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The International Conference on Modern Mechanics and Applications

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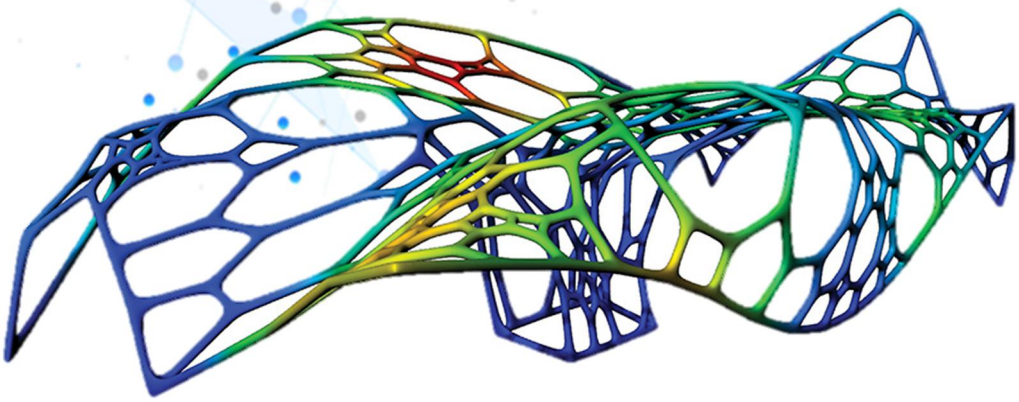

ABSTRACT COLLECTION

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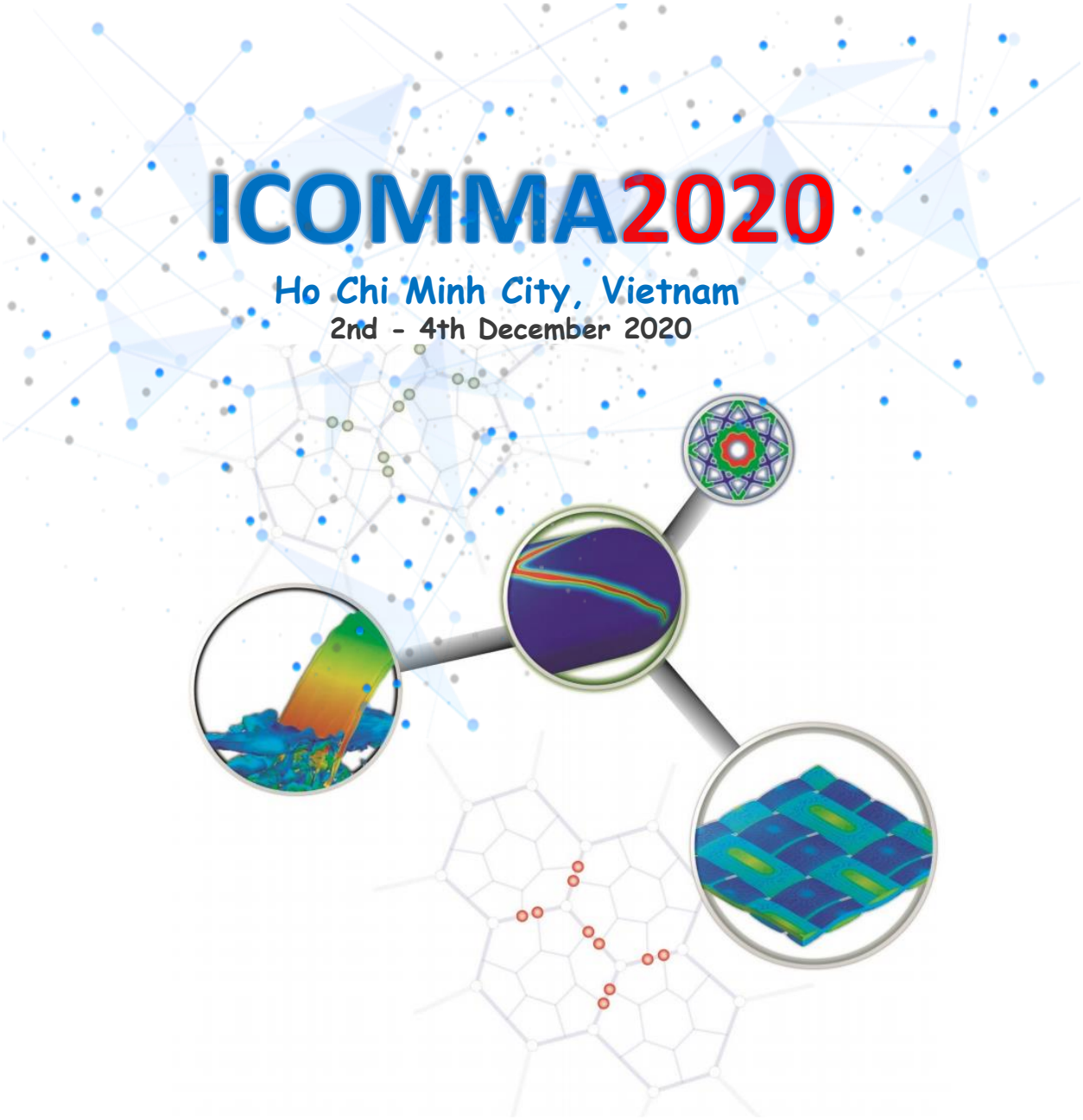

KEYNOTE LECTURES

ON ROBUST SHELL FINITE ELEMENTS AND NONLOCAL MECHANICS

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ABSTRACT

The lecture will present the speaker’s recent research in: (1) the development of locking-free shell finite elements for large deformation of laminated and functionally graded plate and shell structures [1,2] and non-local mechanics [3] ideas to model architected materials [4] and damage and fracture [5,6]. The seven- and twelve-parameter shell elements developed are based on modified first-order and third-order thickness stretch kinematics. Both theories require the use of fully three-dimensional constitutive equations. Through the numerical simulation of carefully chosen benchmark problems, it is shown that the developed shell elements are insensitive to all forms of numerical locking and are the best alternative to 3-D finite elements in saving computational resources [2]. In the context of explaining certain observed phenomena which cannot be explained by classical continuum mechanics models, new theories are being postulated (in an attempt to improve existing models). The non-local continuum models that account for material and/or structural length scales are discussed to model architected materials and structures (e.g., web-core sandwich panels [4]) and graph-based finite element analysis of fracture in brittle-material structures [5,6].

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Multiscale Modeling and Simulation Department

MSME UMR 8208

ACOUSTICAL BEHAVIOR OF THE BONE-IMPLANT INTERFACE: FROM MULTISCALE MODELING TO THE PATIENT'S BED

Guillaume Haiat

Implants are often employed in orthopaedic and dental surgeries. However, risks of failure, which are difficult to anticipate, are still experienced and may have dramatic consequences. Failures are due to degraded bone remodeling at the bone-implant interface, a multiscale phenomenon which remains poorly understood. The implant stability is a key determinant for the surgical success and is determined by the quantity and biomechanical quality of bone tissue around the implant. Two kinds of implant stability may be distinguished. The primary stability occurs at the moment of implant surgical insertion within bone tissue. Implant primary stability should be sufficiently important in order to avoid excessive micromotion (higher than around 50 µm) at the boneimplant interface after surgery, but the pressure on the alveolar bone should not be too high in order to avoid bone necrosis that is related to bone tissue overloading. Secondary stability is obtained through osseointegration process, a complex multiscale phenomenon, which strongly depends on primary implant stability. The objective of this presentation is to show how acoustical methods may be used in order to provide a better understanding of the multiscale and multitime mechanisms at work at the boneimplant interface. A methodology involving combined *in vivo*, *in vitro* and *in silico* approaches is proposed. First, a coin-shaped implant model, which has the advantage of providing reproducible and standardized conditions will be described. A multimodality experimental approach will be carried out. Second, different measurement methods aiming at assessing implant stability will be described. Eventually, a finite element model allowing to estimate the biomechanical determinants of the primary stability of acetabular cups implant will be investigated. Biography:

Guillaume Haiat is a senior research director in the CNRS and an adjunct professor in the ETS Montreal. He graduated from the Ecole Polytechnique in 1998 (X95) in physical acoustics. He defended his PhD study at the French Atomic Energy Commission in 2004 in the domain of ultrasound non-destructive evaluation in the nuclear industry. Since 2004, he works in the domain of bone quantitative ultrasound and biomechanics. He is an associate editor of the journals J Acoust Soc Am, Med Eng Phys, Ultrasound Med Biol, J Mech Med Biol *and* Med. Eng. Phys. *He is the PI of the* BoneImplant *project funded by the European Research Council (ERC Consolidator grant) and that focus on the biomechanical determinants of the osseointegration phenomena.*

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A MASSIVELY PARALLEL EXPLICIT SOLVER FOR ELASTO-DYNAMIC PROBLEMS USING THE SCALED BOUNDARY FINITE ELEMENT METHOD WITH OCTREE MESHES

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ABSTRACT

The applications of transient dynamic analyses include impact, crash test, and wave propagation simulations. Due to the numerically highly demanding nature of these problems, efficient automatic mesh generators and time stepping schemes are required. To this end, a parallel explicit solver exploiting the advantages of balanced octree meshes is introduced. To avoid the hanging nodes problem encountered in standard finite element analysis (FEA), the scaled boundary finite element method (SBFEM) is deployed as a spatial discretization scheme. Consequently, arbitrarily shaped star-convex polyhedral elements are straightforwardly generated. Considering the scaling and transformation of octree cells, the stiffness and mass matrices of a limited number of unique cell patterns are pre-computed. A mass lumping technique yields a well-conditioned diagonal mass matrix. This enables us to leverage the advantages of explicit time integrator, i.e., it is possible to efficiently compute the nodal displacements without the need for solving a system of linear equations. We implement the proposed scheme together with a central difference method (CDM) in a distributed computing environment. The performance of our parallel explicit solver is evaluated by means of several numerical benchmark examples, including complex geometries and various practical applications. A significant speedup is observed for these examples with up to 1 billion of degrees of freedom and running on up to 16,384 computing cores.

NEW ATTACH TECHNOLOGIES AND MATERIALS FOR INTERCONNECTIONS IN ELECTRONIC AND OPTICAL SYSTEMS: EXPERIMENTAL AND MODELING ASPECTS

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Key words: *Experimental characterization, failure mechanisms, finite element modeling, multi-scale approaches*

ABSTRACT

The quality of the assembly of components in electronic systems is an important issue that is essential for their reliability during operation. With the miniaturization of the devices and the severe conditions imposed in service, the components are subjected to high levels of temperature with significant thermal fluctuations. The correct dissipation of heat produced by the electrical loading is thus a key point in the design of these systems. Thermo-mechanical stresses generated in the interconnect materials can indeed become critical and cause mechanical failure by cracking, resulting in debonding and eventually loss of electrical conductivity.

To address these challenges, many solutions have been proposed by both academics and industries. They focused on two main aspects to increase the performance of interconnects. The first aspect is related to the improvement of the material composition by developing new tin solder alloys with small additions of doping elements. This method has allowed to obtain joints with enhanced resistance to creep and longer lifetime [1,2] as demanded in power electronics applications. The second aspect is related to the improvement of the bonding process by using the technique of sintering with silver nano-particles. This method has allowed to obtain a dramatic increase of the thermal conductivity of joints resulting in thermally stable interconnects which are of particular interest in power optics applications [3,4].

It is proposed in this presentation to introduce a large panel of experimental and modeling methods that were developed recently with the of aim of improving the performance of joint interconnects. Appropriate procedures for fabrication of testing samples by soldering or sintering, as well as development of specific tools for their characterization under creep and fatigue conditions, are addressed. Extraction of constitutive laws from the measurements is also done to carry out simulations at different scales. First, phenomenological models are discussed in terms of their ability to correctly predict the observed materials behaviors. Then, more advanced models are used to investigate more accurately the deformation and failure mechanisms at the microstructure level of these materials.

ADVANCED SOFT COMPUTING AND GEOSPATIAL TECHNOLOGY FOR NATURAL HAZARD MODELING AND PREDICTION

Dieu Tien Bui

Professor, GIS Group, University of South-Eastern Norway, Norway

ABSTRACT

The adverse effects of climate change, global warming, and human activities have caused exposing millions of people and infrastructures to natural disasters in many regions of the world. In the last decade, the global economic losses due to natural disasters exceeded US$104 billion per year, and the population affected is more than 109 million yearly. It is anticipated that these figures are continuing to rise in the coming years. Therefore, accurate predictions of prone areas to natural disasters are crucial for preventing, avoiding, and minimizing damages that contribute to socio-economic development and environmental sustainability. This presentation provides some research results of our group in natural and environmental hazard modeling and prediction using advanced soft computing and geospatial technology with case studies in Vietnam. We focus on how advanced soft computing, machine learning, and optimization have been formulated for spatial/temporal prediction of landslides, flash floods, forest fires, soil salinity in various prone areas in Vietnam. Also, some recent results relating to the prediction of soil shear strength and the deformation forecasting of the hydropower dam in Vietnam's engineering projects will be presented. Finally, some discussions on using real-time monitoring and state-of-the-art technology, i.e., IoT, sensors, and big geospatial technology, for natural and environmental hazard modeling and prediction will be provided.

***Speaker Biography**: Dieu Tien Bui is currently a full professor at the GIS group, Department of Business and IT, University of South-Eastern Norway (USN), Telemark, Norway. He is a representative of the National Norwegian IAG Geomorphology Group (GeoNor) members at Norwegian universities and is a global highly cited researcher 2019, ranking among the top 1% by citations for Cross-Field in Web of Science. Besides, he is an editorial board member of scientific journals, Geomorphology, Remote Sensing, Journal of Mountain Science, and Vietnam Journal of Earth Sciences. He received the M.Sc. degree in Cartographic Engineering from Hanoi University of Mining and Geology, Hanoi, Vietnam, in 2004, and the Ph.D. degree in Geomatics at Norwegian University of Life Sciences (NMBU), Ås, Norway, in January 2013. He was a post-doctoral researcher at NMBU between 2013-2014. In 2008, he was a geospatial analyst at Ugland IT Group, a geographic information services company in Lysaker, Oslo, Norway. From 2004 to 2007, he was a university lecturer at the Faculty of Surveying and Mapping, Hanoi University of Mining and Geology. He has more than 200 publications, and out of them, >180 articles were published in Science Citation Index (SCI/SCIE) indexed journals, two edited books published by Elsevier and two conference proceeding books published by Springer. He is a reviewer for more than 30 SCI/SCIE journals. His research interests are GIS and geospatial information science, remote sensing, and applied artificial intelligence and machine learning for natural hazards and environmental problems, such as landslide, flood, forest fire, ground biomass, and structural displacement.*

COMPUTATIONAL MODELLING OF 3D PRINTED LATTICE STRUCTURES

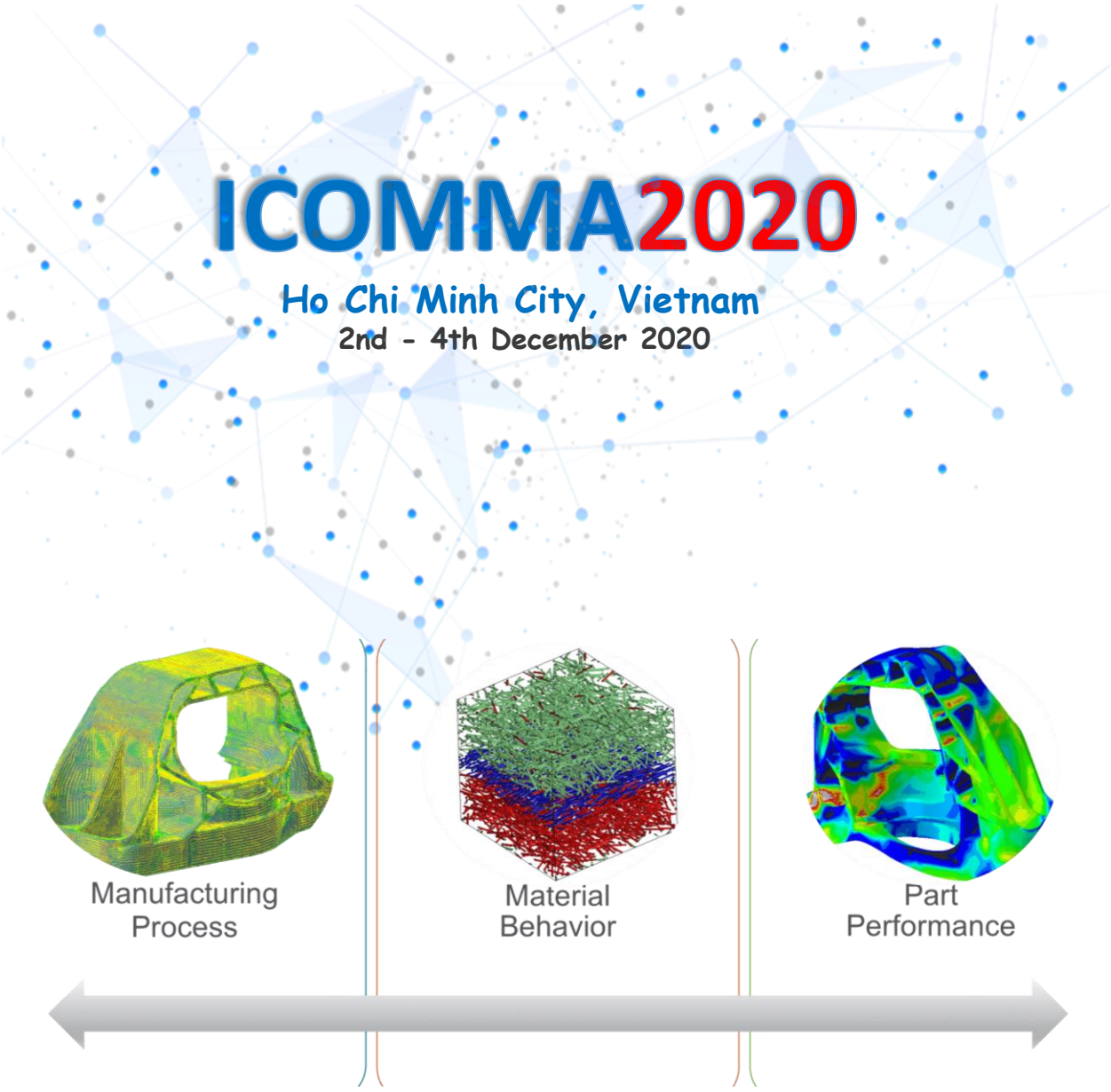
Jonathan Tran

Senior Lecturer, Royal Melbourne Institute of Technology, Melbourne, Australia

ABSTRACT

In lightweight engineering, there is a constant quest for low-density materials featuring high mass-specific stiffness and strength. 3D printing lattice structure, which allows controlling of density and mechanical behaviours of lightweight component is recently popular research topic in Additive Manufacturing for defence, automotive, biomedical etc. However, it is important to consider the manufacturing defects to computational models of 3D-printed lattice structures improve simulation accuracy. A computational model of a cellular structure based on finite element method (FEM) analysis, often starts from defect-free computer-aided design (CAD) geometries to generate discretised meshes. Such idealised CAD geometries neglect imperfections, which occur during the additive manufacturing process of lattice structures, resulting in model oversimplification. This research aims to incorporate manufacturing defects in the strut elements of a lattice structure, thereby enhancing predictive capabilities of models. In this work, a method of generating CAD AM representative strut models is proposed. The models are generated from micro-computer tomography (μCT) analysis of SLM fabricated struts. The proposed additive manufacturing (AM) representative strut FE model's axial stiffness and critical buckling load is compared to idealised- and μCT- based FE models, with significant error reduction over idealised strut models. The AM representative strut models are then used to generate full lattice FE models and compared with manufactured and idealised FE models. The AM representative FE lattice models show greater correlations toward experiment and more realistic deformation behaviours.

***Speaker bio**: Dr Jonathan Tran is a senior lecturer in the Department of Civil and Infrastructure Engineering, and member of the Centre for Additive Manufacturing, School of Engineering, RMIT University since May 2018. His research interests lie at the interface between solid mechanics and materials engineering with the aim to develop novel materials that exhibit paradigm-shifting properties for extreme loading protection that can impact the general field of infrastructure and lightweight structural materials. Dr Tran received his Ph.D. in Theoretical & Applied Mechanics from University of Illinois, Urbana Champaign, USA and then worked as a postdoctoral researcher at Northwestern University, USA. Dr Tran has supervised over 10 Ph.D. students with three completions. He has published three book chapters and over 80 refereed journal articles. Dr Tran and his Ph.D. students were awarded a number of best paper prizes for their research on computational mechanics and shock & impact on structures.*



ADDITIVE MANUFACTURING

STUDY, DESIGN AND MANUFACTURE DETAILS OF CRANIAL IMPLANTS USING ADDITIVE MANUFACTURING SLA TECHNOLOGY

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Key words: *Three-dimensional (3D) printing, Additive manufacturing (AM), 3D scanning, stereolithography apparatus (SLA), Computer-Aided-Design, molding, patient-specific implant, PMMA, selective laser melting*

ABSTRACT

Currently, additive manufacturing (AM) is one of the important technologies of the industrial revolution 4.0. Until now, there are many AM methods, but stereolithography apparatus (SLA) was the first technology invented by Charles Hull in 1984 and commercialized in 1987 by the 3D Systems company. The purpose of this paper is to present the results of research on SLA and apply in transplant surgery to 20 patients at Cho Ray Hospital, Gia Dinh People's Hospital, and 115 Hospital. The operation of AM SLA, the manufacturing process of skull implantation details created by AM SLA technology. The important steps are: reverse-engineering the medical model from CT data to create a 3D model of the cranial defect. From the cranial model, the 3D model of the implant will be designed. The implant is made by manual plaster mold or a plastic mold (machined on a CNC machine). The research results have supported doctors to make implants for 20 patients in 3 hospitals.

AN APPLICATION OF JOHNSON-COOK DAMAGE MODEL IN SMALL PUNCH TEST SIMULATION FOR TYPE-304 AUSTENITIC STAINLESS STEEL

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ABSTRACT

Among stainless steels, type 304-austenitic stainless steel has a wide application in industries because of its high corrosion resistance as well as good mechanical properties such as high strength and good ductility due to the mechanism of strain-induced martensitic transformation. Also, the steel is expected to have excellent fracture toughness, especially at high deformation rate. Although the steel is attracted the considerable attention of scientific community, the mechanism of martensitic transformation during plastic deformation and its effect on fracture toughness of type-304 austenitic stainless steel has been examined insufficiently. Meanwhile, the small punch test has been recognized as a reliable testing method for examination of fracture-mechanical characteristics of the material. In this study, a computational simulation using finite element method for small punch test is performed in order to investigate the fracture-mechanical characteristics of type-304 stainless steel at deformation rate of 0.3 mm/s under the quasi-static condition. An application of modified Johnson-Cook damage model is conducted based on two assumptions that the fracture occurs in the only austenitic phase or the martensitic phase. The obtained results show that an incorporation of damage model is indispensable. Moreover, in the case of very low deformation rate, a large amount of the martensitic phase is transformed in the upper surface of the specimen around the necking region where might appear the initial crack. It is considered that an incorporation of damage model should be examined for martensitic phase rather than for austenitic phase.

