems caused by cracks or variations on the terrain layers which can cause the collapse of the tunnel.

[1] W. Lorensen and H. E. Cline. Marching Cubes: A High Resolution 3D Surface Construction Algorithm. In SIGGRAPH proceedings, 21(4), pages 163-170 (1987).
[2] C. Dyken and G. Ziegler. High-Speed Marching Cubes using Histogram Pyramids. In Computer Graphics Forum, 27(8), pages 2028-2039 (2008).

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ACEX227
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Automation of a pneumatic flow rate test bench compliant to ISO Standards

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The issue of measuring the flow rate through a pneumatic component is a critical one. Several methods exist, each with its own pros and cons regarding the type of gas, measurement range, accuracy [1]. ISO Standards, however, only consider a few of them: orifice plates, nozzles, Venturi nozzles, Venturi tubes [2, 3, 4]. Although amenable to possible criticism, the International Organization for Standardization is an important reference. Designing a test bench according

to its Standards is often more than reasonable: advantages include certification, assessment of test methods and accuracy, worldwide recognition. On the other hand, however detailed the Standards may be, they often lack the designer's and the user's point of view. These results in very complicated realizations, low usability or long test execution times. This paper proposes a flow rate measurement test bench compliant to ISO Standards allowing automated testing, characterized by rational installation, high configurability, and good user-friendliness. The accuracy of the test bench will also be discussed together with the evaluation of measurement uncertainties.

[1] R.W. Miller, Flow measurement engineering handbook, Z.G. Foundotos (McGraw-Hill Professional, Boston, 1996)
[2] ISO 6358, Pneumatic fluid power -- Components using compressible fluids -- Determination of flow-rate characteristics (ISO, 1989)
[3] ISO 5167-1, -2, -3, -4, Measurement of fluid flow by means of pressure differential devices inserted in circular cross-section conduits running full - Part 1: General principles and requirements, Part 2: Orifice plates, Part 3: Nozzles and Venturi nozzles, Part 4: Venturi tubes (ISO, 2003).
[4] ISO 9300, Measurement of gas flow by means of critical flow Venturi nozzles (ISO, 2005).

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ACEX229
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Nonlinear Modeling of Dynamic Response of Clays Deposits

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A constitutive model able to capture the effect of pore pressure generation during seismic loading, plastic deformation and hysteretic soil behavior was implemented in a three-dimensional 8-noded brick finite element. The formulation assumes an idealized state of stresses representing those existing in a DSS (Direct Simple Shear) test, therefore, only a normal stress σn and two orthogonal shears τx and τy are considered. Two parameters w1 and w2 describe the perfect hysteretic behavior of the soil. These parameters are obtained throughout a study which consists on fitting with the model representative experimental modulus degradation and damping curves obtained at a given confining pressure. A demonstration of the predictive potential of the proposed constitutive lawthrough the analyses of the measured response in a seismological station TXS1 located in soft clay in the old Texcoco Lake region, in Mexico City is included, as well as comparisons between uncoupled (i.e. a plane analysis in each component of motion) and coupled analyses (i.e. a bi-dimensional analysis considering both components of motion simultaneously). Overall, coupled analyses using only the hysteretic component better predicted the measured response than the uncoupled analyses for the cases studied. The results of the analyses seem to be highly dependent on the amount of Raleigh damping used, especially for high frequencies. The consideration of plastic deformations during the simulations seems to provide a better representation of the cyclic soil response during transient and steady state conditions. The analyses were made using a Finite Element Analysis Program (FEAP) as platform. FEAP is a computer analysis system designed for using different types of elements and modeling methods. Elements are available to model one, two or three dimensional problems in linear or non-linear structural and solid mechanic.

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ACEX242
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Inverse Kinematic Analysis of a Stanford Robotic arm with SIX degrees of freedom

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The trajectory planning of robots is an important area of research. The determinaion of all possible and feasible sets of joint variables, which would achieve the specified position and orientation of the manipulators end effector w.r.t the base frame. The inverse kinematics is the determination of the set of positions and orientations in cartesian spcae that reachable by the origin of the end effector frame as the joint diplacemnet vector q ranges over the joint space. Inverse kinematics is the mapping from Cartesian space to the joint space. There are Two appraches to the solutions to the inverse kinematic problem, close form solution and numerical solution. Close form solution is adapted.
It is observe that if the joints are activated by servomotors, which are run at unifrom angular velocity then then the end effector may or may not move with uiform velocity. In the trajectory of the end effector, certain point lies where end effector has uniform velocity. A vertual model has generated in Solidworks and the imperical results have been compared with COSMOS Kinematics software.