Key words: *Austenitic stainless steel, computational simulation, damage model, small punch test*

DESIGN AND FABRICATE TRANSMISSION MECHANISM ARM OF THE ROTATIONAL MOULDING

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Key words: *Transmission crank, thermal forming, Additive interactions; Antioxidants; Polyethylene; Stabilization; Discoloration; Long-term Stability and Rotational Molding. waste management; wood polymer composites; recycling*

ABSTRACT

Compared with blow molding and thermoforming technology, rotary die technology has many advantages for manufacturing hollow plastic products. The purpose of this paper is to compute and design the transmission crank mechanism of the rotary die machine. On the basis of comparative analysis of other types of rotary die machines such as Rock & roll Machine, Clamshell Machine, Implependent Arm Carousel Machine (these words are in the article… ..). The authors chose a reasonable solution to design the experimental model to produce flower pots with dimensions of 1000 x 400 x 400 mm. The principle diagram and the dynamic diagram of the machine are presented. Computation and design of main clusters and hand fabrication of the rotary die machine are investigated. The model of the transmission crank mechanism is fabricated to verify the validity of the proposed model. In the future, this manipulator will be integrated into the heating and cooling chamber system.

ANALYSIS OF THE IMPACT OF PONDS LOCATIONS IN FLOOD CUTTING FROM A DEVELOPING CITY IN VIETNAM

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ABSTRACT

With the expansion of imperviousness due to urbanization, flooding frequency and intensity are more likely to increase in many cities [1]. The application of ponds and lakes has seemed like one of a sustainable alternative solution to abate flow urban and developing areas. The fact that design parameters and management procedures of the stormwater conveying system are strongly dependent on local conditions, which resulting in difficulty in choosing the most appropriate plan for pond and lakes design [2]. Thus, this research compares performances of a drainage system by simulation in the Stormwater Management Model (SWMM) under the climate conditions of Quang Ngai city, located on the Central Coast of Vietnam [3]. Results represent that multi-ponds scenarios are more efficiencies than single points scenarios in reducing risks of flooding. Compare to single pond scenarios, water levels of the multi-ponds system increase slightly in upstream while reducing significantly in downstream areas. The study provides an insight into selecting and locating of ponds and lakes in the planning of stormwater management systems.

AN ASSESSMENT OF TERRAIN QUALITY AND SELECTION MODEL IN DEVELOPING LANDSLIDE SUSCEPTIBILITY MAP – A CASE STUDY IN MOUNTAINOUS AREAS OF QUANG NGAI PROVINCE, VIETNAM

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Key worlds: *Digital Elevation Map, Analytic Hierarchy Process, Frequency Ratio, Area Under the Curve, Landslide Density, Quang Ngai*

ABSTRACT

Landslide is one of the most natural disasters in Vietnam especially in mountainous areas, so studying and developing a landslide susceptibility map would make a significant contribution to authorities taking initiative in landslide prevention and mitigation. The quality of input data and the choice of model building methods are two very important impacted factors to accuracy the produced map [1]–[26]. This study will focus on investigating the influences of terrain data, which is a significant causative factor on landslides, by application of two landslide spatial analysis methods: Analytic Hierarchy Process (AHP) [1]–[10] and Frequency Ratio (FR) [11]–[18]. Conducting the investigation with three free sources of Digital Elevation Map (DEM) in mountainous areas of Quang Ngai province has shown that NasaDEM performs better than the other DEM (TanDEM-X90 and STRM). A total of 339 landslide points was collected in this area, they were then randomly split into two parts to generate training (70%) and testing (30%) datasets. Seven affecting factors were selected, including slope, aspect, soil types, land use, distance to roads, distance to rivers, and rainfall. Performances indexes - Untainted Area Under the Curve (AUC) and Landslide Density (LD) - confirm that two methods are appropriate for producing landslide susceptibility maps. Meanwhile, analyzing using the FR would get better AUC and LD index compared to the AHP.

EXPERIMENTAL AND NUMERICAL INVESTIGATIONS ON THE FRACTURE RESPONSE OF TUBULAR T-JOINS UNDER DYNAMIC MASS IMPACT

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Key words: *Tubular T-joint, impact test, numerical simulation, fracture response*

ABSTRACT

This research reports a series of experimental and numerical investigation results on the fracture responses of the T-joints of H-shaped tubular structures under dynamic lateral mass impact. The considered scenarios are the collisions of bracing offshore tubular members (floating production storage and offloading (FPSO) or semi-sub tripod offshore wind turbine support structures) with bow and stern of service vessels or floating objects. Drop-weight tests were conducted with a knife-edge indenter on eight H-shaped tubular member models by changing the dimensions, impact velocity, and striker mass. The details of experimental setups and test results are provided. Finite element analyses of the impact responses of the test models were also performed using the Explicit solver of the ABAQUS Software. A close agreement between the test results and numerical predictions was achieved. Based on the results, two different failure modes of the T-joints of H-shaped tubular structures are discussed.

DYNAMIC ANALYSIS OF A FUNCTIONALLY GREDED SANDWICH BEAM TRAVERSED BY A MOVING MASS BASED ON A REFINED THIRD-ORDER THEORY

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Key words: *FGSW beam, refined third-order theory, moving mass, micromechanical model, dynamic finite element analysis.*

ABSTRACT

Dynamic analysis of a functionally graded sandwich (FGSW) beam traversed by a moving mass is presented in the basis of a refined third-order shear deformation theory. The beam consists of three layers, a homogeneous core and two functionally graded skin layers with material properties varying in the thickness direction by a power gradation law. Both Voigt and Mori-Tanaka micromechanical models are employed to evaluate the effective properties of the beam. A finite element formulation, taking into account the effect of inertial, Coriolis and centrifugal forces, is derived and used in combination with Newmark method to computed dynamic response of the beam. The accuracy and efficiency of the derived formulation are confirmed by comparing results obtained in the present work with the published data in Refs. [1,2,3]. The effects of material gradation, the moving mass speed and the beam geometry on the dynamic behavior of the BFGSW beams are examined and highlighted. The influence of the micromechanical model on the dynamic response of the beam is also examined and discussed.

STUDY ON DESIGN OF DLP 3D PRINTER CONTROL SYSTEM

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Keywords: *3D Printer, Photopolymerization, Digital Light Processing*

ABSTRACT

This article illustrates the result of DLP 3D printer control system research. DLP (Digital Light Processing) 3D printing uses photopolymerization to create 3D objects. Understanding of photopolymerization process helps to deal with common problems that make your prints fail or that reduce print quality. 3D printing technologies based on DLP printing are frequently used for fabricating complex objects without tooling and machining. DLP printing involves the light-mediated conversion of a liquid resin containing monomer or oligomer photopolymers to a solid object. This process leverages the versatility of polymer chemistry to make complex objects with programmable optical, chemical, or mechanical properties. Versatility underpins the popularity of polymer materials within the 3D printing community, encouraging research in photopolymer chemistry and printing applications. In this paper, we use 3D printer models and DLP scanner to export the layer images of objects in the solidifying plastic process. The scanner is manipulated by a computer embedded Raspberry Pi model B plus. Vertical axis motions in the maximum range approximate 200 mm, associates with an elevator that moves the platform upwards to separate the sample in resin tank, and shutter play a role to turn on the scanner. The control system is operated through Arduino Mega 2560 microcontroller and computer embedded Raspberry Pi model B plus.

PROJECT BASED TEACHING SKILLS FOR THE COURSE: DESIGN OF ADDITIVE MANUFACTURING SYSTEM

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Keywords: *AM technology, SLA, SLS, LOM, FDM, Reprap*

ABSTRACT

Additive Manufacturing (AM) technology is one of the key technologies in smart factories of the 4.0 industrial revolution. Design of Additive Manufacturing System is a compulsory subject in the undergraduate training program of mechatronics of Van Lang University. The paper presents the authors' experiences of over 15 years of teaching this course at Van Lang University and similar courses at the Faculty of Mechanical Engineering, Ho Chi Minh University of Technology; the Faculty of Mechanical Engineering, Nha Trang University and the Department of Mechanical Engineering, Can Tho University; as well as the content innovation and upcoming teaching methodologies at Van Lang University. The course content focuses on AM technologies such as: StereoLithography Apparatus (SLA), Selective Laser Sintering (SLS), Laminated Object Manufacturing (LOM), Fused Deposition Modeling (FDM), 3D – Printing (3DP), and some others. Students are equipped with basic knowledge of history, generation development, operating principles and equipment of each technique, as well as basic skills to redesign AM machines through case studies. In addition, RepRap is also presented to students. The course uses both problem-based and project-based pedagogies to present students with opportunities to gain hand-on experience with the AM technologies [1,2,3,4,5,6].

STRATEGY AND A ROADMAP OF ADDITIVE MANUFACTURING IN VIET NAM PERIOD 2021 – 2045

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Key words: *Additive manufacturing, AM development, strategy and roadmap of AM, 4.0 industrial revolution.*

ABSTRACT

Additive Manufacturing (AM) Technology is currently one of the core technologies that have a decisive relationship with other technologies in the 4.0 industrial revolution. The technological World has gone through the stages of technological development from the industrial revolution 1.0 to 4.0. These development stages can be listed as: the platform of manual production (1800 to 1913); the mass production (1913 to 1980); the mass production line (1980 to 2000), and the personalized, regionalized and globalized production (2000 onwards). And today, thanks to promoting the effectiveness of AM Technology, manufactured products have responded quickly and promptly satisfied the needs of consumers. The purpose of this article is to confirm the important role of AM Technology in the Industrial Revolution 4.0. On the basis of research overview documents about development strategy as well as mutual development roadmap of AM Technology in the World, authors propose the Strategy and roadmap of additive manufacturing Vietnam period 2021 – 2045. This strategy is built in 3 phases:

Short-term strategy: from 2021 to 2025

Medium-term strategy: from 2026 to 2030

Long-term strategy: from 2031 to 2045

In the AM development roadmap, there are proposals for orientations for key researches focusing on fields of technology and application of AM. Themes and projects are built in stages, corresponding to funding for each topic or project. In addition, an AM workforce training plan is designed to train: engineers, masters, and doctors, as well as short-term training courses for businesses / companies. The final result of this project is a report on strategy and roadmap for AM development in the period 2021-2045 with all related aspects [1,2,3,4,5,6,7,8].

DESIGN - FABRICATION AM - REPRAP EQUIPMENT USING FUSED DEPOSITION MODELING (FDM) FOR TRAINING

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Key words: AM - *Additive Manufacturing, FDM - Fused Deposition Modeling, Reprap, Training*

ABSTRACT

Additive Manufacturing (AM) is an important technology in the industrial revolution 4.0. AM technology produces products according to the principle of adding and linking layer by layer materials, including typical technologies such as: Stereolithography (SLA), Selective Laser Sintering (SLS), Laminated Object Manufacturing (LOM), Fused Deposition Modeling (FDM) ... Currently, in addition to industrial AM equipment costing from a few tens to several hundred thousand dollars, open-source AM equipment (Reprap), priced from several hundred to several thousand dollars, is being widely applied in many fields, especially in the field of education - training. With the aim of approaching and grasping the educational trend in the industrial revolution 4.0, the authors have researched, designed and manufactured open-source AM equipment using FDM technology for training to help students have access to a new manufacturing technology as well as increase practical skills in the learning process in the higher education environment. The article presents the contents of survey, analysis, design, manufacturing and assembly of mechanical systems (Machine frame assembly, XY drive assembly, extrusion head assembly ...) and the device's controller. Conduct experiments to determine the optimal technology parameters as well as build experiments and practices for students at Van Lang University, Ho Chi Minh.

APPLIED RESEARCH REVERSE ENGINEERING AND CAD/CAM/CNC TO MACHINING MOLDS FOR SKULL IMPLANTS

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Key words: *CAD/CAM/CNC, Stereolithography (SLA), Reverse engineering, Implant*

ABSTRACT

According to statistics in recent years, about 7,000 people have a traffic accident every year, the majority of which are traumatic brain injuries. Up to now, almost all hospitals in the country perform the process of making skull graft for patients by hand. Therefore, the pieces are often inaccurate, are not highly aesthetically pleasing, prolong the time of surgery and depend entirely on the skills of the treating doctor. The purpose of the paper is to introduce a study of reverse engineering to medical model design (puzzle piece) and use of CAD/CAM/CNC technology to design molds for cranial graft, at the same time, demonstrates the process of fabricating the puzzle piece using a plastic mold machined on a CNC milling machine. The authors compared the time between mold making with CNC milling machines and making gypsum molds with samples made using SLA technology for 20 patients at 3 major hospitals: Cho Ray Hospital, Hospital 115 and Gia Dinh People's Hospital.

CALCULATION AND DESIGN DYNAMOMETERS FOR SINGLE POINT INCREMENTAL FORMING (SPIF)

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Keywords: *Single Point Incremental Forming, Sheet metal, Forming*

ABSTRACT

Single Point Incremental Forming (SPIF) is a new sheet metal forming method that parts can be formed without using specialized dies. When the tool tip contact the sheet metal blank surface, it acts three component forces $\boldsymbol{F_x}$, $\boldsymbol{F_y}$, $\boldsymbol{F_z}$ on the blank along three axis. There are many types of dynamometer that can be used to measure the forces but ineffective.

The highlight of this paper is propose a method of calculation and design of the octagonal ring dynamometers using strain gage and the range of measure is 0÷3500 N. The dynamometer using four elastic octagonal ring made form AISI 4140 has dimensions: width b=20 mm; radius: r=16 mm; thickness: t=4mm with 16 strain gages mounted on its forming a Wheatstone bridge. Besides, this paper also establish an amplifier using three Op-Amp.

CRYSTAL STRUCTURE AND MECHANICAL PROPERTIES OF 3D PRINTING PARTS USING BOUND POWDER DEPOSITION METHOD

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Key words: *Metal 3D printing, additive manufacturing, bound powder deposition, bound powder extrusion, binder jetting*

ABSTRACT

This research focuses on introduction and evaluation of machine parts manufactured by bound powder deposition method, a new approach in metal 3D printing. After a review of metal 3D printing technology, a new approach for metal printing, called bound powder deposition, is introduced. Several specimen manufactured by the bound powder deposition are then conducted for experimental works. In the experimental works, the crystal structure of the printed part is investigated. In addition, typical mechanical proprieties of the printed part produced by the bound powder deposition are tested and compared with other those produced by other 3D printing and metallurgy methods.

COMPUTATIONAL DYNAMICS

A STUDY ON COMBINATION OF TWO HIGH DAMPING RUBBER DAMPERS TO CONTROL STAYED-CABLE VIBRATION CONSIDERING ITS BENDING STIFFNESS

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Key words: *High Damping Rubber Damper, stayed-cable, damping ratio, spring constant, loss factor.*

ABSTRACT

Stayed-cables are the critical component of a cable-stayed bridge. During the bridge operation, stayed-cables are commonly forced to vibrate with a large amplitude under dynamic loads, for example wind, coupled rain wind or live loads, etc.; this leads to the fatigue failure mode of the stayed-cables. Damping devices such as Viscous Damper, Friction Damper or High Damping Rubber Damper are one of the most effective equipment used to increase damping ratio of stayed-cables. This study aims to focus on a solution approach of using two combined High Damping Rubber Dampers with the aim of increasing the stability of stayed-cables and investigating the impact of design parameters of High Damping Rubber Dampers on their vibration reduction capacity, where the bending stiffnes of the stay-cables is taken into account. The comparative analysis results show that parameters of the damper device system such as spring constant, loss factor and location of dampers have a significant effect on the damping ratio of stayed-cables. Based on the study results, the optimal parameters of the two High Damping Rubber Dampers and their locations can be chosen and used for the future design.

EFFECT OF ROAD ROUGHNESS ON DYNAMIC IMPACT FACTOR OF CABLE-STAYED BRIDGE SUBJECTED TO MOVING VEHICLE

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Key words: *Dynamic impact factor, cable-stayed bridge, moving vehicle, road roughness.*

ABSTRACT

In this study, a two-dimensional vehicle-bridge dynamic interaction model is used to analyze the dynamic impact factor of cable-stayed bridge in service by considering the effect of the random road surface roughness. Cable-stayed bridge is idealized by an overall system including: girder, towers and cables. The finite element method is used to discrete the structural bridge. The common model of random road roughness vertical profiles are applied in the form of a stationary and ergodic Gaussian process in space. Random samples of road roughness vertical profiles are generated with the Monte-Carlo simulation method. A two-dimension vehicle model with 4 degrees of freedom is adopted. Based on the d'Alembert's principle, the coupled equation of motion of cable-stayed bridge and vehicle are established by combining of both the bridge and vehicle using the interaction force relationship at the point contact. Solutions of the coupled equation of motion in the time domain are solved using Runge-Kutta-Mersion method. The accuracy of numerical results are validated by field test results of cable-stayed bridge at PhoNam bridge, Danang city, Vietnam. Additionally, the influences of random road roughness on dynamic impact factor of cable-stayed bridge were discussed detail. The results of dynamic impact factor study show that bridge design codes currently underestimate the dynamic response of the bridge for moving vehicle under different road surface conditions. The findings of this study can be utilized for the future design.

DYNAMIC ANALYSIS OF CURVED BEAM ON ELASTIC FOUNDATION SUBJECTED TO MOVING OSCILLATOR USING FINITE ELEMENT METHOD

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ABSTRACT

This paper presents the finite element algorithm and results of the dynamical analysis of the curved beam on the elastic foundation (modeled by Winkler foundation) subjected to moving oscillator in which the beam with constant cross-section and three dimensional (3D) beam elements were used. In this study, the inertial forces due to the moving oscillator on the curved beam were also considered. There are many surveys considering the dynamic response of the curved beam when there is a change in the number of moving oscillators, the velocity of the loads, stiffness of the foundation, and curvature of the beam. The numerical survey results have shown that the effect of beam curvature and inertial forces due to the moving mass on the beam's vibration is significant. The results of this study can be used as a reference for calculating and designing traffic structures such as railways, bridges.

Key words: *dynamic, curved beam, moving oscillator, foundation.*

BUCKLING ANALYSIS OF FG GPLRC PLATE USING A NATURALLY STABILIZED NODAL INTEGRATION MESHFREE METHOD

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ABSTRACT

This study presents a meshfree approach using a naturally stabilized nodal integration (NSNI) combined with a higher-order shear deformation theory (HSDT) for buckling analysis of functionally graded graphene platelets reinforced composite (FG GPLRC) plates. Various types of distributed graphene platelets (GPLs) consisting of uniform and functionally graded are considered. The Poisson's ratio, density and Young's modulus are calculated by using the rule of mixtures and modified Halpin–Tsai model, respectively. Discretize governing equations are deduced from the principle of virtual work and solved by a moving Kriging (MK) meshfree method to determine buckling load factor of the FG GPLRC plates. Due to using the direct nodal integration and augmenting of stability components, the computational cost is reduced when comparing to the high-order Gauss quadrature scheme. Through numerical examples, the buckling load factor of FG GPLRC plates are affected by the geometries, boundary conditions and distributed patterns of GPLs.

Keywords: *Graphene platelets reinforced composite (GPLRC); moving Kriging meshfree method; NSNI, HSDT.*

FREE VIBRATION OF A BI-DIRECTIONAL IMPERFECT FUNCTIONALLY GRADED SANDWICH BEAMS

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Key words: *a bi-directional functionally graded material, a high-order shear deformation theory, porous, free vibration, finite element method.*

ABSTRACT

In this paper, the free vibration of a bi-directional functionally graded (2D-FG) porous sandwich beams is studied based on a high-order shear deformation theory. The upper face of the sandwich beam is made of 2D-FG porous, the lower face is made of ceramic and the core is made of one-dimensional functionally graded (1D-FG) porous. The material properties of a bi-directional FGM porous beam are assumed vary in both axial and thickness directions according to a power law. The finite element method is used to discretize the model and to compute the vibration characteristics of the sandwich beams. The accuracy of the derived formulation is confirmed by comparing the obtained results with the published data. A parametric study in carry out to show the effects of the porous parameter, material distribution on the natural frequencies of the sandwich beams are examined and discussed.

A HIGH-ORDER TIME FINITE ELEMENT METHOD APPLIED TO STRUCTURAL DYNAMICS PROBLEMS

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Key words: *High-order time finite element, structural dynamics, variational formulation, accuracy*

ABSTRACT

The article proposes a high-order time finite element method based on the well-posed variational formulation that is equivalent to the conventional strong form of governing equations of structural dynamics. Three cases related to the term "high-order" include: the time finite element that is analoguous to the spatial second-order beam element; the p-power of the time-to-go (T-t) in the formulation of the "stiffness" matrix and of the "nodal force" vector; and the combination of both of them. In each cases, the element "stiffness" matrix and the element "nodal force" vector are established. Through numerical examples, the accuracy in the results of some selected problems obtained by using three formulations of time finite elements is studied and discussed.

EFFECTS OF THE COMPUTATIONAL DOMAIN SIZES ON THE SIMULATED AIR FLOW IN SOLAR CHIMNEYS

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Key Words: *Natural ventilation, solar chimney, thermal effect, computational domain, CFD.*

ABSTRACT

Solar chimneys absorb solar energy to create stack effects which induce air flow for natural ventilation of buildings. Numerical models based on Computational Fluid Dynamics (CFD) have been increasingly utilized to simulate air flow and heat transfer in solar chimneys [1,2]. One of the factors influencing the accuracy of the CFD models for solar chimneys is the size of the computational domain. In this study, the effects of the sizes of the computational domain for a vertical solar chimney were investigated. Two sizes of the domain were tested, as suggested in the literature [1]: A small domain which has the same physical size as a cavity inside the solar chimney and an extended one that covers both the cavity and the ambient air. The predicted air flow rate and thermal efficiency have been found to depend on not only the dimensions (height and the gap of the air channel) and the heat flux in the chimney but also the size of the domain. The results showed that the extended domain can provide more accurate predictions of the air flow and particularly the reversed flow at the outlet of the chimney compared to experimental results [3]. The main reason for the incorrect prediction of the air flow rate with the small domain was found due to the overprediction of the reversed flow at the outlet of the solar chimney**.**

A SOLAR CHIMNEY FOR NATURAL VENTILATION OF A THREE – STOREY BUILDING

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Key words: *Solar chimney, flow rate, thermal efficiency, natural ventilation, CFD*

ABSTRACT

Energy consumption of buildings can be significantly reduced with appropriate design for natural ventilation, particularly based on solar energy. Solar heat gain on the building envelope can be converted into thermal effects to induce air flow for natural ventilation or cooling of the building interior and the building envelope. For the ventilation application, the solar chimney should provide sufficient air flow rate. In this study, we investigated a solar chimney for ventilation of a three – story building. The chimney was assumed to be integrated into the building envelope and connected to all three stories of the building. To predict the air flow rate induced by the chimney through each story, a computational model was built based on the Computational Fluid Dynamics (CFD) method. By changing the design parameters (location and dimensions) of the chimney, ventilation rate through each story was computed. Temperature distribution in the chimney and the thermal efficiency of the chimney were also obtained for different design scenarios. From the results, the optimal design of the chimney which can provide similar ventilation rate for all three stories was found. This study can serve as a demonstration for applications of the CFD technique in design of sustainable buildings.

NATURAL VENTILATION AND COOLING OF HOUSE WITH A SOLAR CHIMNEY COUPLED WITH EARTH – TO – AIR HEAT EXCHANGER

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Key words: *Solar chimney, earth-to-air heat exchanger, ventilation, CFD*

ABSTRACT

A combination of solar chimney and earth – to – air heat exchanger (EAHE) for natural ventilation and cooling of a house was studied numerically in this study. The solar chimney creates an air flow through the house based on the solar heat gain. The EAHE consists of underground pipes which are cooled by the earth temperature, which is sufficiently lower than the air temperature at the ground level in hot climate. By combining the two systems together, ambient air can be drawn into the EAHE, cooled, then supplied to the house. The air flow and heat exchange of the system and in the house were predicted by a numerical model based on the Computational Fluid Dynamics method. Flow and velocity fields inside the chimney, the house, and the EAHE were predicted with different design parameters of the system, including the dimensions of the chimney and the pipes, location of the air supply to the house, and the solar heat flux. Induced air flow rate, air temperature supplied to the house, and distributions of the air velocity and temperature inside the house were considered. From the results, the optimal design of the system to achieve thermal comfort conditions in the house was found.

DYNAMIC ANALYSIS OF LIQUID STORAGE TANK UNDER SEISMIC CONSIDERING FLUID-STRUCTURE INTERACTION IN 2-WAYS

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ABSTRACT

Recent natural disasters such as the 2011 Tohoku, Japan and 2012 Emilia, Italia earthquakes and tsunamis have increased the importance of simulating fluid-structure interaction (FSI) among structural engineering researchers and practitioners, and it's necessary to take the elasticity of tank walls into account in the researches of sloshing phenomenon. In this study, a coupled finite volume and finite element method is suggested to numerical analysis of elastic structural response due to the impact loads of sloshing flows. To validate the feasibility of the suggested method in dealing FSI problems, a benchmark of a water tank subjected harmonic loading with resonance frequency then the flow interacting with elastic lateral wall is studied firstly and results show good agreement with experiment. Then, the sloshing phenomenon in an elastic tank is numerically investigated. By varying the thickness of tank walls, interesting characteristics regarding evolutions of free surface, variation of impact pressures, dynamic responses of the structures in both time and frequency domains are presented.

Keywords: Finite volume method, Fluid structure interaction, Flexible tank wall, Seismic design.

INVESTIGATION OF MOTION CHARACTERISTICS OF FISSHING VESSEL IN IRREGULAR WAVES IN VIETNAM

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Key words: *Fishing vessel, irregular waves, kinematic characteristics, sea sickness.*

ABSTRACT

A ship undergoes at sea is dependent on the interaction between the forces and moments due to waves. Wave-induced ship can be evaluated by the means of semi-empirical formulae, experimental method, fluid computational method or potential method [1,2,3,4,5]. The semi-empirical formulae are the most convenient method for estimating the ship motion characteristics but these are not taking account for specific hull shape. The computational fluid dynamic method is also developed to analyze the ship motion in waves, however it is time-consuming. Experimental method is considered as the most accurate method to investigate the ship behavior in waves. However, it also has some disadvantages such as the limitation of facilities that not allows to generate irregular waves in basin. On the other hand, potential methods have advantages that can compromise the difficulties. It can model the ship in irregular waves with good accuracy and speedily as well. This paper addresses to the motion characteristics of Vietnamese fishing vessel under the irregular wave conditions in order to identify limited operation of the vessel in certain sea states. Ship motions and derived responses are analyzed in fully developed sea states by using the numerical simulation method. Potential flow approach is adopted to determine transfer functions of the full-scale hull in various directions of regular waves. The motion responses of the vessel in irregular waves are then obtained by integrating the transfer functions over the wave spectral in order to assess behaviors of the vehicle that might result in seasickness or hazards. .

FREE VIBRATION OF PRESTRESS TWO-DIMENTIONAL IMPERFECT FUNCTIONALLY GRADED NANO BEAM PARTIALLY RESTING ON ELASTIC FOUNDATION

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ABSTRACT

In this paper, the free vibration of prestress two-dimentional imperfect functionally graded (2D-FG) nano beam partially resting on a Winkler foundation is investigated by finite element method. The material properties of 2D-FG nano beam are assumed vary in both axial and thickness directions according to a power law. Based on Eringen nonlocal elasticity theory, the governing equations of motion are derived. A parametric study in carry out to show the effect of material distribution, nonlocal effect, perstress and elastic support on the natural frequencies of the beams. The finite element method is employed to establish the equations and compute the vibration characteristics of the beam.

Key words: *two-dimentional imperfect functionally graded, nanobeams, nonlocal model, elastic foundation, free vibration, finite element method.*

VIBRATION AND DYNAMIC IMPACT FACTOR ANALYSIS OF THE STEEL TRUSS BRIDGES SUBJECTED TO MOVING VEHICLES

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ABSTRACT

The problem of dynamic response of a structure subjected to moving loads is important. A lot of research on structural analysis of girder, truss and cable-stayed bridge has been published by many authors [1-8]. Studies on the structure of steel truss bridges were also investigated, however to a lesser extent. This paper presents some analysis results of vibration and dynamic impact factor of the steel truss subjected to moving vehicle by numerical method. The moving load model is the three-axle vehicle with each axle modeled by two masses and each mass is linked to a spring and a damping. The numerical analysis results of the vehicle-bridge interaction model with and without of internal and external friction coefficient of the structure are similar to the basic dynamics and bridge model subject to moving loads. The amplitude of vibration and internal force of the structure when considering the coefficient of friction is significantly reduced compared to the case without consideration. Furthermore, the dynamic impact factors of displacement, shear force, axial force and bending moment change significantly as the vehicle speed varies.

Key words: *Vibration, dynamic impact factors, steel truss bridge, moving loads, vehicle-bridge dynamic interaction, numerical methods.*

DYNAMIC IMPACT ANALYSIS OF GIRDER BRIDGE DUE TO VEHICLE LOAD MODEL AND DESIGN CODES

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Key words: *Dynamic impact factors, three-axle loading, tire stiffness, suspension, bridge-vehicle dynamic interaction*

ABSTRACT

In the design codes, the dynamic effects of moving vehicle bridges are designed to withstand static loads that are recommended an increment by dynamic impact factors (DAFs) (or dynamic amplification factors) that are a function of either the span or the first flexural natural frequency of the bridge. The previous studies showed that when analyzing with the difference of the bridge-vehicle dynamic interaction model, the results of different DAFs are obtained [1,2]. Recent studies of the DAFs tend to use an interaction model between multiple-mass vehicle and bridge structure which is more and more similar to the real model [3,4,5]. This paper is to investigate the dynamic response of girder bridge subjected to moving loads by finite element method (FEM) and using bridge design codes. The analysis is based on a continuum girder bridge, in which the vehicle model is from a single-axle loading to a three-axle loading with each axle is modeled in two masses, each mass is linked to a spring and a damping corresponding to the part of the tire and suspension. Based on the dynamic analysis of the bridge under the vehicle loading, which is assumed to have tire stiffness and suspensions, the authors conducted the effects of tire stiffness and suspensions on the DAFs of the girder bridge. The evaluations of this study are expected to help bridge engineers to design girder bridges more reliably and can also be used to reassess the safe live-load capacity of existing bridge structures.

DESIGN AND HYSTERESIS MODELING OF A NEW DAMPER FEATURING SHAPE MEMORY ALLOY ACTUATOR AND WEDGE MECHANISM

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Key words: *SMA actuator, SMA spring, SMA damper, hysteresis model, structural vibrations*

ABSTRACT

This study aims at design and hysteresis modeling of a novel damper featuring shape memory alloy (SMA) to mitigate structural vibrations. The damper consists of SMA springs for actuation and a wedge mechanism to amplify and convert the actuating force into friction against the inner cylindrical face of the damper housing. From the friction between the wedges and housing, the damping force is archived. Following an introduction of SMA spring actuators and SMA dampers, the proposed SMA damper is configured. Experiments are then conducted on SMA springs to obtain their performance characteristics such as stroke, actuating force. Based on the experimental data, a prototype SMA damper is designed and manufactured. Performance evaluation of the damper is then conducted by both calculation and experiment. From the experimental results, hysteresis phenomenon of the SMA damper is presented and investigated. To predict the damper behavior, several hysteresis models are proposed and validated with comparisons and discussions.

RAYLEIGH QUOTIENT FOR LONGITUDINAL VIBRATION OF MULTIPLE CRACKED BAR AND APPLICATION

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ABSTRACT

The Rayleigh quotient is an attractive relationship between natural frequency and mode shape of structural vibration. However, it would be useful only for approximately calculating natural frequencies of a structure by using the properly chosen trial functions of the mode shapes in case when both the modal parameters are unknown. This is completely appropriate for the case of cracked structures when an explicit expression of natural frequencies is needed for some purpose such as structural health monitoring. The present report is devoted first to establish Rayleigh quotient for longitudinal vibration in multiple cracked bars and then to involve it for calculating natural frequencies of the cracked structure by using mode shapes of uncracked one. Numerical examples are accomplished for accessing usability of various approximate expressions of the obtained Rayleigh quotient.

Key words: *Rayleigh quotient; natural frequencies; multiple cracked bar; structural health monitoring.*

FORMULAS FOR THE H/V RATIO OF RAYLEIGH WAVES IN PRE-STRAINED ELASTIC HALF-SPACES SUBJECT TO AN ISOTROPIC INTERNAL CONSTRAINT

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Key Words: *Rayleigh wave, pre-strained, isotropic internal constraint, the H/V ratio*

ABSTRACT

In the present paper, the propagation of a Rayleigh wave in pre-strained elastic half-spaces subject to an isotropic internal constraint is considered. The main aim is to derive exact formulas for the H/V ratio (the ratio of the amplitude of the horizontal displacement to the amplitude of the vertical displacement of the Rayleigh wave). First, the expression of the H/V ratio in terms of the Rayleigh wave velocity for pre-strained elastic half-spaces subject to an isotropic internal constraint is derived using the surface impedance matrix. From this expression and the secular equations of Rayleigh waves, the equation for the H/V ratio is established. It is a cubic equation. Employing the theory of cubic equations, the formula for the H/V ratio has been derived for pre-strained elastic half-spaces subject to an isotropic internal constraint. These formulas are then specified to several particular strain-evergy functions and internal constraint: Incompressibility, Bell, Areal, Ericksen. Since the obtained formulas are exact and totally explicit, they will be a good tool for nondestructively evaluating pre-strain of structures before and during loading.

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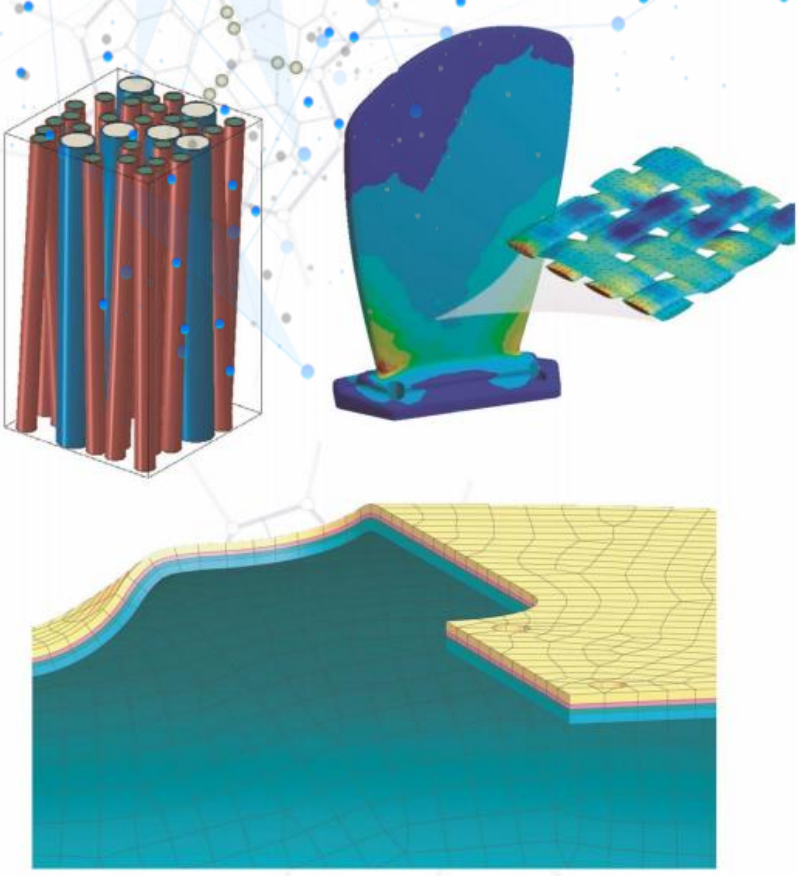

COMPOSITES AND HYBRID STRUCTURESS

LOW TEMPERATURE EFFECT ON DYNAMIC MECHANICAL BEHAVIOR OF HIGH DAMPING RUBBER BEARINGS

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Key words: *High damping rubber bearings, temperature dependence, mechanical behavior, viscosity.*

ABSTRACT

High damping rubber bearings (HDRB) is a useful seismic resistant device that is widely used in buildings due to many outstanding advantages. However, the mechanical characteristics of HDRB are complicated such as temperature-dependent, rate-dependent. This paper is devoted to investigate the low temperature dependence of HDRB's mechanical behavior. For this purpose, the experiments on HDRB conducted at -30^{o}C, -10^{o}C, and 23^{o}C is to investigate the low temperature dependence of mechanical behavior of HDRB. A numerical calculation to determine the viscosity of HDRB was conducted to investigate the low temperature dependence of HDRB's viscosity. Experimental results show that a significant increase in the rate-dependent overstress at low temperatures. This behavior can be ascribed to the temperature dependence of HDRB's viscosity. It means that the viscosity effect of the material increases when temperature decreases. In addition, the experimental observations indicate that the rate sensitivity of HDRB depends on the low temperatures. On the contrary, the dependence of the rate-independent equilibrium stress at the end of the relaxation process is quite weaker. Furthermore, the results of the numerical calculation to identify the viscosity of HDRB also agree with the conclusions obtained from the experimental observations.

OPTIMAL DESIGN OF FUNCTIONALLY GRADED SANDWICH POROUS BEAMS FOR MAXIMUM FUNDAMENTAL FREQUENCY USING METAHEURISTICS

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Key words: *Sandwich beam, functionally graded materials, porous materials, optimal design, metaheuristics*

ABSTRACT

In this paper, the optimal design of sandwich beams with a functionally graded porous core and functionally graded faces is freshly addressed. The layer thickness, porosity distribution of the core, and material volume fraction of the face sheets are optimized to obtain maximum fundamental frequency. High-order shear deformation theories are applied to analyze the fundamental frequency. The optimal design is obtained by some popular metaheuristics, including genetic algorithm (GA), differential evolution (DE) article swarm optimization (PSO) teaching-learning-based optimization (TLBO) and Jaya. Beams with different materials properties are examined. The effectiveness of the considered metaheuristics in solving the optimal design of functionally graded sandwich porous beams is explored in detail.

NONLINEAR BUCKLING BEHAVIOR OF FG-CNTRC TOROIDAL SHELL SEGMENTS STIFFENED BY FG-CNTRC STIFFENERS UNDER EXTERNAL PRESSURE

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Key words: *Functionally graded carbon nanotubes reinforced composite (FG-CNTRC), Toroidal shell segment, Nonlinear buckling, Stiffener, Elastic foundation*

ABSTRACT

An analytical approach of nonlinear buckling and postbuckling analysis of functionally graded carbon nanotubes reinforced composite (FG-CNTRC) [1-3] toroidal shell segments stiffened by ring or stringer FG-CNTRC stiffeners under external pressure taking into account the elastic foundation effect is presented in this paper. The smeared stiffener technique [4] is developed for FG-CNTRC stiffeners. Governing equations for shells are established by using the Donnell shell theory with the geometrical nonlinearity term in von Kármán sense with shell-foundation interaction formulated by Pasternak elastic foundation model. Three-term solution form of deflection is chosen, the stress function is introduced, and the Galerkin method is used to establish the nonlinear postbuckling relation. Numerical results validate the effects of stiffeners, volume fraction of carbon nanotube, type of carbon nanotube distribution of shell skin and stiffeners with different geometrical parameters, elastic foundation moduli, on the nonlinear buckling and postbuckling behaviors of stiffened toroidal shell segments.

NONLINEAR VIBRATION OF SHEAR DEFORMABLE FG-CNTRC PLATES AND CYLINDRICAL PANELS STIFFENED BY FG-CNTRC STIFFENERS

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Key words: *Functionally graded carbon nanotubes reinforced composite (FG-CNTRC), Plate, Cylindrical panel, Nonlinear vibration, Stiffener*

ABSTRACT

A semi-analytical approach of nonlinear vibration of functionally graded carbon nanotubes reinforced composite (FG-CNTRC) [1-3] plates and cylindrical panels stiffened by longitudinal or transversal FG-CNTRC stiffeners by using the first-shear deformation theory (FSDT) with the geometrical nonlinearity term in von Kármán sense is reported in this paper. The smeared stiffener technique [4] is improved for FG-CNTRC stiffeners in framework of FSDT. The stress function is introduced, the Galerkin method is used to establish the nonlinear motion equation system, and dynamic responses of panels are obtained by using the fourth order Runge-Kutta method. Numerical results can show the very large effects of stiffeners, volume fraction of carbon nanotube, type of carbon nanotube distribution of panels and stiffeners with different geometrical parameters, on the nonlinear vibration behaviors of stiffened FG-CNTRC plates and cylindrical panels.

POSTBUCKLING ANALYSIS OF STIFFENED SHEAR DEFORMABLE FG-GRC LAMINATED DOUBLY CURVED SHALLOW SHELLS RESTING ON NONLINEAR ELASTIC FOUNDATION

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Key words: *Functionally graded graphene reinforced composite (FG-GRC), Doubly curved shallow shell, Postbuckling, Stiffener*

ABSTRACT

In this paper, the nonlinear buckling behavior of functionally graded graphene reinforcement composite [1-3] (FG-GRC) doubly curved shallow shells taking into account the nonlinear effect of elastic foundation subjected to external pressure in thermal environment is analytically examined. Assuming that the FG-GRC laminated doubly curved shallow shells are reinforced by FG-GRC laminated stiffeners and rested on a three-parameter nonlinear elastic foundation. The first-order shear deformation theory taking into consideration the geometrical nonlinearity of von Kármán is applied to establish the basic formulations. Moreover, the Lekhnitskii's smeared stiffener technique [4] is successfully improved for the first-order shear deformable anisotropic stiffener system by using a homogeneous model of laminated beam. Galerkin's method is used to achieve the nonlinear algebraically equation system, then the obtained equation system can be solved by the simple calculation procedure and the expressions of critical buckling loads and postbuckling load-deflection curves are determined in explicit form. The numerical values display the influences of nonlinear elastic foundation, laminated stiffeners, material, and geometrical features on nonlinear responses of FG-GRC laminated doubly curved shallow shells.

NONLINEAR BUCKLING OF ECCENTRICALLY SPIRAL STIFFENED FG-GPLRC CYLINDRICAL SHELLS SUBJECTED TO TORSIONAL LOADS

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Key words: *Functionally graded graphene platelet reinforced composite (FG-GPLRC), Spiral stiffener, Nonlinear buckling, Torsional load, Cylindrical shell*

ABSTRACT

The nonlinear buckling behavior of functionally graded graphene platelet reinforced composite [1-3] (FG-GPLRC) cylindrical shells reinforced by ring, stringer and/or spiral FG-GPLRC stiffeners under torsional loads is studied by an analytical approach. The governing equations are based on the Donnell shell theory with von Kármán-Donnell-type geometrical nonlinearity, combining the improvability of Lekhnitskii's smeared stiffeners technique for spiral FG-GPLRC stiffeners [4]. The effects of mechanical and thermal loads are considered in this paper. The number of spiral stiffeners, angle stiffeners, foundation and graphene volume fraction, are numerically investigated. A very large effect of spiral FG-GPLRC stiffeners on nonlinear buckling behavior of shell in comparison with orthogonal FG-GPLRC stiffeners is approved in numerical results.

LARGE AMPLITUDE FREE VIBRATION ANALYSIS OF FUNCTIONALLY GRADED SANDWICH PLATES WITH POROSITY

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Keywords: *Computational mechanics, nonlinear vibration, finite element, FGM sandwich, porosity*

ABSTRACT

In this paper, the large amplitude free vibration behavior of the functionally graded sandwich plates with porosity is investigated. The upper and lower layers of the plate are made of functionally graded material with a power-law variation (P-FGM) of the constituents' volume fraction in the thickness directions while the core layer is made of a porous material (metal foam) characterized by a porosity coefficient which influences the physical properties of the plates in the form of a harmonic function. The nonlinear finite element model is obtained using the first-order shear deformation plates theory with **t**he von Karman nonlinear strain displacement relation. Results are obtained by employing an efficient c^0 finite element with 5 degrees of freedom (DOFs) per node. Convergence and accuracy of the model are validated by comparing its numerical results with available data in the literature. Some new parametric studies are also investigated and discussed in detail.

FREE VIBRATION ANALYSIS OF FUNCTIONALLY GRADED CARBON NANOTUBE-REINFORCED COMPOSITE PLATES SUBMERGED IN FLUID MEDIUM

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Keywords: *Free vibration, FG-CNTRC, fluid-structure interaction, four-variable theory*

ABSTRACT

In this paper, an analytical solution for free vibration analysis of functionally graded carbon nanotube-reinforced composite plates submerged in a fluid medium is developed. Here, the distribution of CNTs across the panel thickness may be functionally graded or uniformly distributed. The fluid is considered to be ideal, incompressible, inviscid, and irrotational. Thus the effects of hydrostatic pressure and free surface waves are not taken into account. Based on the four-variable shear deformation refined shell theory, the set of governing equations for the fluid-panel system is obtained by applying Hamilton's principle. The fluid velocity potential is derived from the boundary conditions for the plates-fluid system and is used to determine added mass. The Navier's solution for the plates with simply supported boundary condition at all four edges is derived. Several numerical examples validate the accuracy of the presented solution. Also, new parametric studies regarding the effects of different material properties, interaction boundary conditions, and geometric parameters on the free vibration responses of the plates are investigated and discussed in detail.

FREE VIBRATION OF STIFFENED FUNCTIONALLY GRADED POROUS CYLINDRICAL SHELL WITH DIFFERENT BOUNDARY CONDITIONS

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Key words: *Free vibration, Functionally graded porous material, Cylindrical shell, First-order shear deformation theory, Different boundary conditions.*

ABSTRACT

In this study, an analytical solution for the free vibration of stiffened functionally graded porous cylindrical shells with different boundary conditions is presented. Here, two types of porosity distributions, symmetric or non-symmetric, are considered. Based on the first-order shear deformation theory (FSDT), the set of governing equations are obtained by applying Hamilton's principle, and the Lekhnitsky smeared stiffener technique. The natural frequencies of the shell with several boundary conditions are determined by applying the Galerkin method with beam functions of the axial displacement fields. Besides, the influences of inlet parameters such as porosity coefficient and geometrical parameters on natural frequencies of the shell are also investigated and discussed in detail. Finally, some useful comments for the relevant subjects on the stiffened functionally graded porous cylindrical shells are also given.