[1] Maria da Graça Marcos, J.A. Tenreiro Machado and T.-P.Azevedo-Perdicoúlis, Trajectory planning of redundant manipulators using genetic algorithms, Communications in Nonlinear Science and Numerical Simulation Volume 14, Issue 7, p. 2858-2869, July 2009.
[2] Keith L. Doty, C. Melchiorri and C. Bonivento, A theory of generalized inverses applied to robotics, Int J Robot Res 12 p. 1–19 (1993).

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ACEX2453
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Cantilever Type MEMS Probe with Double Beam and Hinge Structure

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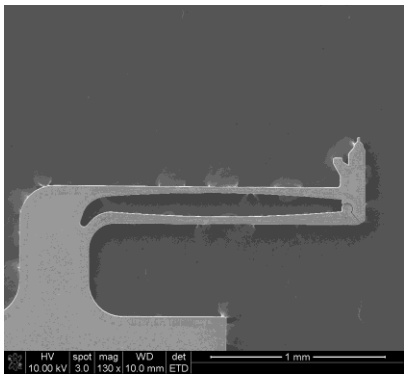
We propose the cantilever type MEMS probe with double beam and hinge structure for the application of integrated circuit chip inspection. The conventional cantilever type MEMS probe uses a double beam to reduce the scrub length for the application of small electrode pad [1]. However, stress concentration occurs easily at the corner of double beam and allowable overdrive is restricted by stress concentration [2]. In this paper, we add the hinge structure to the cantilever type MEMS probe with double beam not only to reduce the scrub length but also to relax stress concentration. In the hinge structure, there is no moment because it can absorb the rotation. This probe was designed using finite-element methods and fabricated using Ni–Co electroplating. Compared to the conventional probe, the proposed probe can have

more overdrive. This new cantilever type MEMS probe with double beam and hinge structure satisfies the design requirements for integrated circuit chip inspection.



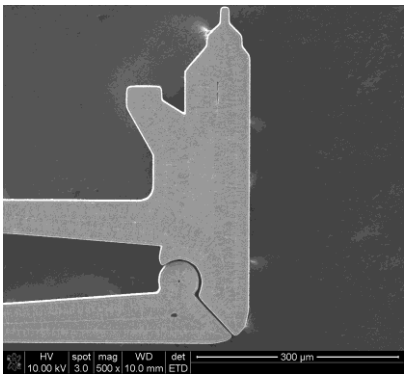


Fig. 1 SEM image of proposed probe Fig. 2 Enlarged view

[1] T. Inoue, Fred Megna, Semiconductor Wafer Test Workshop 2005.
[2] J.Y. Kim, Korean MEMS conference 2008.

FLUID-STRUCTURE INTERACTION

ACEX024
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HYDRODYNAMIC DESIGN AND DEVELOPMENT A SMALL PLANNING CATAMARAN BOAT WITH LOW DRAG FRICTION

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Key word: Catamaran boat- hydrodynamic design- CFD method- experimental test- hydrodynamic effects

Proper hydrodynamic design is necessary in order to achieve the effective performance of a Catamaran boat. An incorrect shape cans excessive drag and instability. This paper explains how a reasonable hydrodynamic design can result in low drag. Also this paper contains a description of the shape and size, hydrodynamic design, estimate calculate drag as a function of speed, computational fluid dynamic (CFD) method and experimental test were carried with areal scaled model in five different speed at Towing Tank facilities of Sharif Industrial University on hydrodynamic design and development a small planning catamaran boat. Power requirements include speed of vehicle and drag friction calculated and discussed on propulsion system for more efficiency and more endurance with determinate power. After a brief overview of how hydrodynamic effects Catamaran boat performance stability of all kind of body shape is discussed. The external shape of a Catamaran is important for minimizing the energy required to move boat through the water at the required speed for the desired range. Experimental maneuvering testing had been down and result of testing provided by diagram of reduce and power requirement. The best agreement between experimental result and numerical simulation.