THERMAL BENDING ANALYSIS OF FGM CYLINDRICAL SHELLS USING A QUASI-3D TYPE HIGHER-ORDER SHEAR DEFORMATION THEORY

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Key words: *Thermal Bending, Functionally Graded Material, Cylindrical shell, Higher-order Shear Deformation Theory,*

ABSTRACT

Functionally graded materials (FGMs) have been created to minimize the effect of the abovementioned disadvantage of composite materials. An FGM is regarded as an advanced composite material, which is manufactured from several components with the smooth variations of the mechanical properties between surfaces. The history of FGMs may be found in the literature [1] by Jha et al. The overview of mathetical models used in FGM structural analyses was presented by Birman and Byrd [2], and Thai and Kim [3].

Developing shell theories with a high accuracy level to model the responses of shell structures subjected to external loads has drawn the interest of many researchers in recent years. An increasing number of shell theories have been developed on the basis of various assumptions and approximation methods. We can categorize the shell theories into following groups: classical shell theory (CST), first-order shear deformation theory (FSDT), higher-order shear deformation theory (HSDT) and three-dimensional elasticity theory (3D theory). The overview of these shell theories can be found in the literature [4] of Reddy.

This paper explores the thermal stresses of FGM cylindrical shells with various boundary conditions using the quasi-3D type higher-order shear deformation theory [5]. The displacement field is expressed by polynomials of the coordinate along the thickness direction. The equations of equilibrium including thermo mechanical effects and their corresponding boundary conditions are derived based on the principle of virtual work. Using simple trigonometric series and the Laplace transform, the solutions of boundary problems with different conditions are derived. The results from the present theoretical models are compared with previously published data using several other models. A bending analysis is made to illustrate the influences of boundary conditions and several geometric parameters on the thermal responses.

NON-UNIFORM POLYGONAL CROSS-SECTIONS OF THIN-WALLED FG SANDWICH BEAMS

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Key Words: *Computational mechanics, thin-walled beams, functionally graded sandwich material, general polygonal cross-sections.*

ABSTRACT

The paper adequately presents a computational modeling concerns with thin-walled FG sandwich straight and curved beams for general non-uniform polygonal cross-sections. In analysis, warping and distortion generally play a major role that extremely affect to behaviors of the beam, which in turn has to be considered. In addition, to mathematically model a complex beam, whereas mechanical and geometrical information need to be determined from multiple patches across the blade thickness and in every cross-section through longitudinal direction, a higher-order approach has been employed. Subsequently, the higher orders of warping, coupling distortion including bending, torsion as well as Poisson's distortion were fully taken into account. The anisotropy of materials with its effects are then also included. A multi-separated beam on each edge of the cross-section which is an application of the so-called beam-frame-modal method is adopted. Consequently, the effects of these major importance along with transformation of materials are then strictly investigated. As a result, the study allows a blended coupling of closed-section beam-shells on different curvatures. Various examples have been conducted to illustrate the performance and accuracy also the computational efficiency of the method. It opens the door for further investigation on beam/shell-like structures that widely used in auto-mobile and aerospace engineering and potentially providing access to the full 3D stress state within preferred subdomains.

COMPUTATIONAL MECHATRONICS

SIMULATION OF A WAVE ENERGY CONVERTER USING THE FLOATING STRUCTURE

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Key words: *Floating structure, WEC, Slider and Crank, Simulation, Renewable energy*

ABSTRACT

An innovative design of a wave energy converter (WEC) is presented to convert wave energy into electric energy. The floating structure is employed to transfer the wave motion in heave mode into one way rotation of an electric generator. Here, an arm structure converts the relative linear upward and downward movement of the floating buoy into the linear motion of a double sided toothed gear linear rack by using the slider and crank mechanism. Then, the rack drives the pinions to convert its linear motion into one way rotary of the main shaft, which is driving the generator. Moreover, the working principle is explained clearly. The complete model coupled mechanical and hydrodynamic behavior simulated in Matlab/Simulink to investigate the performance of the WEC. Simulation results show the potential application of the proposed WEC in the real ocean.

STUDY ON THE MOTION CONTROL OF A TORPEDO THROUGH THE WATER

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Keywords: *Motion control, torpedo, underwater vehicle, ability judgment*

ABSTRACT

In this study, the proposed algorithm is utilized to optimize the motion control analysis and mathematical model for the torpedo. Torpedo is the popular weapon of submerged fighting, but a successful attack is not achieved easily. This paper gives an illustration about using MATLAB, Simulink, Proteus,...to calculate the equations of motion and math functions for controlling propeller with wings, rudders and finding the best way to achieve the desired value. To optimize the system, a Micro-Electro-Mechanical System (MEMS) Gyroscope and Proportional Integral Derivative (PID) controller are essential. An emulated MEMS Gyroscope is adjusted and simulated so that its simulated result matches with the practical MEMS Gyroscope. The PID controller is used to obtain better control performance over the motion. The numerical results show the response of control system and the controller performance are stable and accurate. For evaluating the response of PID controller and system, step block and sine wave block are added as input signals. A comparison of the system performance between a torpedo with and without PID controller is also investigated.

A NEW SLIDING MODE CONTROLLER FOR FORCE CONTROL OF MAGNETORHEOLOGICAL HAPTIC JOYSTICKS

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Key words: *Sliding mode control, bilinear function, haptic joystick, magneto-rheological fluid*

ABSTRACT

In this research, a new sliding mode control algorithm with bilinear saturation boundary layer function is proposed and implemented in force control of a 2D haptic joystick featuring bidirectional magnetorheological actuator (BMRA). After a review of haptic joystick development featuring magnetorheological fluid (MRF) and chattering reduction approaches in sliding mode controllers (SMC), the configuration and a prototype of the 2D haptic joystick featuring BMRAs are presented with both simulated and experimental performance characteristics. A new sliding mode control algorithm using a bilinear saturation boundary layer function is then proposed to control feedback force of the joystick. The proposed SMC is implemented for the prototype of the 2D haptic joystick. Experimental results on feedback force of the joystick with the proposed SMC are then obtained and compared with other conventional SMC and PID controller with discussions.

EFFECTS OF DESIGN PARAMETERS ON DYNAMIC PERFORMANCE OF A SOLENOID APPLIED FOR GAS INJECTOR

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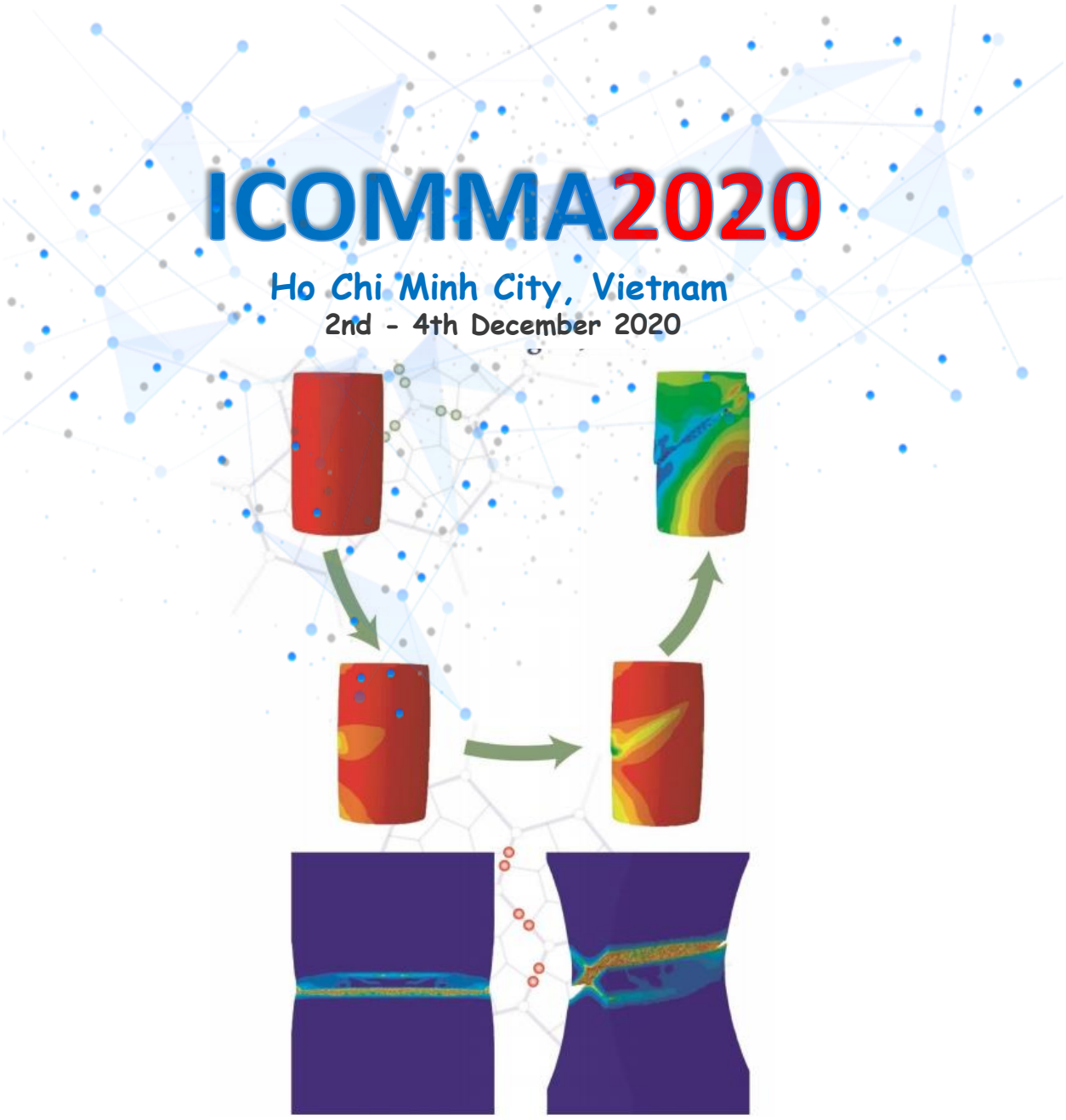
Key words: *Solenoid, gas injector, electromagnetic force, plug shape*

ABSTRACT

The development of fast response injectors is one of the potential research trends, which plays an important role to improving the performance and reducing exhaust emission of the internal combustion engine. A model-based study is conducted to examine the effects of design parameters on electromagnetic force as well as dynamic performance of a solenoid applied for gaseous fuel injectors. Operation of the solenoid is depicted by mathematical models including a mechanical model and an electrical model. A 2D model of the solenoid is created in Maxwell software to calculate electromagnetic force. This 2D model is created in a symmetric shape to reduce the computational cost. Afterwards, the 2D model of solenoid with the electromagnetic force calculated is imported into a Simplorer software to simulate the dynamic performance. The establishment of the solenoid model in Simplorer is based on the mathematical models presented previously. The shape of plug in the solenoid is changed as an input variable to examine its effect on the electromagnetic force and dynamic response of the solenoid. The simulation results show that the change of plug shape can improve the electromagnetic force and minimize dynamic response of the solenoid, which can be a useful contribution for designing a high performance solenoid gas injector.



DAMAGE, FRACTURE AND FAILURE

FORECAST THE IMPACT OF EXPLOITING UNDERGROUND SPACE TO LAND SUBSIDENCE

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ABSTRACT

Exploiting underground space is understood as creating space in the ground to use for different purposes such as:

- Mining,
- Construction of traffic tunnels, subways,
- Construction of infrastructure tunnels, tunnels for water supply and drainage
- Construction of underground warehouses and cultural facilities,
- Construction of multi-storey house basements,
- Groundwater exploitation is also considered as a form of underground space exploitation.

Exploiting underground space in soft soil layer and putting shallow shall cause land subsidence. This is a problem that needs attention. In the world, there have been many scientific publications on this issue. In Vietnam, this issue has not been paid enough attention. Some scientific publications have not been adequately addressed, incomplete and incomplete. In this article, the authors have given the calculation method to forecast land subsidence based on supplementing and completing previous studies of foreign authors.

Key words: *Land subsidence, underground space exploitation, underground constructions*

DAMAGE DETECTION OF CABLES IN CABLE STAYED BRIDGES USING VIBRATION DATA MEASURED FROM CLIMBING ROBOT

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ABSTRACT

This paper presents a wavelet based method for crack detection of the bridge cable using the vibration signal measured from the climbing robot. The climbing robot consisting of a body and three wheels is modeled as a vehicle with one body connected to one wheel by a spring. The cable is modeled as an axially loaded Euler beam. When there is no crack, the displacement time history of the vehicle is smooth and no distortion at the crack position can be inspected. However, when there is a crack, there is a distortion in the vehicle displacement at the crack location but this distortion is small and difficult to be observed visually. The distortion in the displacement of the vehicle is detected clearly by applying the wavelet transform. The distortion caused by the crack is presented significantly in the wavelet transform of the vehicle displacement. The proposed method is promising since the crack with depth as small as 2.5% can be detected. The motion equation of the vehicle-cable is derived and the numerical simulations are provided.

Keywords: *Receptance; frequency response function; crack, crack beam, concentrated mass*.

ADVANCED SIGNAL DECOMPOSITION METHODS FOR ROTATING MACHINE DIAGNOSIS: A REVIEW AND A CASE STUDY

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ABSTRACT

Effective signal processing methods are essential for machinery fault diagnosis. Most conventional signal processing methods lack adaptability, thus being unable to extract the meaningful diagnostic information. Signal decomposition methods have excellent adaptability and high flexibility in describing arbitrary complicated signals. They are free from the limitations imposed by conventional basis expansion, thus adapting to the signal characteristics, extracting rich characteristic information, and revealing the underlying physical nature. This study aims to provide a review on the application of a number of signal decomposition methods for vibration diagnosis of rotating machines. A case study is also provided to illustrate the selection of diagnostic features which are input for an automatic diagnostics system based on neural networks.

Keywords: *Signal decomposition, fault diagnosis, EMD, Wavelet packet, neural networks*

STUDY ON THE IMPACT OF TIME EXPLOSION TO STABILITY OF UNDERGROUND MILITARY CONSTRUCTION

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ABSTRACT

Military underground constructions are usually affected by dynamic loads caused by explosive waves caused by bombs. The stability of underground military construction facility depends heavily on the rate of detonation or the duration of the detonation [2,3,4].

The paper presents the method of solving the dynamics problem of the structure of military underground construction affected by the load due to the explosion of bombs. The calculation results of the impact time of the explosion on the stress-deformation state of underground military structures were presented.

The problem is solved by finite element method.

The algorithm to solve dynamic problems is Newmark's direct integration method.

Key words: *Explosion Wave, Military Underground Constructions, The Impact Time*

RESEARCH, ASSESSMENT FOR FATIGUE STRENGTH OF SHAFT PARTS MANUFACTURED FROM TWO PHASE STEEL (DUPLEX)

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Key words: *Fatigue strength; duplex stainless steel; DSS 2205; duplex heat treatment; shaft parts*

ABSTRACT

Duplex stainless steel (Duplex) is a new material that has superior properties compared to other stainless steels in terms of avoiding corrosion stress and extremely good yield strength, high flow resistance and cheaper than austenite stainless steel series. However, fatigue strength that always leads to destruction occurs during the working process of axle-shaped machine parts under phase changes. In this paper, the evaluation of fatigue strength of Duplex steel to predict the longevity, maintenance plan for axial-shaped machine parts as well as the advanced mechanical heat treatment mode for Duplex steel are investigated. Samples are made from Duplex SAF 2205 (ISO 1143: 2009) to run fatigue tests by "Staircase" method to determine fatigue strength for Duplex 2205. In addition, this study also provides heat treatment mode for Duplex 2205: heating temperature 950^0C, heat retention time of 15 minutes and cooling down in the same furnace. The results indicate that supplied-stage Duplex 2205 steel will not be destroyed by fatigue under load under phase changes with 360 MPa stress, which is about 50% higher than AISI 304 (240 MPa) stainless steel. Duplex 2205 steel after heat treatment is enhanced mechanical properties and better durability than Duplex 2205 steel in the supply state.

DETERMINING THE REASONABLE WIDE OF THE EQUIVALENT STRIP IN THE CALCULATION OF REINFORCED CONCRETE BRIDGE DECKS

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Key words: *bridge decks, reinforced concrete, crack, equivalent strip, nonlinear*

ABSTRACT

Reinforced concrete bridge decks in many bridges are being exploited are calculated according to the equivalent strip plate method according to bridge design standards. During the life of the project, the spherical surface fractures the most frequent occurrence. In particular, cracking due to load is one of the main causes leading to a costly repair, reinforcement, and even replacement. This study aims to provide a diagram of equivalence resolution according to the criteria of initial crack formation due to load. In the study using numerical simulation by finite element method, nonlinear analysis. Compare the results of the spherical 3D model on the supporting girder with the plate on 2 edges. Conducting experiments to verify the expression model plate on 2 edges. From there, the equivalent strip depends on the slab structure parameters and boundary conditions. The research results aim to provide a simple calculation diagram of the spherical the deck but minimize the crack phenomenon to maintain the working of the deck.

ASSESSMENT OF REDUCED STRENGTH OF EXISTING MOORING LINES OF FLOATING OFFSHORE PLATFORMS TAKING INTO ACCOUNT CORROSION

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Key words: *Floating Offshore Platforms, Existing Mooring lines, Reduced Strength, Corrosion, Numerical Models, Probability Method*

ABSTRACT

Strength of mooring lines of floating offshore platforms are specified by Minimum Breaking Loads (MBL) [1], [2]. The MBL are determined by experimental formula depended on diameters of mooring lines in catalogues of manufacturer, such as [3]. For existing floating offshore platforms, after an operating duration the diameters are reduced due to corrosion. It means that strength of the mooring lines are reduced, too. There are some studies about the problem, such as [4], [5]. However, the corrosion is not uniform for different locations of the lines, so it is not easy to estimate accurately the reduced strength. In our previous researches [6], [7], [8], the theoretical basis and fundamental steps for evaluating and re-evaluating the durability of mooring lines of floating offshore structures were studied.

In this paper, we propose a method to assess reduced strength of the existing mooring chains based on numerical models comply with probability methods. It will be applied to evaluate strength of mooring line system of DH 01 FPU Platform which is operating in Dai Hung field in Viet Nam sea. The research results can be used as a reference for similar projects in Vietnamese conditions.

THE LONG-TERM GROUND DEFORMATION EFFECTS ON CONSTRUCTIONS

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Key words: *Settlement forecast, the long-term settlement, consolidation process, lean clay with sand*

ABSTRACT

Currently, the settlement forecast when designing the constructions is done more and more accurately with the relatively complete theoretical methods and supports of the specialized software that contain the efficient numerical method. However, this forecast is almost only conducted in the short-term while the process of exploiting and operating the constructions is always desired in the long-term. Moreover, with the constructions located at the steeply mountainous areas, the effect of the long-term deformation of the foundation also contribute to cause the instability of buildings [2]. Therefore, the long-term settlement forecast should be considered to add for consolidation theory. This is the consolidation process for a long time, it shows the relationship between strain and time, stress and strain, which have the differents from the normal consolidation process (in short-term) used in currently computational theory [1].

This paper presents the determination of parameters in the consolidation test (for a long time) such as compression index (C_c), Coefficient of consolidation (C_v), coefficient of secondary compression (C_a), time factor (T_v)... to calculate long-term settlement of constructions built on lean clay with sand ground [2,3]. These calculation results are used as a basis for evaluating the impact of long-term settlement on constructions.

NONLINEAR EFFECTS OF THE MATERIAL IN THE PIER DAM EXPERIMENT UNDER CYCLIC LOADING

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Key words: *monotonic loading, cyclic loading, nonlinear material, dynamic, pier dam*

ABSTRACT

A pier dam is a newly built efficient water regulation facility in Vietnam. With the pier dam using the radial gate, all the load and the impact from the radial gate to the pier trunnion are concentrated in the area of the mandrel wheel. During the operation and operation, the pier trunnion area has many potential dangers if not evaluated properly. The 1986 Dau Tieng hydroelectric pier trunnion accident has left many harmful consequences as a proof [1].

Designing the structure of the reinforced concrete cellar pillar structure in accordance with TCVN 10400: 2015, TCVN 5574: 2012 often assumes that the working material is in the linear elastic phase, not considering the nonlinear stress-strain relationship the actual material [2,3]

Some constructions in the 50s of the 20th century, such as the Folsom dam, USA, had a breakdown in 1995, due to the error of not considering the effect of friction on the stress distribution in the ear region. pin valve, which has a nonlinear effect on geometry and material, leads to poor design stress distribution, bending stresses in the compression member area of the valve gate system [4].

In the world, the problem of structural analysis in the nonlinear behavior has been studied and included in the standards in the form of additional formulas for determining internal force, such as EN 1992 1-1 of the European Union, JSCE No15 of Japan, ACI 318-95 of the United States, ... but just stop at some basic forms [5,6,7,8,9]. With the types of specialized structures, simulation work is mostly tested and is the basis for the numerical model [10,11,12].

In experiments, depending on each stage of loading, stress - strain values have differences compared with theoretical calculations [9,13,14]

In the scope of the paper, the authors analyze the effect of the choice of concrete grades on the material nonlinearity in this area, the effect of the dynamic load with the fluctuation amplitude of the wave cycle, from there determine the permissible strain - strain versus stress - strain of the material on the basic cross section.

AN INVESTIGATION ON BEHAVIORS OF MASS CONCRETE IN CUA-DAI EXTRADOSED BRIDGE DUE TO HYDRATION HEAT

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Key words: *Hydration heat, mass concrete, Cua-Dai Extradosed Bridge, crack stress, crack ratio, displacement*

ABSTRACT

We would like to invite you to submit an abstract for the upcoming International Conference on Modern Mechanics and Applications – ICOMMA 2020 which will be held at Ho Chi Minh City, Vietnam on December 02-04, 2020.

The effects of hydration heat to mass concrete has been studied so far. In Vietnam, many of large projects are being built with very huge foundation. Therefore, the study of the behavior of concrete due to hydrothermal heat in massive concrete is particularly significant. In this paper, The FEM software will be used to investiage the heat of hydration characteristics. The heat of hydration in tower footing of Cua-Dai Extradosed Bridge will be discussed in detail. The effects of hydration heat can cause the potential of cracks in tower footing. In addition, the changing temperature by time in foundation block will be clarified. Furthermore, the stress and displacement due to hydration heat in Cua-Dai Bridge foundation will be elucidated clearly. From the FEM analysis of concrete behavior, the recommendations for hydration heat effects will be given.

PRACTICAL METHOD FOR TRACKING FATIGUE DAMAGE

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Key words: *Fatigue dynamics, variogram, smooth orthogonal decomposition.*

ABSTRACT

Estimating and tracking dynamics of fatigue damage is essential for fatigue failure prediction. Many recent developments in the area of damage diagnosis are mainly aimed at detecting damage in variable environmental or operating conditions. These methods do not provide a comprehensive framework that can be used to determine the time evolution in damage. In this paper, a reliable and practical methodology for tracking the evolution of the fatigue damage from the measurement of structural vibration is presented. The proposed approach is independent of any particular model of the system and is only based on the variogram [1] of the measured data in conjunction with the smooth orthogonal decomposition [2,3]. Validation of the method is demonstrated for both synthetic and experimental data.

THE NUMERICAL AND EXPERIMENTAL RESEARCH ON CUTTING FORCES IN THE SURFACE GRINDING OF TI-6AL-4V ALLOY

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Keywords: *Grinding, Titanium alloy, Grinding force, Grinding temperature, Finite element simulation.*

ABSTRACT

The simulation and experiments are performed in this research to estimate the influence of cutting parameters i.e. workpiece infeed speed, depth of cut (DOC), and cooling condition on the cutting forces in grinding of Ti-6Al-4V (Ti64) alloy using a resin-bonded cBN wheel of #120 mesh. The experimental results show that increasing workpiece infeed speed or depth of cut produces higher cutting forces. The relative difference between simulated and experimental forces is in the range of 1 - 15%, therefore this simulation model can be used for prediction of grinding temperatures. It is then observed from the simulation results that the increase of feed rate considerably reduces the cutting temperature, while the increase of cutting depth enhances it.

FAILURE BEHAVIOR OF THE DISSIMILAR FRICTION STIR WELDING BETWEEN PURE COPPER AND ALUMINUM 1050

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Key words: *Failure behavior, dissimilar bonding, interface delamination.*

ABSTRACT

The bonding between the pure copper and aluminum 1050 was fabricated by friction stir welding. The bonding strength was investigated experimentally by tensile test and bending test. The macrostructure and microstructure of the joint were polished and monitored by the optical microscope. The failure behavior of the joint was found to be sensitive to the tool rotation speed. The fracture locations were addressed and discussed.

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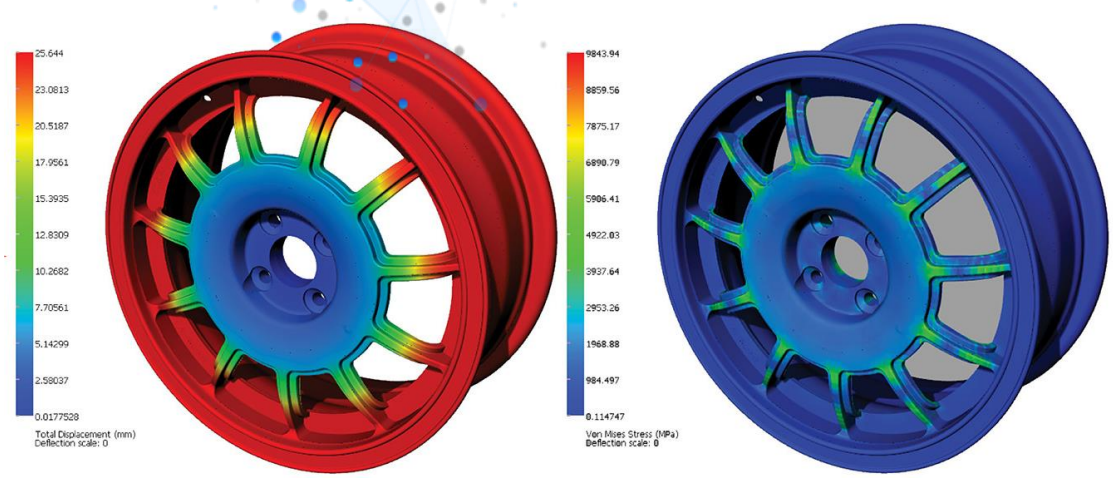

DYNAMICS (DNM)

INVESTIGATION OF MANEUVERING CHARACTERISTICS OF HIGH-SPEED CATAMARAN USING CFD SIMULATION

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Key words: *Delft 372 catamaran, RANS solver, high-speed, virtual captive model test, hydrodynamic characteristics, maneuvering simulation.*

ABSTRACT

Many studies have been done to estimate the maneuvering characteristics of commercial ships. Studies on high-speed catamaran, there was a great number of theoretical, numerical studies, and experimental investigation, most of them have focused on the resistance performance. In addition, a CFD (Computational Fluid Dynamics) method has become a possible tool to predict the hydrodynamics. In this study, it was focused on to predict hydrodynamic maneuvering characteristics of high-speed catamaran by utilizing RANS (Reynold-Averaged Navier-Stokes) solver. The Delft 372 catamaran model was selected as the target hull to analyze hydrodynamic characteristics. Due to the high-speed condition and changeable attitude, the motion of catamaran was complex. The comparisons of the obtained CFD results including the free surface effects in resistance performance with experimental data were shown a relatively good agreement and it could demonstrate that the presented method could be used for predicting hydrodynamic coefficients of high-speed catamaran. Then virtual captive model test was performed to obtain hydrodynamic coefficients. The lower order Fourier coefficients were applied to get the hydrodynamic coefficients in dynamic motion. Finally, by substituting the obtained hydrodynamic coefficients into the mathematical model, the maneuvering simulation of high-speed catamaran was carried out and those results were confirmed to be reasonable.

NATURAL FREQUENCY ANALYSIS OF MULTI-SPAN NANOBEAMS MADE OF FUNCTIONALLY GRADED MATERIALS

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Key words: *FGM; Nanobeam; Nondimensional frequency; Nonlocal; DSM.*

ABSTRACT

This paper presents natural frequency analysis of Functionally Graded Material (FGM) multi-span nanobeams using Dynamic Stiffness Method (DSM). The nanobeam is investigated on the basis of the Nonlocal Elastic Theory (NET). The NET nanobeam model considers the length scale parameter, which can capture the small scale effect of nano structures considering the interactions of non-adjacent atoms and molecules. Material characteristics of FGM nanobeams are considered nonlinearly varying throughout the thickness of the beam. The nanobeam is modelled according to the Timoshenko beam theory and its equations of motion are derived using Hamilton's principle. The DSM method is used to obtain an exact solution of the equation of motion taking into account the neutral axis position with different boundary conditions. The method is validated by comparing the obtained results with published results. Numerical results are presented to show the significance of the material distribution profile, nonlocal effect, and boundary conditions on the free vibration of nanobeams. It is shown that the study can be applied to other FGMs as well as more complex of framed structures.

A MULTIBODY DYNAMICS APPROACH TO STUDY AN INSECT-WING STRUCTURE

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Key words: *Multibody dynamics, hawkmoth, flapping wings*

ABSTRACT

In recent years, flapping-wing micro air vehicles (FWMAVs) mimicking insect flight are widely developed and have many applications. A lot of effort has been made for research on insect-wing structures, flight dynamics and stability characteristics [1]–[3]. Results from these studies play an important role in the improvement of modern FWMAVs' designs.

In general, an insect wing has a complex structure with veins and membrane that undergo large deformation while flapping in the air. Thus, building a precise wing model and investigate its dynamic characteristics is a difficult task. In this paper, an in-house code based on a multibody dynamic approach is presented to compute the dynamic of a hawkmoth wing. From the experimental data of a biological wing, a finite element method (FEM) model is firstly constructed (fig. 1), then is used to build an equivalent beam model [4]. From the equivalent beam structural parameters, a Hencky-bar chain model of the wing is created with rigid bodies connected together by bending and torsion springs. The equations of motion are derived using the Lagrange's equation and solved by a quasi-Newton method. The code is then validated against MSC Adams. The experimental results of the biological wing and numerical results show good agreement. The code presented here can be further completed with the integration of an aerodynamic model.

AERODYNAMIC RESPONSES OF INDENTED CABLE SURFACE AND AXIALLY PROTUBERATED CABLE SURFACE WITH LOW DAMPING RATIO

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ABSTRACT

Cable vibration due to wind is one of key issue in design of stayed-cable bridge. To control the rain wind induced vibration, indented surface and axially protuberated cables have been applied in Japan for many years. Nevertheless, it is also figured that those methods are still defective in mitigating cable dry galloping. Moreover, vibration characteristics of indented surface and axially protuberated cables with low damping ratio have not fully investigated yet. The aim of this study is to investigate the aerodynamic responses of low damping indented surface and axial protuberated cable. Firstly, the WTT will examine cables vibration in dry and rain condition for indented cables. Then, aerodynamic responses of axial protuberated cables will be elucidated fully. Finally, the axial flow in the wake of cables will be measured and discussed in detail.

Key words: *Aerodynamic responses, indented surface, axially protuberated cables, low damping ratio, axial flow.*

SELF-VIBRATIONAL ANALYSIS OF A TENSEGRITY

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ABSTRACT

A tensegrity structure's self-vibrational behavior is investigated to validate explanations that the natural frequencies of the tensegrity are composed of the individual natural frequency of strut and cable elements. Tensegrity structure is described as a "self-stressing" object to maintain its equilibrium state. In the equilibrium state, struts are designated to be in compressive state, and cables are designated to be in tensile state. Because all the tensegrity structure elements are connected to preserve the equilibrium state, no boundary condition is needed. To solve this kind of structure by using the conventional finite element procedure is not feasible. Little study has been done to explore the self-vibrational behavior of a tensegrity structure. Previous studies of vibrational tensegrity behavior are limited to specific kind of modular tensegrity (cylinder, sphere) and predefined simple geometric form of tensegrity with some boundary supported nodes to avoid rigid body motion. In this paper, the self-vibrational dynamic equations of the prestressed strut, which is treated as an axially vibrating element, and the prestressed cable, which is treated as a transversally vibrating element, are derived consistently in the frequency domain in the context of spectral element procedure. The Wittrick-Williams procedure uses the determinant value of the equilibrium equation matrix; thus, no singularity problem is encountered. The derived self-vibrational dynamic equations are applicable for general tensegrity form without predefined conditions necessary. A numerical example is presented to demonstrate the efficiency of the present study.

Keywords: *Self-Vibration, natural frequency, tensegrity, strut, cable, spectral element method*

ADVERSE EFFECTS WHEN THE WAVE EXPLOSIONUNDERGROUND STRUCTURE TO MILITARY

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Key words: *Wave Explosion, Underground Structure, Adverse Effect, Bomb's Load*

ABSTRACT

This article presents a method of solving the problem of structural dynamics underground military environment under the effect of the blast wave load bombs and make the calculation results affect duration of the blast wave state of stress - deformation of structures. The problem is solved by the finite element method. Algorithm to solve the problem is the direct integration method Newmark.

NONLINEAR DYNAMIC BUCKLING OF VARIABLE THICKNESS FGM CYLINDRICAL SHELLS SUBJECTED TO MECHANICAL LOAD

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Key words: *Dynamic buckling, variable thickness, FGM cylindrical shell, dynamics responses.*

ABSTRACT

The main purpose of this paper is study on nonlinear dynamic buckling of FGM cylindrical shell with variable thickness under mechanical load. The governing equations of this structure are established base on the classical shell theory and take into account the geometrical nonlinearity in von Karman-Donnell sense. Dynamic critical load and nonlinear dynamic responses of the shell are determined by using Runge-Kutta method and Galerkin method. Effect of coefficient k and geometric dimension on critical load and nonlinear dynamic responses of the shell are also considered.

OPTIMAL ELECTRICAL LOAD OF THE REGENERATIVE ABSORBER FOR RIDE COMFORT AND REGENERATED POWER

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ABSTRACT

The automotive industry has also started to show interest in harvesting energy from the motion of the suspension. Unlike conventional shock absorber which dissipates energy by passing a fluid, generally oil, through small orifices, thus generating heat, the regenerative shock absorber transforms the linear motion of the suspension into a rotation of an electric generator. The electrical load of the generator should be optimized because the too large value suppresses the useful electric current while the too small value gains too little energy. This paper presents the analytical solutions of the optimal electrical load of the generator for two objectives: ride comfort and regenerated power, under two cases of excitation: harmonic and random.

Key words: *Vibration energy harvesting, Analytical optimization, Regenerative shock absorber, Regenerative damper*

NONLINEAR VIBRATION ANALYSIS FOR FGM CYLINDRICAL SHELLS WITH VARIABLE THICKNESS UNDER MECHANICAL LOAD

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Key words: *Nonlinear vibration, variable thickness, FGM cylindrical shell, dynamics responses.*

ABSTRACT

The paper investigates nonlinear vibration of FGM cylindrical shells with varying thickness under mechanical load. The novelty of the paper is to establish motional equations of the structure. Since then, the natural frequency of vibration and the dynamic responses of the structure have been determined. Effect of material (coefficient k) and geometric parameters on natural frequency and nonlinear dynamic responses of the shell are also examined.

RESPONSES OF INDENTED SURFACE CABLE AND PARALLEL PROTUBERANCES IN DAMPING RATIO REGION DUE TO WIND AND RAIN WIND INTERACTION

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Key words: *Indented surface and parallel protuberances, damping ratio, wind, rain/wind interaction, wind attack angles, cable galloping*

ABSTRACT

In this study, response of bridge cables with parallel protuberances and indented surface in low damping area due to wind and rain/wind interaction will be examined. Experiments were carried out in wind tunnel circuit of the Yokohama National University, Japan. Cable model was supported by Single Degree of Freedom spring system. Cable diameters are 110mm and 158mm with damping ratio ranges from approximate 0.08 to 0.25% while natural frequency is around 0.8-1.Hz.

OPTIMUM TUNING OF TUNED MASS DAMPERS FOR ACCELERATION CONTROL OF DAMPED STRUCTURES

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Key words: *Tuned mass damper, optimum parameters, harmonic excitation, acceleration, curve fitting, explicit formulae*

ABSTRACT

A tuned mass damper (TMD) is a type of auxiliary energy dissipation device mounted in a structure to mitigate the vibrations of the structure. Optimum TMD's parameters including the natural frequency and damping ratio have been suggested in the literature, which normally focus on attenuating the displacement response of the primary structure. While excessive displacements can affect the safety and integrity of a structure, limiting acceleration response levels are more important at serviceability limit state as these relate to the functionality of nonstructural components and occupier comfort. The current paper aims at developing optimum TMD parameters for minimizing the steady state acceleration of structures such as building floors subjected to harmonic forces, especially considering the inherent damping present in the main structure. For each mass ratio and structure damping value considered, numerical simulations are performed to search for a combination of TMD tuning frequency and damping that minimize the peaks observed on the response spectra of the combined structure-TMD system. The new optimum TMD parameters are found for a range of mass ratios and primary structural damping ratios commonly used in practice. Empirical expressions for the tuning parameters are also derived by means of curve fitting to facilitate design work. The reliability of the fitting models is satisfactory with the calculated 95-th percentile error being as low as 0.2% and the correlation coefficient being as high as 0.995. Compared with various tuning formulas in relevant literature, the new solutions for TMD parameters are found to provide higher reduction in the structural acceleration response, hence more effective in terms of acceleration control.

ANALYSIS THE INFLUENCE OF THE THIN PLATES MATERIAL TO THE VEHICLE'S NOISE AND VIBRATION

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Key words: *Bus vehicle, Thin plate materials, Noise and Vibration reduction.*

ABSTRACT

Noise and Vibration are important problems in automotive design and production process, particularly in passenger bus, where it affects not only the structural integrity of the bus, but also the level of comfort of the passengers. There are multiple factors that affect the noise and vibration behavior of the bus, one of which is the selection of main material for the body.

This paper presents the noise and vibration characteristics of the bus vehicle are analyzed on the metal thin plate material original. Second, are analyzed on the composite material to changed. The results, the composite noise and vibration reduction materials which have the function of damping and acoustic absorption are used to control the vehicle interior noise.

FREQUENCY EQUATION AND COUPLING STRENGTH BETWEEN CANTILEVERS IN AN ARRAY

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Key Words: *Computational mechanics, multi-physics, optimization, finite element*

ABSTRACT

Microcantilevers are the main structure of sensing systems relying on the change in mechanical or electrical properties under external effects. In conventional cantilevers, an undercut or overhanging part is usually available due to the limitation of fabrication technique. This is the connecting part between the clamped base and the cantilever part. Several studies explored the role of these parts on the final response of the cantilever and the accuracy of a measurement [1, 2, 3, 4]. In this work, we analytically examine the role of the overhanging part on the changes in the mode shape and frequency of a microcantilever. The Euler-Bernoulli theory of beam has been used and the frequency equation for the cantilever has been obtained. The changes in the mode shape and frequency due to the overhanging part were clearly shown. These results could give fruitful information on using the approximate mode shapes in cantilever dynamics.

FLOW PROBLEMS (FP)

A DUAL APPROACH FOR MODELING TWO-DIMENSIONAL AND ONE-DIMENSIONAL SOLUTE TRANSPORT

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Key words: Dual approach, two-dimensional horizontal solute transport equation, two-dimensional vertical solute transport equation, one-dimensional solute transport equation.

ABSTRACT

Currently, the solute transport equation of one-dimensional (1D) or two-dimensional vertical (2DV) flow are constructed by classic average method [1]. These solute transport equations is totally integrated one time from the right bank to the left bank of river; the average values received by classic average method do not generalize by means of dual approach [2,3]. So, in this paper, a dual approach is applied to establish the solute transport equation of two-dimensional vertical flow. The 2DV equation describing the concentration of the solute transport in 2DV flow is obtained by two times integration: the first time integral is from the right bank to the intermediate surface lays between right bank and the left bank of the river, the second time integral is from the right bank to the left bank.

From the two-dimensional horizontal [4,5] and two-dimensional vertical solute transport equation are constructed by dual approach, we receive the one-dimensional solute transport equation.

With the dual approach, the received average concentration is better, particularly, in the case of stratification, mixed solute, and so on. The received governing equation based on the dual approach describes more accurately the physical characteristic of the transport phenomena in nature. Moreover, it provides flexible parameter adjustment based on the experimental data. A case study of salinity transport in Huong river is illustrated.

THE EQUATION THAT CONNECTS BOYLER'S AND BERNOULLI'S LAW

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Key words: *Boyler, Bernoulli, flow, equantion, connect*

ABSTRACT

An Isothermal process is a basic process which can occur in any kind of system that has some means of regulating the temperature, including highly structured machines and even living cells. In this paper, the authors propose the equations which demonstrate the relationship between the internal pressure of an isothermal system (with orifices ventilating out) and the velocity of a gas flow field (abide by Bernoulli's law) that this system is immersed in.

INVISCID SIMULATION OF CAVITATION FLOW BY A HOMOGENEOUS EQUILIBRIUM MODEL

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Key words: *Cavitation, Homogeneous Model, Inviscid, Finite Difference Method*

ABSTRACT

This study presents a numerical simulation approach for the cavitating flow by an inviscid homogeneous equilibrium model. The in-house code for a compressible three-phase liquid – vapor - air flow base on the Finite Difference Method (FDM) and TVD MacCormack scheme was developed [1,2,3,4]. The water cavitation on difference cavitators such as a hemispherical headform, blunt body, and NACA0015 hydrofoil were validated [5,6].

According to the results, the pressure distribution on the hemispherical headform and blunt body were reasonable predicted in comparison with experimental data [5]. The steady cavitation was observed for hemispherical headform. On the other hand, for the blunt body and NACA0015 foil, the time dependent characteristics of cavitation such as the cyclic frequency and flow re-entrance jet were satisfactory reproduced [5,6]. It indicates the capability of present technique to resolve the characteristic of cavitating flow problems.

ASSESSMENT OF DYNAMIC EFFECTS OF WAVE LOADS ON THE FIXED STEEL OFFSHORE STRUCTURES THROUGH THE FATIGUE DAMAGE

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Key words: *Dynamic effect, Jacket, fatigue damage*

ABSTRACT

The dynamic effects of wave loads due to dynamic structural response is taken into account in the ultimate strength and the fatigue strength evaluations. The effect of dynamic amplification may be significant for the evaluation of fatigue strength, because the frequently occurring waves may have frequencies corresponding to the lowest natural frequencies of the structure [1,2,3,4].

For the ultimate strength (ULS), dynamic effects are assessed by base shear, displacements, moments. Dynamic amplification is accounted for by: simplified dynamic amplification factor (DAF) or stochastic dynamic amplification factor (DAF_S) for ULS [3,4].

For the fatigue strength (FLS), design fatigue life at survey hotspots depend on fatigue damage accumulation and S-N fatigue curve. Therefore necessary dynamic effects are assessed through fatigue damage.

This paper presents the assessment of dynamic effects of wave loads on the jacket structures through the fatigue damage and specific application for Vietnamese sea conditions.

THE APPLICATION OF THE PANEL METHOD TO PREDICT THE UNSTEADY AERODYNAMIC COEFFICIENTS OF A WING MODEL FLYING OVER BUMPY GROUND

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Key words: *Ground effect, unsteady panel method, unsteady aerodynamics*

ABSTRACT

In this paper, the unsteady aerodynamic coefficients of a wing model while flying over bumpy ground is computed by the potential-flow-based panel method [1,2]. The mirror-image method used to incorporate the ground effect into the computation. The program is written in FORTRAN with the use of a parallel computation technique to reduce the run time. The convergence analysis is conducted for various types of mesh with different levels of resolution in an effort to obtain the most suitable one (Fig. 1). It is found that using a higher-resolution mesh can smooth out the results; however, more computational resources are required. Numerical results obtained in this study are validated against those from previous papers based on the Computational Fluid Dynamics (CFD) approach [3,4]. In this work, for the first time, the panel method is employed to study the unsteady aerodynamics of a 3D wing flying over bumpy ground. In comparison with approaches based on higher-order numerical methods, this approach tends to be more efficient due to its low computational cost while the accuracy of the results is still guaranteed [3, 4].

THE EFFECT OF GROUND SURFACE GEOMETRY ON THE WING LIFT COEFFICIENT

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Key words: *Ground effect, unsteady panel method, unsteady aerodynamics*

ABSTRACT

The studies of wing aerodynamics in ground effect generally consider the ground surface to be either absolutely flat or wavy in a form of a sinusoidal function [1,2]. However, in practice, ground surfaces may have complex geometry, which affects the aerodynamic charactersitics of wings flying over them. The aim of the paper is to analyze the influence of some basic ground geometry parameters [3] on the lift force coefficient of a wing model. The mirror-image method is integrated into the unsteady panel code to solve the ground effect problem with the complex geometry. The program of the panel method, which was developed based on the potential-flow theory [4,5], is written in FORTRAN with the use of parallel computation techniques to reduce the run time. The calculation results show that the variation of the ground surface geometry may have profound effects on the unsteady lift coefficient properties of the wing (Fig. 1). The phase, the shape and the amplitude of the lift coefficient variation may be altered significantly when we change the geometry of the ground surface. Moreover, the effect of the ground geometry in the presence of horizontal wind is also analyzed. This paper provides close insight into these phenomena with physical explanations, which have not been addressed by other researchers.

ENHANCING VENTILATION PERFORMANCE OF A SOLAR CHIMNEY WITH A STEPPED ABSORBER SURFACE

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Key words: *Computational fluid dynamics, solar chimney, natural ventilation, stepped surface*

ABSTRACT

Maximizing the utilization of renewable energy is one of the important points for designing sustainable buildings. Among the natural energy resources applied in buildings, solar radiation can be harnessed with solar chimneys. These devices absorb solar radiation for heating air in an enclosed channel. The thermal effects associated with the heated air can induce an airflow which can be used for ventilation, heating, or cooling of the connected buildings. This method can help to reduce the energy consumption of a building significantly [1].