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ACEX090
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Computational Study on Fluid Structure Interaction of a High Pressure Axial Compressor

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A preliminary computational study has been made to investigate the fluid structure interaction (FSI) of a multi-stage axial compressor which is under development by Korea Aerospace Research Institute. The compressor has mass flow rate of 11.56 kg/s and rotating speed of 25,000 rpm at design point. In the present study, computation has been made for flow passages of one rotor blade and two stator blades of the first stage of the compressor which actually has thirteen rotor blades and twenty eight stator blades. The computational domain was spatially discretized by multi block structured grids with almost a million points. ANSYS CFX-11 has been used to do FSI parallel computations on Supercomputer IBM p595. The FSI computation is made by a CFD code and a FEM code that are almost independent each other. Information transfer between the CFD code and the FEM code was made by MpCCI (Mesh based parallel Code Coupling Interface) library. Computed results include thermodynamic performance parameters and full CFD features such as three dimensional distributions of pressure, velocity, temperature and Mach number inside the flow passages and the spanwise distribution of rotor blade loading. The results also include the corresponding FEM calculations such as the distribution of stress, deformation, and strain rate of the rotor blade. At present moment, a fully-coupled FSI computation is being made to capture high-cycle fluid-induced vibration such as flutter. Future study will extend the computational domain to cover all the rotor and stator blades of the first stage of the compressor. After then, results will be compared with those of Wu, et al. [1]

[1] X. Wu, M. Vahdati, A. Sayma, and M. Imregun, in Int. J. of Computational Fluid Dynamics, Vol. 19, p. 211(2005)

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ACEX157
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A Study on LP Blade Flutter for Power Generation Turbine by Numerical Analysis

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Abstract In this paper, three-dimensional nonlinear flutter analysis for aeroelastic behavior of the turbine blade of low pressure final stage was carried out by a fluid-structure interaction method. Computational fluid dynamics (CFD) and Computational structural dynamics (CSD) solvers were coupled to model the interaction between the fluid and the structure. In order to achieve the corresponding model, the vibration test was carried out on the LP blade specimen and the resulting test data was compared between the test and the modal analysis on three-dimensional finite element model. K-ε turbulent model was adopted and the H-grid was applied to the inlet, outlet and blade as well as the O-grid were generated around a blade.

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ACEX173
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Macroscopic stability analysis in periodic composite solids

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In the theory of composite solids with heterogeneous microstructure subjected to large deformations, the investigation of microscopic stability using homogenization procedures plays a central role since microscopic failure mechanisms in these materials are often induced by instability phenomena. Moreover the stability analysis allows to define the region of validity of the standard homogenization procedure [1,2]. A fundamental measure of stability based on the homogenized constitutive properties is the strong ellipticity condition of the homogenized moduli tensor. This condition allows to obtain un upper bound beyond which the microstructure is surely unstable, thus providing an unconservative prediction of the primary microscopic instability load. In order to investigate alternative macroscopic conditions able to obtain accurate prediction of the microscopic instability mechanisms in composite solids with periodic microstructure, a stability analysis on the micro and macro scales is here carried out. Numerical applications for fibre-reinforced and cellular microstructures with hyperelastic constituents are developed by implementing a one-way coupled finite element approach. Results show the ability of the proposed macroscopic stability conditions based on the positiveness of the homogenized moduli tensor related to specific work-conjugate stressstrain measures, to give conservative predictions of the primary instability load along the examined monotonic macrostrain paths.

[1] G. Geymonat, S. Muller, N. Triantafyllidis, Arch. Ration. Mech. Anal., 122, 231-290 (1993).
[2] C. Miehe, J. Schroder, M. Becker, Computer Methods in Applied Mechanics and Engineering, 191, 4971–5005 (2002).

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ACEX180
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THE PRINCIPALE ELEMENTS OF THE FRICTION CIRCUIT IN THE HARMONIC FLOW

Bal Carmen1, Bal Nicolaie1, Riti-Mihoc Emil1
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In the last time, the development of the science and the technicians are realised the big progress and the level of the general knowledge of the persons implicated in this activity are advances and probable the knowledge of the sonicity are not brake by the wrong idea or disregarded by “incompressibility of flow” Sonicity is the science of transmitting mechanical energy through vibrations. Starting from the theory of the musical accords, this paper found the laws for transmitting the mechanical power to the distance through oscillations that propagate in continuous environments (liquid or solid) due to their elasticity.