As solar chimneys have been attracting a number of studies in the literature, research interests in this topic have been focusing on enhancing the ventilation performance of typical solar chimneys by testing different shapes of the absorber surface [2 – 5]. In this study, a novel type of a vertical solar chimney with a stepped absorber surface, unlike a straight one in typical chimney, was studied with a numerical model. The air flow and heat transfer inside the air channel were computed with a CFD (Computational Fluid Dynamics) model. Performance of the chimney in terms of the induced air flow rate and thermal efficiency through the chimney, and the Nusselt number inside the air channel was investigated under different dimensions of the step and at different heat fluxes. The results show that the step strongly disturbed the distribution of the Nusselt number on the absorber surface and enhanced the induced air flow rate, the air temperature rise through the chimney, and the thermal efficiency of the air flow up to 20% compared to those of a typical solar chimney. Therefore, effectiveness of the proposed stepped absorber surface can be seen.

SOLAR CHIMNEYS FOR NATURAL VENTILATION OF BUILDINGS: INDUCED AIR FLOW RATE PER CHIMNEY VOLUME

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Key Words: *Natural ventilation, solar chimney, thermal effect, CFD, flow rate per volume.*

ABSTRACT

Ventilation of buildings can be based on mechanical systems, such as fans, or natural driving forces, such as wind or heat. Of common natural ventilation methods, solar chimneys convert solar heat gain on the envelope of buildings into flow energy to ventilate or to cool the buildings. As solar chimneys are typically integrated into the building envelope, i.e. walls or roofs, architects determine shapes and sizes of a chimney mainly based on available space on the envelope. This raises the need for maximizing the ventilation performance of a solar chimney for a given space on a building envelope.

In this study, ventilation performance of a typical vertical solar chimney was accessed in the term of the induced flowrate that it can provide per its volume. A three-dimensional numerical model based on the Computational Fluid Dynamics method was built to predict the induced air flow rate through the chimney as its dimensions changed. The tested dimensions included the height, the width, and the gap of the chimney. The induced air flow rate was obtained with different volumes of the chimney.

The results show that the induced air flow rate nominated by the chimney volume changed with all three dimensions. Higher ratios were achieved with lower length, gap, and width. Therefore, it is suggested to maximize the air flow rate per chimney volume, smaller chimneys are preferred. These findings agree with the results in the literature [1].

NEW CONCEPT DESIGN BASE ON THE EFFECT OF THE AIR GAP ON LCP FULL FILLING IN MICRO-INJECTION MOLDING

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Keywords: *LCP, Micro injection molding, air gap, micro connector*

ABSTRACT

With the advantage of fast processing time, cost savings, and product weight, micro injection molding technology is increasingly paying attention. However, the control of material shrinkage characteristics of this technology is a problem that always focused on solving products that need high accuracy. With micro-sized products and thin-walled, the full-filling process is a major technological challenge. The air gap is one of the useful key and simple methods for solving this above problem, while also solving faults of plastic shortage and burning. Due to the superiority in high heat solder resistance, high-temperature strength, dimensional stability, easy melt processing, outstanding electrical properties, good chemical resistance, low flammability, and low water absorption, Liquid Crystalline Polyester (LCP) is a resin with high potential in industrial applications. In the following study, based on the analysis of the influence of residual air, a new design concept was presented that increased the ability to fill material in the mold, overcome product damage. The simulation results show the distribution and concentration of residual air in the product and product quality after applying the adaptive subdivision concept is effective. Contribute to reducing research costs to increase production productivity.

VORTEX DYNAMICS OF A PULSED JET FLOW AT VARIOUS FORCING FREQUENCIES

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Keywords: *Pulsed jet, vortex dynamics, shear layer, forcing frequency*

ABSTRACT

The effects of excitation frequency on vortex characteristics and shear layers of a round jet were investigated numerically. The jet with a diameter of 5 mm was issued from a nozzle assembly and connected to the downstream region via a 5mm diameter and 600 mm length of the tube. The forced frequencies were performed at 5 Hz, 50 Hz, and 250 Hz, while the jet exit Reynolds number was fixed at 1660. The vortex characteristics were predicted using the turbulent model of Reynolds-averaged Navier-Stokes (RANS) type. The results show that large turbulent kinetic energy and vorticity regions are located around the shear layers of the forced jet where the vortex rings existed. The vortex rings are induced firstly at the jet exit, growth, and move quickly downstream along the axial direction during a forcing cycle. The size of vortex rings formed at a low frequency is much larger than that at a high frequency. The jet structures are earlier break up into small eddies as increasing the forcing conditions. The formation process of vortex rings moves upstream gradually as increasing the forcing frequency. The spreading of the forced jet is significantly larger than that of the unforced jet. The evolutions of radial and axial velocities, vorticities, and turbulent kinetic energies of the forced jet at various frequencies were presented and discussed in the present study.

CFD ANALYSIS OF SUBCOOLED BOILING FLOWS IN VERTICAL ANNULAR CHANNEL WITH IAT MODELS

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Key words: *CFD, two-phase flow, subcooled boiling, interfacial area transport*

ABSTRACT

The use of Computational Fluid Dynamics (CFD) may bring a real benefit for the analysis of the nuclear reactor safety problems involved dry-out, departure from nucleate boiling (DNB), pressurized thermal shock, pool heat exchanger, and so on [1]. Accurate closure models for subcooled flow boiling are of primary importance for the prediction of the temperature and wall heat flux at the fuel cladding surface and DNB conditions. This paper presents a CFD analysis of subcooled boiling phenomena in vertical annular channel focusing on interfacial area transport (IAT) models which can mechanistically predict the dynamic changes in the two-phase flow structure. Also, all state-of-the-art hydrodynamic and wall boiling models are fully implemented in the CFD solver and thoroughly assessed against SUBO experiments [2]. The simulation results show the large discepancies with measured data and a new approach for model calibration/validation is recommened.

DESIGN A SMALL, LOW-SPEED, CLOSED-LOOP WIND TUNNEL: CFD APPROACH

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Key words: *Small wind tunnel, Aerodynamics, CFD*

ABSTRACT

Closed-loop small wind tunnels, with many advantages, play an essential role in experimental research on aerodynamics in many fields [1]. In this study, to design a small, low-speed, closed-loop wind tunnel for researching and teaching, the author carried out a systematic investigation of flow in the wind tunnel using Computational Fluid Dynamics (CFD) [2]. The required objective is a uniform flow in the test section of the wind tunnel and a low pressure losses. The effect of guide vane configurations on the flow quality in the test section was evaluated. This analysis showed the flow in the test section was more affected by the upstream guide vanes than the downstream section. Finally, the simulation results demonstrated that the designed wind tunnel is suitable and could be used for research in universities.

A STUDY OF FLUID-STRUCTURE INTERACTION OF UNSTEADY FLOW IN THE BLOOD VESSEL USING FINITE ELEMENT METHOD

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Key words: *fluid-structure interaction, unsteady flow, blood vessel, finite element method*

ABSTRACT

Hemodynamic characteristics in the blood vessel wall play an essential role that is closely related to the progression of cardiovascular diseases. Primarily, transcatheter aortic valve implantation (TAVI) has been carried out as an alternative to patients with severe aortic stenosis, who are at high risk for surgical therapy. The biomechanical environment of TAVI is closely related to the interaction of the motion of the aorta as well as leaflets with the aortic hemodynamics with unsteady blood flow [1].

Fluid-structure interaction (FSI) occurs when fluid flow creates a deformation of the structure. This deformation, in turn, changes the boundary conditions of the fluid flow. Nowadays, the FSI problem plays an important role, and its applications are seen in various fields of engineering and sciences such as airplanes, bridge deck, turbomachinery, and blood flow through arteries. During the last few decades, there has been a substantial improvement in the numerical method for simulating FSI problems [2,3,4].

Computational simulations for the blood flow in the artery have been performed by many investigators with the real geometry and material are employed. Fluid-structure interaction is a robust method to investigate the mechanisms of the blood vessel and predict early atherosclerosis. However, FSI simulation for the large deformation of a vessel with unsteady flow remains a challenging problem. In this work, we present a FSI algorithm based on the finite element method for a partitioned semi-implicit scheme with a segregated pressure equation for the fluid solver and the incomplete Quasi-Newton method for the interface prediction. The Navier-Stokes equations are solved by using the projection method based on the arbitrary Lagrangian-Eulerian (ALE) formula for the moving grid and the P2/P1 finite element discretization [4]. Fluid mesh movement is updated by the spring analogy, and then the quality of the mesh is improved by the swapping face technique. The updated Lagrangian formulation is used for the non-linear hyper-elastic material of the blood vessel with the Mooney-Rivlin material model adopted as a constitutive equation of the blood vessel [2]. We show that the present method is able to simulate efficiently unsteady blood flow through a large deformed vessel wall with complex geometry, and can be used for predicting the risk of cardiovascular diseases. The performance of the present algorithm is evaluated by comparison the CPU time simulation with a commercial code. The present FSI algorithm can be further developed to simulate the unsteady blood flow in the aortic valve of the human heart.

EXPLICIT HOMOGENIZED EQUATIONS OF THE ORTHOTROPIC ELASTICITY IN TWO-DIMENTIONAL DOMAINS WITH VERY ROUGH INTERFACES OF CIRCULAR TYPE

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Key Words: *Homogenized, orthotropic, rough interface, dispersion equation.*

ABSTRACT

The present work aims to derive explicit homogenized equations of the linear elasticity theory in twodimensional domains containing very rough interfaces oscillating between two concentric circles. Usingthe new techniques presented recently in [1], the explicit homogenized equation in matrix form as well as component form along with the associate continuity condition are derived. These equations are more compact than the ones reported [2]. Using the obtained explicit homogenized equation, the propagation of SH waves in an orthotropic elastic medium containing a very rough interface oscillating between two concentric circles is considered.

EFFECTS OF LIGHT WELL SHAPE ON THE AERODYNAMIC CHARACTERISTICS OF A BUILDING USING COMPUTATIONAL FLUID DYNAMICS SIMULATIONS

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Key Words: *Triangular building, CFD simulation, aerodynamic force.*

ABSTRACT

This study aims to investigate the aerodynamic characteristics of a real tall building with a triangular cross-section. Computational Fluid Dynamics (CFD) simulation technique is used to simulate the wind flow around the building and then estimate aerodynamic forces and pressures on the building surfaces. The simulated results show some insights into the characteristics of the aerodynamic forces and pressures, indicating a significant influence of building shapes [1,2,3,4].

LIGHTWEIGHT STRUCTURES (LS)

A STUDY TOWARD GOLDEN RATIO APPLICATION IN THE OPTIMIZATION OF COLD-FORMED STEEL SECTIONS

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Keywords: *Cold-formed steel, golden ratio, finite element method, optimization, rhino grasshopper.*

ABSTRACT

The golden ratio is a ratio that used popularly and is a standard to evaluate the beautiful form in the Architecture [1,2]. This ratio appears in the fundamental rule and satisfies sustainable conditions to form and structural geometries in nature. This study will approve a useful characteristic of the golden ratio when it is applied for optimizing geometries of the cold-formed steel sections. The optimized problem is established by combining the parametric design software, such as Rhino grasshopper and 3D Karamba, with an applied Galapagos Algorithm [3]. The post-optimized geometric sections archive symmetric forms and high strength when two typical sections, C and Z sections [4,5,6], combine each other based on the golden ratio. Besides, the proposed sections are evaluated with the experimental results by using a finite element analysis to increase the reliability of the proposed approach. This study performs reliable and robust parametric design tools, especially with every analysis step in the optimized process. We will create collected data to build a predicted model about geometries and the strength curves of structures by using Machine Learning Tools in the later researches.

STATIC BEHAVIOR OF SANDWICH BEAM WITH FLUID-INFILTRATED POROUS CORE

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Key words: *Functionally graded material, fluid-infiltrated porous material, porous sandwich beam, Navier's solution*

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ABSTRACT

In this report, static response of sandwich beam with fluid-infiltrated porous core and two face sheets made of functionally graded materials is investigated. Variation in mechanical properties of the sandwich beam is assumed to be continuous along the thickness direction. Various beam theories for one-dimensional modelling of the beam are considered. The relationship between stress and strain obeys Biot's theory of linear poroelasticity. The governing equations of the system are derived by applying Hamilton's principle and solved analytically by Navier's solution. Comparative and comprehensive studies are conducted to examine both the accuracy and the effects of parameters, such as power law index, porosity and pore pressure coefficients, core-to-face thickness ratio, span-to-height ratio on the bending characteristics of the beam.

MULTISCALE MULTIPHYSICS PROBLEMS (MMP)

FAILURE ANALYSIS OF PRESSURIZED HOLLOW CYLINDER MADE OF COHESIVE-FRICTIONAL GRANULAR MATERIALS

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Key words: *Multi-scale, FEM, DEM, granular materials, hollow cylinder*

ABSTRACT

Innovative approach that combines Finite Element Method (FEM) and Discrete Element Method (DEM) [1,2] has been applied for investigating the failure of pressurized hollow cylinder made of cohesive-frictional granular materials. At microscopic level, a Representative Volume Element (RVE) by granular assembly is used to describe the discrete nature of granular media. DEM-based model is defined through this RVE. At macroscopic level, we use FEM to simulate the boundary value problem. Two levels are then bridged through numerical homogenization. By the way, the numerical problem is studied at both macro- and micro-scales. The recent findings within the framework of multi-scale modeling showed that the existence of RVE was not evident, especially for softening materials. This relates to the loss of uniqueness when bifurcation occurs. To preserve the objectivity of the solution, local second gradient is proposed and shown to be efficiently regularize the problem. The numerical results by FEM-DEM modeling indicate that when failure occurs, shear band is reproduced numerically in case of pressurized hollow cylinder, consistent with those from experiment. As a unique opportunity, macro-micro analyses reveal a close connection between macroscopic phenomenon and microscopic properties evolutions.

ISOGEOMETRIC ANALYSIS FOR A PHASE-FIELD MODEL OF VESICLES UNDER THE INFLUENCE OF AN ELECTRIC FIELD

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Key Words: *Isogeometric analysis, phase-field method, lipid bilayer, vesicle, electromechanics*

ABSTRACT

We present an isogemetric formulation [1] for a phase-field model that describes the shape changes of a vesicle under the influence of an electric field [2]. The model can be considered as a constrained optimization problem with the objective of minimizing the total energy of the system, which includes the bending, flexoelectric, and dielectric energies of the vesicle, and the dielectric energy of the electrolyte. This optimization problem is coupled with a Poisson's equation of the electrostatics. Compared to the previous mixed finite element implementation for this phase-field model using a monolithic approach [2], our method, implemented based on a staggered scheme, has the advantage that it exploits high-order global continuity of spline functions, thus makes it possible to directly solve the primal variational formulation of the 4th-order shape equation of the vesicle. Moreover, we adopt a modified augmented Lagrangian method (ALM) [3] for imposing volume and area constraints; these geometric constraints are typical for this class of problems. It turns out that ALM can impose the constraints very accurately throughout the whole duration of simulation. This, as a result, provides a good numerical stability and allows for relatively large time-step sizes. Through several 3D numerical examples, we study the electric response of vesicles under different conditions and investigate the effects of electric conductivity and flexoelectricity on the vesicle shape.

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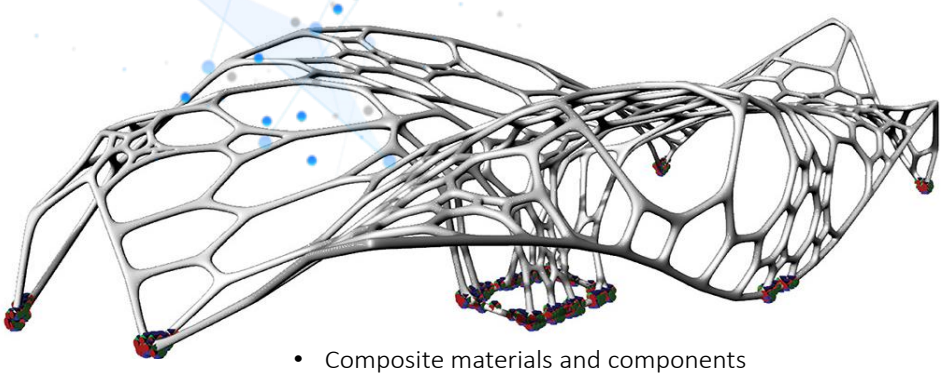

- Composite materials and components
- Computation methods for lightweight composite materials
- Optimization and Design for Additive Manufacturing
- Data-driven Modeling Using Uncertainty Quantification, Machine Learning and Optimization
- Reinforced concrete, steel and steel-concrete composite structures
- Smart Structures: From 3D to 4D Printing Computational
- Modeling of Damage and Fracture in Brittle and Quasi-Brittle Materials
- Advanced Plate/Shell Models and Computational Aspects

SMART STRUCTURES AND MATERIAL SCIENCES

EFFECT OF LOW TEMPERATURE ON THE MECHANICAL BEHAVIOR OF HIGH DAMPING RUBBER BEARINGS

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Key words: *High damping rubber bearings, temperature dependence, mechanical behavior, viscosity*

ABSTRACT

High damping rubber bearings (HDRB) is a useful seismic resistant device that is widely used in buildings due to many outstanding advantages. However, the mechanical characteristics of HDRB are complicated such as temperature-dependent, rate-dependent. This paper is devoted to investigate the low temperature dependence of HDRB's mechanical behavior. For this purpose, the experiments on HDRB conducted at -30oC, -10oC, and 23oC is to investigate the low temperature dependence of mechanical behavior of HDRB. A numerical calculation to determine the viscosity of HDRB was conducted to investigate the low temperature dependence of HDRB's viscosity. Experimental results show that a significant increase in the rate-dependent overstress at low temperatures. This behavior can be ascribed to the temperature dependence of HDRB's viscosity. It means that the viscosity effect of the material increases when temperature decreases. In addition, the experimental observations indicate that the rate sensitivity of HDRB depends on the low temperatures. On the contrary, the dependence of the rate-independent equilibrium stress at the end of the relaxation process is quite weaker. Furthermore, the results of the numerical calculation to identify the viscosity of HDRB also agree with the conclusions obtained from the experimental observations.

NONLINEAR BUCKLING AND POSTBUCKLING OF ES-FG POROUS CYLINDRICAL SHELLS UNDER EXTERNAL PRESSURE

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Key words: *Porous cylindrical shells, Stiffened, Post-buckling, Analytical modeling*

ABSTRACT

The nonlinear buckling and post-buckling behavior of eccentrically stiffened functionally graded (ES-FG) symmetric porous cylindrical shells subjected to external pressure are investigated by the analytical approach in this paper. The shells are reinforced by eccentrically rings and stringers attached to the inside and material properties of face sheets and stiffeners are assumed to be continuously graded in the thickness direction. Fundamental relations, equilibrium equations are derived based on the smeared stiffeners technique and on the Donnell shell theory with von Kármán geometrical nonlinearity. Using three-terms solution and Galerkin's method, the expression to determine the critical load and post-buckling are given. To validate the proposed method, the comparisons are made with available results and show good agreements. The effects of Geometric parameter, porosity parameters, the thickness of the porous core, stiffeners and material parameters are investigated.

NONLINEAR TORSIONAL BUCKLING AND POSTBUCKLING OF ES-FG POROUS CYLINDRICAL SHELLS IN THE FRAMEWORK OF THE SHEAR DEFORMATION THEORY

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Key words: *Torsion, FSDT, Buckling and post-buckling, ES-FG Porous Cylindrical shells*

ABSTRACT

The main aim of this paper is to investigate the nonlinear buckling and post-buckling of eccentrically stiffened functionally graded (ES-FG) porous cylindrical shells surrounded by elastic foundations in thermal environments and under torsional load by analytical approach in terms of displacement components. Shells are reinforced by eccentrically rings and stringers attached to the inside and material properties of face sheets and stiffeners are assumed to be continuously graded in the thickness direction. Based on the first order shear deformation theory (FSDT) with von Karman geometrical nonlinearity and smeared stiffeners technique, the governing equations are derived. Using Galerkin method, the closed form to find critical torsional load and post-buckling load-deflection curves are obtained. The effects of porosity parameters, the thickness of the porous core, temperature, stiffener, foundation, material and dimensional parameters are analyzed.

EXPERIMENTAL AND FINITE ELEMENT ANALYSIS OF HIGH STRENGTH STEEL FIBER CONCRETE – TIMBER COMPOSITE BEAMS SUBJECTED TO FLEXION

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Key words: *Concrete-timber, composite beams, flexural behavior, fiber content, Dramix fiber*

ABSTRACT

The timber- concrete composite structure has been widely used in both new or repair buildings. In fact, concrete cracking in timber–concrete composite beams causes a stiffness reduction of the concrete and increases deformations and stresses [1]. The addition of high strength steel fibers to the concrete limits effectively the appearance of cracks and improves the ductility of the structure. In the experimental study, the concrete beams realized with high strength Dramix fibers have been tested in compression and 3-point bending. The content of steel fibers has been taken into account with a range from 0 to 50 kg/m^3. The results demonstrated that the content of steel fibers did not impact to the compressive strength of concrete but had an important influence on the bending strength. Besides, the mechanical properties of oak and beech have been presented as well. Based on the experimental response, a finite element model has been constructed for imitating the behavior of the steel fiber concrete-timber beam in 3-point bending. In this model, the Concrete Damaged Plasticity Model and Hill yield criterion have been integrated in order to catch the concrete's and timber's response.

BUCKLING ANALYSIS OF FG GPLRC PLATE USING A NATURALLY STABILIZED NODAL INTEGRATION MESHFREE METHOD

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ABSTRACT

This study presents a meshfree approach using a naturally stabilized nodal integration (NSNI) combined with a higher-order shear deformation theory (HSDT) for buckling analysis of functionally graded graphene platelets reinforced composite (FG GPLRC) plates. Various types of distributed graphene platelets (GPLs) consisting of uniform and functionally graded are considered. The Poisson's ratio, density and Young's modulus are calculated by using the rule of mixtures and modified Halpin–Tsai model, respectively. Discretize governing equations are deduced from the principle of virtual work and solved by a moving Kriging (MK) meshfree method to determine buckling load factor of the FG GPLRC plates. Due to using the direct nodal integration and augmenting of stability components, the computational cost is reduced when comparing to the high-order Gauss quadrature scheme. Through numerical examples, the buckling load factor of FG GPLRC plates are affected by the geometries, boundary conditions and distributed patterns of GPLs.

Keywords: *Graphene platelets reinforced composite (GPLRC); moving Kriging meshfree method; NSNI, HSDT.*

VIBROACOUSTIC BEHAVIOR OF FINITE COMPOSITE SANDWICH PLATES WITH FOAM CORE

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ABSTRACT

In this study, based on modal superposition method and Biot's theory, an analytical model on vibroacoustic behavior of clamped and simply supported orthotropic rectangular composite sandwich plates with foam core has been derived. Theoretical predictions of sound transmission loss (STL) across finite composite sandwich plates with poroelastic material agree well with the experimental results in most frequency ranges of interest.

Basing on the numerical results obtained, the influence of different parameters of the two thin laminated composite sheets and polyurethane foam core layer on STL of sandwich plate is quantitatively evaluated and discussed in detail.

POST-BUCKLING RESPONSE OF FUNCTIONALLY GRADED POROUS PLATES RESTED ON ELASTIC SUBSTRATE VIA FIRST-ORDER SHEAR DEFORMATION THEORY

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Key words: *Post-buckling, porous plates, analytical approach, first-order shear deformation theory, stress function.*

ABSTRACT

This paper presents the post-buckling analysis of functionally graded porous (FGP) plates rested on the elastic substrate subjected to in-plane compressive mechanical loads. Based on the first-order shear deformation theory taking into account Von Karman nonlinearity, the governing equations are derived. The Young's modulus of FGP material is assumed to vary through the plate thickness according to three different distribution types including uniform, symmetric, and asymmetric. Galerkin's approach and stress function is utilized to obtain the load-deflection relation for analyzing the post-buckling response of FGP plates. The theoretical formulation is verified by comparing the present results with those available in publications and found good agreement. Through the numerical results, the effect of porosity distribution pattern, porosity coefficient, geometrical configurations, elastic foundations, as well as mechanical loads on the post-buckling response of the FGP plate is indicated.

A SIZE-DEPENDENT MESHFREE APPROACH FOR FREE VIBRATION ANALYSIS OF FUNCTIONALLY GRADED MICROPLATES USING THE MODIFIED STRAIN GRADIENT ELASTICITY THEORY

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ABSTRACT

In this study, we present a size-dependent numerical approach for free vibration analysis of functionally graded (FG) microplates based on the modified strain gradient theory (MSGT), simple first-order shear deformation theory (sFSDT) and moving Kriging meshfree method. The present size-dependent approach reduces one variable when comparing with the original first-order shear deformation theory (FSDT) within five variables and only considers three material length scale parameters to capture size effects. Effective material properties as Young's modulus, Poisson's ratio and density mass is homogenized by a rule of mixture. Thanks to the principle of virtual work, discrete system equations which are solved by the moving Kriging meshfree method, are derived. In addition, due to satisfying a Kronecker delta function property of the moving Kriging integration shape function, essential boundary conditions are easily enforced similar to the standard finite element method. Rectangular and circular FG microplates with different boundary conditions, material length scale parameter and volume fraction are exampled to evaluate natural frequencies.

Keyword: *Moving Kriging meshfree method, functionally graded microplate, modified strain gradient theory, simple first-order shear deformation theory.*

NONLINEAR BENDING ANALYSIS OF FG POROUS BEAMS REINFORCED WITH GRAPHENE PLATELETS UNDER VARIOUS BOUNDARY CONDITIONS BY RITZ METHOD

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***Key words**:* Porous beam, nonlinear bending, Ritz method, different shear deformation beam theories, graphene platelet reinforcement.

ABSTRACT

This paper deals with the nonlinear bending response of functionally graded porous beams reinforced with graphene platelets (GPLs) with various boundary conditions using Ritz method. Based on a general form of different beam theories with Von Kárman type of geometrical nonlinearity, the nonlinear governing equations are derived. The resulting set of equations are solved by the Newton–Raphson iterative technique. Obtained results are verified by comparing with available published results. The effects of porosity distribution patterns, porosity coefficient, GPL reinforcements, slenderness ratios and boundary conditions on the nonlinear deflection of the FGP porous beam are thoroughly investigated.

ELASTIC BUCKLING BEHAVIOR OF FG POLYMER COMPOSITE PLATES REINFORCED WITH GRAPHENE PLATELETS USING THE PB2-RITZ METHOD

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Key words: *Buckling behavior; graphene platelet; pb2-Ritz method; first-order shear deformation theory*

ABSTRACT

This paper deals with the elastic buckling analysis of functionally graded polymer composite plates reinforced with graphene platelets (GPL) subjected to in-plane compression loads based on first-order shear deformation theory. The effective material properties of the nanocomposite are estimated by using the Halpin-Tsai micromechanics model and the extended rule of mixture. Three graphene nanoplatelets distribution types, within the polymer matrix, are considered. The pb2-Ritz method is employed for developing mathematical modelling. The results of this study have been verified by comparing them with those of an existing study. The effects GPL distribution type, weight fraction, geometry and size as well as aspect ratio, and length-to-thickness ratio on the buckling behavior of the functionally graded GPL reinforced composite plate are examined through the numerical examples.

EFFECT OF TEST SPECIMENS ON THE SHEAR BEHAVIOR OF MORTAR JOINT IN HOLLOW CONCRETE BLOCK MASONRY

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Key words: *Shear behavior, mortar joint, hollow concrete masonry*

ABSTRACT

The shear characteristic of mortar joint is the most important factor which decide the behavior of masonry structures subjected to lateral in-plane loading. This article focuses on the experimental study of shear behavior of mortar joint in hollow concrete brickwork. In this experimental program, two types of specimen prepared according to two different standards (RILEM and European standard) were tested in order to study the influence of some formal parameters of test specimens to the shear behavior of mortar joint in hollow concrete brickwork. The test results indicate that the presence of horizontal mortar joints in the assemblies may cause the artifacts which tend to impact the damage and failure mechanism and therefore the failure criteria of brickwork under shear loading. On the other hand, there are very few test results in which the residual shear strength is recorded, which shows that for both cases it is difficult to properly transmit the lateral compressive pressure on shear mortar joint, and the shear failure therefore does not comply with the Mohr - Coulomb criteria. However, the Mohr-Coulomb failure criterion is still satisfied with 99% accuracy if the effect of horizontal mortar joint could be eliminated and the lateral compressive stress could be properly transferred on shear joint.

BULK MODULUS PREDICTION OF PARTICULATE COMPOSITE WITH SPHERICAL INCLUSION SURROUNDED BY A GRADED INTERPHASE

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Key words: *Particulate composite, bulk modulus, graded interphase*

ABSTRACT

The aim of this paper is to estimate the bulk modulus of composite containing spherical inclusion surrounded by an interphase whose elastic properties vary with radius. Based on the sphere assemblage model and the differential substitution scheme, the differential equation for the bulk modulus is established. The effective bulk modulus of the material are predicted by numerical integration. The effect of interphase zone is also investigated.

STUDYING THE STRENGTH OF AN ACIDIC SOIL-CEMENT MIXING IN LABORATORY

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Key words: *Design of experiments, orthogonal array, unconfined compression strength, ANOVA, percentage of contribution..*

ABSTRACT

This paper aims to study the control factors which contribute to the unconfined compression strength (UCS) q_u of acidic soil mixing with cement in the laboratory. By selecting factors of physical properties (represented by plasticity index Ip), mechanical properties (undrained strength Su), chemical property of pore water (pH degree, or fine contents that stand partly for mineral components), and binder (by weight per m3 of improved soil), a design of experiments are preliminarily studied to rank the importance of each factor. It is necessary to govern the lab test by using a Plaxis model in which the lab test is simulated with data obtained from the real lab test. Two uncontrollable factors are the undrained/drained condition of analysis and the scale of mixing, i.e. mixing with a small amount and mass mixing. There are 9 runs of virtual experiments, integrated with four cases of possible uncontrollable. An analysis of variance (ANOVA) was conducted to identify the percentage of contribution of control factors in all the possible cases. The results indicate unconfined compression strength is affected mostly by the binder, then the pH concentration, the soil plasticity, and the strength of the original soil. The best performance of the mixture will be of high percentage of binder, for high plasticity soil and soft soil. This study can be further to predict the effectiveness of soil-cement mixture in the laboratory before mixing the materials on the site.

A STUDY ON METHODOLOGY OF IMPROVEMENT THE HYDRAULIC SYSTEM FOR COMETTO SELF-PROPELLED TRAILER SYSTEM

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Key words: *Self-propelled trailers, Hydraulic system, MSPE, Heavy transpost.*

ABSTRACT

In recent years, the transport of large packages with super weight from 100 tons to several thousand tons is no longer a difficult problem due to the continuous development of technology. Experienced transport companies, specializing in transporting heavy goods in Vietnam, have invested in very modern equipment and machinery such as self-propelled trailers of Cometto (Italy) in order to transport safely mentioned parcels of great economic value arrive at the requested location. This trailer can be self-propelled, does not need to use a tractor, and only needs to use a remote control handheld device. Moreover, the trailer axes can rotate 360 degrees. In particular, the hydraulic system supports trailers operating with high accuracy and absolute safety including functions such as 360 degree rotation, lifting, transmission, braking, etc. In order to improve the performance of trailers when actually used in large projects, an important detail in the trailers hydraulic system has been inserted a throttle valve with to increase the safety of the hydraulic pump and the entire system as well as the safety of the goods that trailers are transporting. The trailer system has transported the rig with a capacity of up to 3,200 tons in Vietnam, the shipment of 15,000 tons in the world and beyond in the future.

AUXETIC STRUCTURE DESIGN: A MULTI-MATERIAL TOPOLOGY OPTIMIZATION WITH ENERGY-BASED HOMOGENIZATION APPROACH

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Keywords: *topology optimization, homogenization, multiphase, auxetic material*

ABSTRACT

In this research, the auxetic structure is designed by employing multi-material topology optimization approach to form the unit cells that reproduce the negative Poisson's ratio property. The multiphase topology problem is divided into a series of binary phase topology optimization sub-problems, which are partially solved by homogenizing the material constitutive parameters concerning element mutual energies. With constraints on individual material volume fraction, this numerical framework allows to extremize the objective function constructed by homogenized Poisson's ratio. Several two-dimensional numerical examples are studied to illustrate the performance of this algorithm. Benchmark auxetic designs are verified through finite element simulations.

MUTI OBJECT PREDICTION AND OPTIMIZATION PROCESS PARAMETERS IN COOLING SLOPE USING TAGUCHI-GREY RELATIONAL ANALYSIS

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ABSTRACT

In the present work, the effect of processing parameters of cooling slope techniques of ADC 12 Aluminum alloy on its microstructural evolution has been studied in detail. Three important process parameters such as the pouring temperature (580^{o}C, 585^{o}C and 590^{o}C), slope length (300, 450 and 600 mm) and slope angle (300, 450 and 600 deg) were investigated in this study. The plan of experiments based on Taguchi's were used for acquiring the data. The effect of processing parameters on the particle size and shape factor have been investigated by applying analysis of variance (ANOVA) for grey relational grade. ANOVA results show the influence of these parameters on the experimental results as the slope angle (37.3%) is the most significant input variables that influence particle size followed by pouring temperature (35.3%) and slope length (27.3%). The results also indicated a new optimal value that has not been conducted in the experimental plan to improve the effectiveness of the experiment.

Key words: *Semi – solid, cooling slope casting, Taguchi method, ANOVA, grey relational analysis*

DISCUSSION ON CHOOSING LOCATION AND DISTANCE TO PUT GEOTEXTILE LAYERS IN EMBANKMENT OF HIGHWAYS TO INCREASE THE STABLE SAFETY FACTOR

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ABSTRACT

The geotextile is being widely used to reinforce embankments, dikes, dams, etc. because this material has many advantages such as high tensile strength, durability, reasonable price, easy to manufacture and use and so on. In recent years, geotextile with tensile strength from dozens of kN/m to dozen thousands of kN/m have been produced all over the world.

In embankment designs of highways using geotextile for stabilization of soil foundation, the choice of location to put geotextile layers in the background and how much distance between them to be able to promote ability and mobilize simultaneously the efficient functioning of the soil-geotextile structure system is an important consideration. In this article, the author analyzes the finite element method, experiments on computational software and discusses the location solution to improve the efficiency of work, increase safety factor stability of embankment, as well as save materials, and lower construction costs. In the calculation of this paper, the author analyzes the data of the Da Nang - Quang Ngai highway (Vietnam), in the section from Km0 + 00 to Km8 + 00 on the mechanical properties of the ground soil, embankment soil and strength of geotextile as well as geometry of this high embankment. (The Da Nang - Quang Ngai highway was built and started to be used in phase 1 in 2017 and the entire route in 2018).

Keywords*: geotextile, embankment, safety factor, highway , finite element.*

CLASSIFY MATURITY OF CHERRY TOMATO USING DEEP LEARNING TECHNIQUES

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Key words: *Deep Learning, Convolutional Neural Network, Cherry tomato classification*

ABSTRACT

Cherry tomatoes maturity level plays a significant part in the harvest. In a high-tech agricultural environment, cherry tomato harvesting systems based on personal experience and conventional knowledge systems are unable to meet the manufacture and management requirements since they are time-consuming and lack accuracy. This research studies a method of deep learning-based grading to maturity. We carry out sorting systems adopting convolutional neural network (CNN) by preparing and verifying the model on various augmented datasets, and we attempt to select an optimal method to increase image datasets. The experimental results show that there is a high precision in evaluating the level how the cherry tomatoes ripen. Our solution has obtained better predictive performance both in terms of precision and time utilization in comparison with the current methods.

GENERATING DATABASE USING UNCERNTAINTY ANALYSIS AND MODERN INTEGRATED CODE FOR TRAINING NEURAL NETWORK BASED – IDENTIFICATION SYSTEM OF NPP's REPRESENTATIVE ACCIDENTS WITH VVER-1000 REACTOR

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Key words: *Uncertainty analysis, accident identification, safety analysis, best estimate codes, neural networks*

ABSTRACT

Problem of accident identification in a nuclear power plant (NPP) is an actual question. Beginning stage of an accident and its progression can be difficult to identify because of nonlinearity, non-monotonicity, multidimensionality, and stochastic properties of the accident processes, uncertainty in forecasting by system codes. Existing systems of operator support in an NPP are often based only on determination of a pre-accident situation and identification of the monitoring parameters deviating from their nominal values. However, for effective measures against an accident, it is necessary to have an efficient system which allows determining types of accidents and is able to support an operator or a crisis center during the accident progression.

To solve mentioned problem an accident identification system based on artificial intelligence algorithms in particular neural networks (NN) is proposed [1]. For successful building this system, one of the most important steps in building process of proposed system is to create database of accident scenarios for training and testing neural network model. However, in fact real-database of NPP's accidents is very little and in some cases it is not supplied in full scale. Therefore, real data is not enough for training a neural network model for accident classification/identification.

For supplying data for training and testing phases of training/testing neural network, the method to predict (for modeling) the NPP state during an accident is the using of modern integrated codes (example: RELAP5 type [2]) with taking into account of all possible uncertainties associated with inaccuracy of simulation and with random parameters of the streaming of an accident based on the application of uncertainty analysis.

This paper presents an effective method for generating database using the uncertainty analysis and modern integrated code for training and testing neural network based – identification system of NPP's accidents with VVER-1000 reactor. In current research the uncertainty analysis on base of Wilkes formula has been used as e.g. in [3]. Training of neural network model for accident identification and its results are discussed. NN based – identification system allows identifying a type of accident on earliest stage and during of the accident evolution as well. The proposed system was demonstrated by calculations for accidents of the NPP with VVER-1000 reactor. In order to increase the effectiveness of calculation implementation for uncertainty analysis, a technique of parallel computing realized in a developed program complex "Nuclear Plan Optimizer –NPO" has been applied.

ON THE APPLICATION OF THE THIN-WALLED THEORY TO CALCULATE THE SEMI-ENCLOSED CORE WALL STRUCTURE OF HIGH-RISE BUILDINGS SUBJECTED TO LATERAL LOADS

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Keywords: *Semi-enclosed core wall, coupling beam, thin-walled theory, discrete-continuous model, SAP2000*

ABSTRACT

The shape of the core walls of a high-rise building is usually semi-enclosed; the coupling beams connecting the two open flanges at the level of floors play an important role in the working of the core.

The discrete-continuous model used to calculate semi-enclosed core structures based on the thin-walled theory proved to be quite useful and evaluated the overall working as well as the structural components in the core. However, this theory also has certain assumptions about the correlation between core flanges and coupling beams.

The paper will investigate cases of core flanges corresponding to the several cases of the height of coupling beams according to the above theory and compare with calculated results of SAP2000 to evaluate, figure out the right use of the calculation theory. The research results serve as a basis for the design of the core wall structures of high-rise buildings.

NUMERICAL SIMULATION OF FULL-SCALE SQUARE CONCRETE FILLED STEEL TUBULAR (CFST) COLUMNS UNDER SEISMIC LOADING

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Key words: *Square CFST columns, finite element analysis (FEA) model, concrete confinement effect, local buckling, width-to-thickness ratio (B/t), high axial compression, seismic performance*

ABSTRACT

This paper presents numerical investigations on the seismic behavior of full-scale square concrete filled steel tubular (CFST) columns. The main objective is to understand the seismic behavior and evaluate the seismic performance of these composite columns under high axial compression. Finite element analysis (FEA) models in Abaqus software were used to simulate a series of columns subjected to axial compression and cyclic lateral loading. The CFST columns were modeled using nonlinear tri-dimensional (3-D) finite elements for the concrete infill with confinement effect, and nonlinear two-dimensional (2-D) finite elements for the steel tube with consideration of steel-concrete interaction and steel wall's buckling. The feasibility of the FEA models has been validated against published experimental results. The validated FEA model was further extended to conduct parametric studies with various parameters including width-to-thickness ratio (B/t), steel grade, concrete strength, and axial compression level. The numerical analysis results reveal that with the same B/t and constitute materials, the higher the axial compression, the lower the shear strength and deformation capacity were. Also, the higher axial compression led to earlier local buckling of the steel tube, especially in the case of the thinner steel wall (B/t of 41.7). The thicker steel wall (B/t of 20.8) resulted in higher strength and larger deformation capacity of the column. Increasing material strengths helped to significantly develop the column's shear strength for both thinner and thicker steel walls, but it just led to significant development in deformation for the column having thicker steel walls. This study also reveals that only the square CFST columns with B/t of 20.8 using medium material strengths satisfy the seismic performance demand for the building columns in high seismic zones (ultimate interstory drift ratio not less than 3% radian) under high axial compression (up to 55% of the nominal compression strength, P_0).

SEISMIC PERFORMANCE OF CONCRETE FILLED STEEL TUBULAR (CFST) COLUMNS WITH VARIOUSLY AXIAL COMPRESSIVE LOADS

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Key words: *Concrete filled steel tubular (CFST) columns, seismic performance, deformation capacity, axial compression, width-to-thickness ratio (B/t), interstory drift ratio (IDR)*

ABSTRACT

This paper presents a study on the seismic performance of square concrete filled steel tubular (CFST) columns under different axial compressions. A total of four full-scale specimens using the steel tube with a width-to-thickness ratio (B/t) of 42 was tested by combined axial compression and cyclic lateral loading. In which, three specimens were subjected to constant axial compression, P = 0.15, 0.35 and 0.55P_0, respectively, and one specimen was applied varied axial compression varying from 0.15 to 0.55P_0 (P_0 is nominal axial compression strength of the column) that is an assumption for designing exterior columns in a typical moment resistance frame (MRF) system. An identical loading protocol according to the AISC 341-16 code was adopted as the basis of cyclic lateral displacement loading for all four specimens. Test results reveal that there were significant differences in yielding and local buckling process in the steel tube, lateral (shear) strength, deformation capacity, and lateral stiffness degradation of the columns. For three CFST specimens with constant axial compression, the higher the axial compression, the smaller the lateral strength and deformation capacity were. Another important finding in the specimen with varied axial compression, CFST42-15/55C, was a discrepancy in lateral strength and deformation capacity in positive and negative directions of cyclic lateral displacement. It was found that Specimen CFST42-55C possesses the lowest lateral strength and deformation capacity with the average ultimate interstory drift ratio (IDR) of only 1.29% radian. The study results also show that these square CFST columns satisfy the highly seismic requirement when the axial compression not exceeded to 0.35P_0 with their average ultimate IDR of more than 3% radian. To improve the seismic performance of these composite columns with higher deformation capacity, reducing the B/t limit is one of the effective ways.

NUMERICAL MODELING OF SHEAR BEHAVIOR OF REINFORCE CONCRETE BEAMS WITH STIRRUPS CORROSION: FE VALIDATION AND PARAMETRIC STUDY

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Key words: *Reinforced concrete, corroded beams, stirrups corrosion, shear behavior, nonlinear finite element.*

ABSTRACT

Stirrups in reinforced concrete (RC) beams are more vulnerable to corrosion than longitudinal steel bars due to the thinner concrete cover [1]. As a result, the stirrups corrosion can lead to a possibility of shear failure instead of bending failure for RC beams. While the shear behavior of RC beams with stirrup corrosion has been mainly studied using experimental investigations, the numerical methods on this subject have not been efficiently documented. In this study, finite element (FE) model is used to simulate the structural behavior of five RC beams with the dimensions of 130 x 260 x 2000 mm having different corrosion degrees of stirrups ranging from 0% to 30% tested in the experiment conducted by Ye et al. [2]. To model the shear behavior of the tested beams, the existing constitutive models of the materials and the steel-concrete bond [3] are used. The FE model validation is calibrated based on the experimental results (e.g. load-deflection relationship, crack pattern). A parametric study was then implemented to assess the effect of influencing parameters on the shear strength of corroded RC beams, such as stirrup corrosion degree, concrete compressive strength, stirrup ratio, and steel-concrete bond strength. The results show that the loss of bond between stirrups and concrete resulted in the greatest reduction in load and deflection among the parameters of corrosion damage. Moreover, as concrete compressive strength decreased or the stirrup ratio increased, the contribution of corroded stirrups to the shear strength of the beam increased followed by the rapid deterioration of shear strength and ductility in corroded RC beams.

CHARACTERIZATION OF STRESS RELAXATION BEHAVIOR OF POSCABLE-86 HIGH-STRENGTH STEEL WIRE

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Keywords: *Stress relaxation, Relaxation rate, Long term behavior, High-strength steel*

ABSTRACT

High-strength steel has been widely used in civil and building structures, especially in the cable-supported structures, since this material can be designed as a key structural component to support high-tension loads in the cables [1–7]. Generally, high-strength cables play an important role in the loading bearing capacity as well as the stiffness of structures and are usually designed to support long-term tension loads during the in-service state [8,9]. The long-term tension loads can generate the stress relaxation/creep behavior in the cable components, resulting in the degradation of the tension force in the cables. This can cause the degradation of the initial stress as well as the degradation of the mechanical properties, for example, indentation hardness and yield strength, and finally the failure of whole structures. The degradation of mechanical properties is quite important in the case of the cable structures since these cables are the main components in the structures. Thus, this study reported the stress relaxation of Poscable-86 high-strength steel wire. For this purpose, three stress relaxation experiments were performed at three different initial stress relaxation levels, i.e. $0.5f_u$, $0.6f_u$, and $0.7f_u$. The results showed that stress relaxation behavior includes two main stages. The first stage was a transient relaxation occurring at a few hours of stress relaxation, while the second stage was a secondary relaxation exhibiting a stable rate of stress loss. At $0.5f_u$, the relaxation rate was limited within 1.5% in the period of 10 hours, slightly increased from 1.37% to 1.96% at a testing time from 10 hours to 500 hours, and became stable at 1000 hours. At $0.6f_u$, the relaxation rate quickly increased in the range of 0-1.5% at 10 hours, slightly increased from 1.25% to 2.31% at the corresponding testing time from 10 hours to 500 hours, and finally became stable at 1000 hours. The same behavior could be observed in the case of $0.7f_u$. Furthermore, relaxation rates of all stress levels were limited within 3% at a period of 1000 hours, in which high-strength steel wire exhibited a more rapid transition to the secondary stage at a lower initial stress level. Another interesting feature of stress relaxation behavior is that the relaxation rate is strongly sensitive to the initial stress level. The present relaxation behavior of Poscable-86 was consistent with the general trend reported in the literature [7]. The long-term relaxation rate ($R_{\text{Long-term}}$) of the tested wire was investigated using a Fib model via the values of relaxation rates at 1000 hours (R_{1000}) as, $R_{\text{Long-term}}=R_{1000}(t/1000)^K$ [10]. The results indicated the relaxation rates of Poscable-86 wire at $0.7f_u$ at 10 years, 20 years, and 50 years were 4.23%, 4.54%, and 4.98%, respectively. Similarly, at $0.5f_u$, the relaxation rates of $0.5f_u$ are 3.34%, 3.57%, and

3.89% were calculated at 10 years, 20 years, and 50 years, respectively. It could be recognized from the long-term relaxation rate behavior that there was no indication that the relaxation rates will reach the limiting values for all cases. The present results of the relaxation rate at both the short-term and the long-term were in good agreement with the general trend reported in the literature [7,11–13].