In the paper we make the effect of the friction in the sonic system were the sonic flow are influence by the friction. This effect makes the growing of the temperature in the sonic resistance, same the caloric effect of the alternative current. This paper is the base of departure for the future research about the thermic effects of the sonicity theory in the practice.

ACEX024
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HYDRODYNAMIC DESIGN AND DEVELOPMENT A SMALL PLANNING CATAMARAN BOAT WITH LOW DRAG FRICTION

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Key word: Catamaran boat- hydrodynamic design- CFD method- experimental test- hydrodynamic effects

Proper hydrodynamic design is necessary in order to achieve the effective performance of a Catamaran boat. An incorrect shape cans excessive drag and instability. This paper explains how a reasonable hydrodynamic design can result in low drag. Also this paper contains a description of the shape and size, hydrodynamic design, estimate calculate drag as a function of speed, computational fluid dynamic (CFD) method and experimental test were carried with areal scaled model in five different speed at Towing Tank facilities of Sharif Industrial University on hydrodynamic design and development a small planning catamaran boat. Power requirements include speed of vehicle and drag friction calculated and discussed on propulsion system for more efficiency and more endurance with determinate power. After a brief overview of how hydrodynamic effects Catamaran boat performance stability of all kind of body shape is discussed. The external shape of a Catamaran is important for minimizing the energy required to move boat through the water at the required speed for the desired range. Experimental maneuvering testing had been down and result of testing provided by diagram of reduce and power requirement. The best agreement between experimental result and numerical simulation.

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ACEX090
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Computational Study on Fluid Structure Interaction of a High Pressure Axial Compressor

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A preliminary computational study has been made to investigate the fluid structure interaction (FSI) of a multi-stage axial compressor which is under development by Korea Aerospace Research Institute. The compressor has mass flow rate of 11.56 kg/s and rotating speed of 25,000 rpm at design point. In the present study, computation has been made for flow passages of one rotor blade and two stator blades of the first stage of the compressor which actually has thirteen rotor blades and twenty eight stator blades. The computational domain was spatially discretized by multi block structured grids with almost a million points. ANSYS CFX-11 has been used to do FSI parallel computations on Supercomputer IBM p595. The FSI computation is made by a CFD code and a FEM code that are almost independent each other. Information transfer between the CFD code and the FEM code was made by MpCCI (Mesh based parallel Code Coupling Interface) library. Computed results include thermodynamic performance parameters and full CFD features such as three dimensional distributions of pressure, velocity, temperature and Mach number inside the flow passages and the spanwise distribution of rotor blade loading. The results also include the corresponding FEM calculations such as the distribution of stress, deformation, and strain rate of the rotor blade. At present moment, a fully-coupled FSI computation is being made to capture high-cycle fluid-induced vibration such as flutter. Future study will extend the computational domain to cover all the rotor and stator blades of the first stage of the compressor. After then, results will be compared with those of Wu, et al. [1]

[1] X. Wu, M. Vahdati, A. Sayma, and M. Imregun, in Int. J. of Computational Fluid Dynamics, Vol. 19, p. 211(2005)

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ACEX157
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A Study on LP Blade Flutter for Power Generation Turbine by Numerical Analysis

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Computational structural dynamics (CSD) solvers were coupled to model the interaction between the fluid and the structure. In order to achieve the corresponding model, the vibration test was carried out on the LP blade specimen and the resulting test data was compared between the test and the modal analysis on three-dimensional finite element model. K-ε turbulent model was adopted and the H-grid was applied to the inlet, outlet and blade as well as the O-grid were generated around a blade.

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ACEX180
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THE PRINCIPALE ELEMENTS OF THE FRICTION CIRCUIT IN THE HARMONIC FLOW

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c effects of the sonicity theory in the practice.

PLASTICITY

ACEX023
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Design of Automotive Frame Cross Member by Hydro-Forming Process Using Computer Aided Engineering

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Hydroforming is a forming technology in which a steel tube is set in a die and formed to fit a specified shape by applying hydraulic pressure from inside the tube while also applying force in the tube axial direction (axial feed). In present study, the whole process chain of frame component (cross member) simulation and development by hydroforming technology to apply high strength steel having tensile strength of 440 MPa grade is studied. At the part design stage, it requires feasibility study and process design aided by CAE (Computer Aided Design) to confirm hydroformability in details. Overall possibility of hydroformable frame part could be examined by cross sectional analyses. Moreover, it is essential to ensure the formability of tube material on every forming step such as pre-bending and hydroforming. At the die design stage, all the components of prototyping tool are designed and interference with press is investigated from the point of geometry. For the improvement of it, the hydroforming was carried out with adding the axial feeding of 45 mm at both ends of the part for supplying materials to the end zone where thinning occurs and retards burst. From this treatment, the thinning

of the tube wall was experimentally measured and it was improved as 17.9%. It is in good agreement with calculated one and the position of the maximum thinning corresponds to the result of the simulation.

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ACEX073
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The kinetics of Dynamic Recrystallization in a Low Alloy Steel

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In industrial forming processes, the metals and alloys are often subjected to complex time, strain, strain rate, and temperature histories. On the one hand, a given combination of thermo-mechanical parameters yields a particular metallurgical phenomenon (microstructural evolution); on the other hand, microstructural changes of the metal during the hot-forming process in turn affect the mechanical characteristics of the metal and hence influence the forming process. In order to achieve the desired mechanical properties of the product, understandings of microstructure changes and softening
mechanisms taking place during the complex forming processes has a great importance for designers of metal forming processes [1-3]. In this study, the hot deformation behavior and the microstructure evolution of 42CrMo steel were investigated by uniaxial hot compression tests at deformation temperatures of 850℃ to 1050℃ and strain rates of 0.01 s-1 to 50 s-1. Based on experimental results, the kinetic equations for the dynamic recrystallization behaviors of 42CrMo steel were proposed. Results indicate that: (1) the deformation temperature, strain rate and the initial austenitic grain size greatly affect the dynamic recrystallization behaviors in 42CrMo steel. The sizes of dynamic recrystallization grain increase with the increase of the deformation temperature and the decrease of the strain rate. Also, the small initial austenitic grain can easily make the dynamic recrystallization occur. (2) A good agreement between the experimental and predicted results shows that the proposed kinetic equations can give an accurate estimate of the dynamic recrystallization behaviors for hot deformed 42CrMo steel.

[1] G. Kugler and R. Turk, Comput. Mater. Sci., 37, 284 (2006).
[2] Y.C. Lin, M.S. Chen and J. Zhong, Mater. Lett., 62,2136 (2008).
[3] A. M. Elwazri, E. Essadiqi and S. Yue, ISIJ Int., 44, 744 (2004).

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ACEX108
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Experimental Study of the Structural Effects on Impulse Produced by Explosion of a Closed Container

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Many researchers have studied the explosion in free-field environment experimentally or numerically like Kinney and Graham [1] or Goodman [2]. But, to author's knowledge the impulse induced by the explosion of the container and the effects of the container specifications on it have not been investigated.

In present study impulse produced by explosion of a container in the shape of a cylindrical shell with a conical head has been investigated experimentally. The procedure followed includes considering two moods for explosion of a container. The first one is "pre-failure" of the container in which no impulse is sensed in surrounding environment. In this mood the specifications of the container is taken into account as a parameter known "explosive mass for the failure". In second mood, referred "post-failure", the container is failed and explosion impulse is sensed in surrounding environment. The space around of the container in second mood has been divided into two intervals. The first interval is affected by the container specifications involved material and geometrical properties and is located in the vicinity of the container. In this article the impulse and the length of this interval has been formulated. In second interval, the effects of the container specification are damped and the impulse can be calculated by the explosion in free-field environment. Mathematical model exploited in this interval is the Kinney-Graham formula.1] Kinney G.F., Graham K.J., "EXPLOSIVE HOCKS IN AIR", Second Edition, Springer-Verlage, 1985.[2] Goodman, H.J., "Compiled Free-Air Blast Data on Bare Spherical Pettolite", Ballistic Research Laboratories, Aberdeen proving ground, Maryland, BRL-1092,1960.