STATISTICAL ERROR IN THE DETERMINATION OF CONCRETE PROPERTIES AND ITS INFLUENCE ON PREDICTED SHEAR CAPACITIES OF RC BEAMS WITHOUT STIRRUPS

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Key words: *parameter uncertainty, sample size, shear capactiy, reinforced concrete, shear model*

ABSTRACT

We The shear strength of a reinforced concrete beam without stirrups depends strongly on the concrete properties. Due to the high testing effort involved, often only the concrete compressive strength is determined experimentally, while other concrete properties such as tensile strength, modulus of elasticity and fracture energy are estimated on the basis of the compressive strength using certain conversion factors. The experimental results depend on the number of specimens tested, which is often limited by 3. These concrete parameters therefore show uncertainties and thus directly influence the calculated load-bearing capacity of the examined reinforced concrete member [1]. In this paper, an analysis of the parameter uncertainty, especially the statistical error in the determination of concrete properties and its influence on the calculated shear strength of reinforced concrete beams without stirrups is presented. To illustrate this effect, a newly developed mechanical shear model [2] is used in shear strength calculations, which shows a high prediction accuracy when compared with experimental results, e.g. from the shear test database [3]. Based on the obtained sensitivity factors of the influencing parameters regarding the shear strength, the required sample sizes for the dominant concrete parameters are proposed in order to reduce the parameter uncertainty in shear strength calculation, considering the complexity and the testing effort. The obtained results are discussed and some conclusions on the effect of statistical error in shear strength calculation are drawn.

VARIABILITY OF CONCRETE COMPRESSIVE STRENGTH IN EXISTING CONCRETE BRIDGES

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Key words: *drill core, concrete compressive strength, sample size, concrete bridge*

ABSTRACT

The impact of environment and traffic loads leads to degradations of load-bearing capacities of existing concrete bridges during their service lifes. Therefore, technial assessments are often required for these structures to ensure safety in the operational phase. To this purpose, concrete core drilling is one of the best way to accurately determine the concrete properties. The obtained variability of concrete properties is strongly dependent on the sample size [1], thus shows certain statistical uncertainty, which should be taken into account in the determination of the characteristic and design values of concrete strength. This paper presents investigation results of concrete strength in some existing concrete bridges with the use of drilling cores taken from different positions of the studied structures. The experimental results are evalulated and analysed in detail to establish the relationship between the statistic results and sample size. The obtained results are discussed, leading to some conclusions and suggestions for practical application.

MODELING OF BEAM – COLUMN JOINTS DETAILED COMPLIED WITH VIETNAMESE STANDARDS IN REINFORCED CONCRETE FRAME BUILDING UNDER SEISMIC CONDITIONS

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Key words: *Beam – column joints, seismic resistance,*

ABSTRACT

Experienced showed that Beam - Column joints in Reinforced Concrete Frame Buildings can be one of the first to reach the critical conditions when the earthquake happened. For structural analysis under seismic loading, the goal is to capture the hysteresis behavior of these critical components to serve the next step. Reinforced Concrete Frame structures in Vietnam are currently conforming to the old concrete structure design code (TCVN 5574: 1991), current standards (TCVN 5574-2012) including / not including seismic resistance code (TCVN 9386: 2012), This resulted in wide range of joints with different detailed (also called seismically or non-seismically joints). The paper is based on Vecto2 software (University of Toronto, Canada) to model the beam –column joints which be designed and detailed according to the above criteria to describe cyclic loading response and some calibrations are made during the modeling process according to the test results were conducted in Vietnam.

EXPERIMENTAL STUDY ON SHEAR RESITANCE OF REINFORCED CONCRETE BEAM REINFORCED BY INCLINED STIRRUPS

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Key words: *Shear resistance, transverse stirrups, inclined stirrups, reinforced concrete beam*

ABSTRACT

Shear capacity of reinforced concrete beam has been intensively investigated both in domestic and international research community. In this work, the shear capacity of reinforced concrete beam with rectangular cross section is further enhanced by stirrups. Experiments are conducted for two cases: transverse stirrups and inclined stirrups with various angles of inclination. Results are verified with available codes and standards. Based on the experimental outcomes, suggestions on procedure and methods to design reinforced concrete beam with stirrups are made.

PROPOSAL OF THRESHOLD VALUE OF MOISTURE CONTENT OF CONCRERE FOR APPROPRIATE MEASUREMENT OF SURFACE WATER ABSORPTION TEST

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Key words: *Threshold value, moisture content, appropriate measurement, Surface Water Absorption Test, measurement time, surface absorption resistance.*

ABSTRACT

There are several methods to estimate the surface absorption of concrete cover (covercrete). Surface Water Absorption Test (SWAT) [1] is fully non-destructive test of covercrete which can evaluate the surface absorption resistance of concrete in real structures with short measurement duration. However, moisture content in covercrete of real structures changes when weather changes affecting water absorption of concrete. Therefore, it needs to define the rational threshold values of moisture content to apply for surface water absorption test (SWAT). Moreover, when concrete is stored in wet condition for long duration, the inner moisture profile becomes complex. In this case, conducting SWAT in 10 minutes [2] is not sufficient to evaluate the surface water absorption resistance of covercrete. Therefore, define the rational threshold values of HI-100 for SWAT is important to investigate. In addition, the effect of rehydration of concrete stored in humid condition for long duration on the absorption of covercrete was investigated in the present study. It was found in some cases that. In dry to wet process, CMEX-II, HI-520-2 can be used to detect moisture content for SWAT when moisture contents are lower than 6.0%, and 5.0% respectively. CMEX-II and HI-520-2 cannot be used to detect moisture content before conducting SWAT test in wet to dry process. HI-100 can be utilized to detect moisture content for SWAT when count values are lower than 190. A new index called water absorption coefficient which may reduce the measurement time for SWAT and can evaluate quality of covercrete reliably is proposed.

NUMERICAL MODELING OF CREEP CONCRETE BEAM AND SLAB WITH BOLTZMANN SUPERPOSITION PRINCIPLE

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Key words: *Creep, linear viscoelastic, beam, slab, Boltzmann*

ABSTRACT

Creep behavior can be idealized by a visco behavior combined with another mechanical behavior such as elastic and plastic behavior of structures to describe the recoverable and non-recoverable deformations which are existence of structure when subjected by the environmental factors caused the deterioration of material properties. The linear viscoelasticity using history variable can be described the creep behavior of structure composites such as concrete which uses the principle of superposition and proportionality property then leads to Boltzmann integral also called memory integral. By using this integral method, the creep model for Timoshenko beam and Mindlin plate will be evaluated by the Finite Element Method (FEM) combined Prony's series interpolation through MATLAB program. The creep datas used for Prony's series interpolation are based on international standards. These results obtained by FEM will be compared with available referred results and the results of the analytical method.

FINITE ELEMENT MODELLING FOR CONCRETE ENCASED STEEL USING HIGH STRENGTH MATERIALS

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Keywords: *Concrete encased steel columns, Axial capacity, High strength, FEM, Composite columns.*

ABSTRACT

In this paper, the authors present an investigation of structural behavior on Concrete Encased Steel (CES) composite short columns subjected to uneccentric loading. Test specimens are using the material high strength concrete and high strength steel. Specifically, two concrete grades C90, C130, and two steel grades S500, S690 are used. The ultimate strength of columns is affected by parameters such as material strength, residual stress in encased steel, and spacing of transverse reinforcement bars. 3D finite element (FE) model is used to evaluate and analyze the behavior of the CES column including failure modes, load-carrying capacity, load-deformation response. Finally, codes' prediction using the EC4, ACI, and the prediction form the proposed FE model are used for comparison and discussion. CES columns with normal strength, both codes give a reasonable prediction. However, both codes overestimate the load-carrying capacity when using concrete grade up to C130.

NANOINDENTATION FOR MECHANICAL PROPERTIES OF MICROSTRUCTURE IN ULTRA-HIGH PERFORMANCE CONCRETE

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Key words: *Ultra high performance concrete, microstructures, micromechanical properties, nanoindentation, statistical analysis*

ABSTRACT

In this study, grid nanoindentation and statistical deconvolution analysis were applied into a developed Ultra-high performance concrete (UHPC) to broaden the understanding of the microstructure phases and their mechanical properties. A larger number of nanoindentation tests was carried out on UHPC and the mechanical properties, including indentation modulus and hardness of the indented material were extracted from nanoindentation load-depth curves. The statistical deconvolution analysis was then utilized to analysis the modulus and hardness spectra. The experimental and analysis results revealed that the modulus and hardness data obtained from nanoindentation tests can be used in the accurate and reliable identification of the microstructure phases and their properties in UHPC. For the present UHPC, the microstructure can be characterized into 6 phases with distinguishable mechanical properties, including micro porosity, LD and HD CSH, silica powder and sand, and residual cement clinker. The modulus and hardness values of these phases are obtained to be in the range of various reported ones for cement based materials and UHPC.

AN ARTIFICIAL INTELLIGENCE APPROACH FOR PREDICTING COMPRESSIVE STRENGTH OF ECO-FRIENDLY CONCRETE CONTAINING WASTE TIRE RUBBER.

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Key words: *Artificial neural networks, eco-friendly concrete, compressive strength, multilayer perception, sensitivity analysis*

ABSTRACT

Using waste tire rubber as replacement aggregate in the production of concrete can be considered as an effective way for environment and economic. This study presents an approach based on prediction model by using Artificial Neural Networks (ANN) to predict compressive strength of eco-friendly concrete containing waste tire rubber (RC). A data set including 129 samples with nine influencing features of water, cement, supplementary cementitious materials, coarse aggregate, coarse rubber aggregate, fine aggregate, fine rubber aggregate, superplasticizer, age using for training and validating models have been collected from the literature. The output was compressive strength of RC. The combination of root mean square propagation and stochastic gradient descent with momentum method is employed to train the ANN. Using various validation criteria such as coefficient of determination (R2), Mean Absolute Error (MAE) and Root Mean Squared Error (RMSE), the ANN model was validated and compared with two machine learning (ML) techniques Random Forest (RF) and Multilayer Perception (MLP). A Sensitivity analysis also was carried out to validate robustness and stability of these models. The experimental results showed that the ANN model outperformed in comparing with other models and therefore it can be used as a suitable approach to predict compressive strength of eco-friendly rubber concrete.

ANALYSIS THE EFFECT OF VOIDS, INCLUSIONS ON CRACK BEHAVIOR BY THE EXTENDED TWICE - INTERPOLATION FINITE ELEMENT METHOD

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Key words: *XTFEM, twice-interpolation, inclusion, void, crack*

ABSTRACT

The mixing of inclusions into materials is one way to strengthen and increase the durability of them. However, apart from inclusions in material, other defects such as voids still have the chance to appear and affect the durability of the material. The existence of voids, inclusions will affect the behavior of the crack. In this paper, the authors will analyze the effects of voids, inclusions, on the behavior of crack when under various loads by extended twice-interpolation finite element method-XTFEM. The results of stress intensity factor obtained from numerical examples will clearly show the impact of different types of voids and inclusions on cracks. The results obtained by XTFEM will be compared with the results with different methods published in prestigious international scientific journals.

CONSTITUTIVE RESPONSE AND FAILURE PATTERN OF HIGHLY POROUS CEMENT-BASED MATERIALS UNDER TRUE TRIAXIAL STRESS STATES

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Keywords: *porous material, triaxial, constitutive behaviour, DEM*

ABSTRACT

The constitutive response and failure mechanism of a highly porous cemented material are controlled by the competition of the shear failure and pore collapse. These micromechanical processes are mainly dependent on the material density and the stress state. In the study, the discrete element method (DEM) is utilised to explicitly describe the internal pore-structure, while the mortar phase is modelled at the micro/meso-scale using a cohesive-frictional model. Numerical true triaxial tests are conducted on numerous DEM foam concrete specimens with various densities/porosities and stress paths. The mechanical data show that the transition, from brittle failure into cataclastic flow, is heavily dependent on the material density as well as the stress state. The insight into pore collapse and share failure development is well discussed. In addition, the failure surface of a typical highly porous material is defined in the paper. This feasible study demonstrates the potential of the DEM modelling in investigating the failure mechanism of the highly porous cemented material under multi-axial tress state.

DAMAGE SIMULATION BASED ON THE PHASE FIELD METHOD OF POROUS CONCRETE MATERIAL AT MESOSCALE

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Key words: *damage modelling, pervious concrete, phase field method*

ABSTRACT

In this research, a study on damage behavior of porous concrete was conducted. Based on the phase field theory and the generation process based upon Monte Carlo's simulation method, we construct a numerical procedure to solve complex damage thermodynamic problems. The phase field variable obtained can be used to model crack behavior within porous concrete structure. Some factors that affect the results are discussed to make the predictions more accurate for the case of porous concrete material. Illustrations of applications are provided in examples to show the usefulness of the approach.

STUDY ON DESIGN OF SOLAR ENERGY RECEIVER

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Keywords: *Solar design parabola, solar receiver tube, solar energy, solar radiation spectrum*

ABSTRACT

This research presents the principle of solar system energy receiver recently in Vietnam and around the world. We have investigated the strategy to collect solar energy with high productivity due to its practical application in life. On the other hand, we have used this method because of its outstanding advantages comparing to others in Vietnam. The collector will be put incline compare to horizontal approximate that local latitude. It is made from glass flats absorbed thermal energy or parabolic-shaped materials. Meanwhile, the surface area of the receiver depends on the power of thermal appliances. The solvent using in the collector is any liquid, but water is applied widely to ensure economic efficiency and high safety. As a result, the design of a mini-sized solar energy receiver was innovated from the old versions to consider whether theoretical fundamentals and realistic models are in a good agreement [1,2,3,4,5,6].

IMAGE RECOGNITION USING UNSUPERVISED LEARNING BASED AUTOMATIC FUZZY CLUSTERING ALGORITHM

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ABSTRACT

This article proposes a novel techniques for unsupervised clustering in image recognition using automatic fuzzy clustering algorithm (AFCA) for discrete data. There are two main stages in order to recognize images in this study. First of all, new technique is shown to extract sixty four textural features from n images represented by a matrix ($n \times 64$). Afterwards, we use the proposed algorithm to simultaneously determine the appropriate number of clusters, and probability of assigning objects to the established clusters. The simulation result built by Matlab program shows the effectiveness of the proposed algorithm using the corrected rand, the partition entropy, and the partition coefficients index. The experiment outcomes illustrate that the proposed algorithm is better than the existing ones as Kmean, Fuzzy C-mean and self-update clustering algorithm. As a result, we believe that the proposed algorithm is filled with a potential possibility which can apply in practical realization.

Key Words: *automatic algorithm, cluster analysis, image, fuzzy, unsupervised clustering*

BUILDING A TIME SERIES FORECASTING MODEL BASED ON FUZZY RELATIONSHIPS

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ABSTRACT

This study builds a forecasting model for time series based on important improvements. In this model, the universal set is the variable value of two consecutive time points of the past, and the relationships between the elements in the series are built based on the fuzzy cluster analysis algorithm. The forecasted value for the future is based on the contiguous value, and the average of the variation of the historical values determined from the established fuzzy relationships. Implementing for many important knowledge data sets, the result show that the proposed model has many advantages over the common others. This study also apply the proposed model to forecast the salty peaks for a coastal province in the Mekong Delta, an urgent problem in Vietnam today.

Key Words: *Cluster analysis, forecast, fuzzy relationship, time series model*

MECHATRONICS

STABLE WORKING CONDITION AND CRITICAL DRIVING VOLTAGE OF THE ELECTROTHERMAL V-SHAPED ACTUATOR

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Key words: *Electrothermal V-shaped actuator, stable working condition, critical driving voltage, finite differential equation.*

ABSTRACT

Micro electrothermal actuators are significant component of MEMS devices thanks to some outstanding feature as a large output force, low driving voltage, simple structure and batch fabrication. Based on an elastic beam shape, they can be classified into three types: U-shaped, V-shaped and Z-shaped actuators. Comparing to U-shaped and Z-shaped, the V-shaped actuator provides a both larger force and displacement. Hence, it is widely applied for micro devices such as: micro gripper [1], nano material testing device [2], safe thermal device [3] or linear motor [4], etc.

DESIGN OF HIGH RISE BUILDING CLEANING DEVICE

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Key words: Cleaning *device , Glass cleaning , robot,*

ABSTRACT

Cleaning of high rise building glasses is an extremely important problem for building manager. They hire human workers for cleaning their exterior frontage of buildings, which takes too much cost and is highly dangerous. To replace and protect human workers from the risk of falling, design and create automatic building window glasses cleaning device has been one of the concerned topic in the issue of occupational safety recently. In this paper, the authors analyze existing device using functional decomposition. Within the context of a morphological matrix, these device' design embodiment decisions are compared and the resulting performance tradeoffs are quantified. The cleaning device consist of the trapezoid frame, suction cups, and threaded shafts along with AC geared motor, DC motors, and water pumps. The device will be designed using the Solidword software. The cleaning device has two degrees of movements (X, Y). The final targets are to design building window glasses cleaning device that can clean window glasses efficiently and safely.

`DESIGN AND FABRICATION OF MECANUM WHEEL FOR FORKLIFT VEHICLE

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Keywords: *Omni-directional vehicle, Mecanum wheel, Forklift vehicle, Airtraxlift vehicle*

ABSTRACT

Nowadays, science and technology have made remarkable progress in the level of competitive flexibility and broad applicability of the types of automation equipment for the human being developed. In the context, our country's industry is in the process of development to catch up with the level of modern world technology, we require the research that needs a reasonable strategy. The orientation and movement of a ForkLift through the limited narrow space are a rather complex and difficult task. Therefore, some solutions to these problems are offered, one of them is to develop vehicles capability of moving directly to the side, which is known as the name the "Omni-directional vehicle". The use of Mecanum wheeled Vehicles has been becoming imperative in many fields which require high flexibilities. This study introduces some aspects of the Mecanum wheeled Vehicles such as the brief introduction, development history, some advantages, and practical application in various fields. The main content of this paper is that we present the methods of design profile of Mecanum rollers and the mechanical wheeled structure for Omni-directional ForkLift Vehicles that we fabricated. We also implement some results and calculation methods for inspecting the limitation geometry of rollers to get the achievement for workspace requirements and loading capacity.

TOTAL SOLUTIONS IN CREATIVE DESIGN OF GLASS CLEANING ROBOT TYPES OF MULTI-STORY BUILDINGS

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Keyword: Glass Cleaning Robot, Robotic Window Cleaners.

ABSTRACT:

Vietnam is a country with a population of about 100 million people, so the need for housing is always an urgent issue. To solve the problem of housing on small land areas like our country, high-rise buildings have appeared more, with modern designs using glass for apartments or high-rise buildings has also become popular. However, to clean and keep the glass clean during construction and use is not an easy problem.

The use of direct labor for the window cleaning process for tall buildings is not highly efficient, so the automation solution has become the most suitable key, this superior solution brings high productivity. and ensure labor safety for workers.

To clarify this automation solution, the article has used an innovative method to design a robot to wipe glass windows for tall buildings, creating training models for students of mechatronics at Van Lang University.

On the basis of a literature review, the authors have given specific design tasks and proposed methodologies for making various types of robot models. This robot model has a compact design that serves for experimental practice.

RESEARCH AND DESIGN MECHANICAL STRUCTURE OF DNA/RNA AUTOMATED EXTRACTION MACHINE

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Key words: Dentine Caries, RNA Extraction. Gene Expression, Streptococcus mutans, genomic DNA extraction, DNA purification, automation, robotics

ABSTRACT

As of today, Covid-19 patients globally are nearly 20 million. In Vietnam, the second recurrence of the epidemic in Danang brought the number of Covid-19 cases of the country to more than 700 people. The demand for real-time PCR testing here is extremely large. Each automatic DNA / RNA PCR system includes DNA / RNA Extraction Machine, Automatic Divider, Real-time PCR Machine. The purpose of the paper is to design a DNA / RNA extraction machine with an average capacity of 323 samples/time. The working principle of the machine and the component assemblies such as the machine frame, the robot arm gap, the reagent tray assembly, the bar code reader assembly, etc., and the control assembly were analyzed. Base on analyzing the commercial machines in the world, a reasonable solution to design is compared and designed. In this paper, an innovative design method is applied to design a DNA / RNA extraction machine.

SIX-WHEEL TERRAIN ROBOT DESIGN

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Keywords: *Rover robot, Rocker-Bogie suspension, 6 wheel robot*

ABSTRACT

Currently, most robots are two – four wheel ones, used for targets of moving on flat surface, so it is hard to use them on rough terrain. In order to meet the social demands, the authors have designed a six-wheel robot that uses a parallelogram bogie mechanism to ensure that the robot can easily move on any terrains. Six-wheel robot is often used to probe the planets, to replace humans to work in certain complex conditions and dangerous situations, such as: demining operations, toxic-chemical environments, biological virus environments as Covid-19.

In order to meet the flexibility requirements, the six-wheel robot designed can be controlled wirelessly. Integrate sensors are equipped to detect images of the scene. Signals and images are detected can be transmitted from a long distance. Each structure of a wheel is integrated directly with a motor, also known as the direct drive technology. Six wheels are driven and moved separately to ensure the robot to move perfectly on the complex terrains. [1,2,3,4,5,6]

DESIGN OF CONTROLLER FOR GLASS CLEANING ROBOT IN BUILDING

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Key words: *fuzzy logic, robot safety control, glass building cleaning, glass cleaning robots.*

ABSTRACT

Glass building cleaning is very difficult and dangerous work for human workers. The robot of glass building cleaning is considered a large market with significant potential. However, the ability to climb vertical surfaces is one of the crucial requirements of a glass cleaning robot. Currently, there are many vacuum solutions and mechanisms that are widely used in this problem. The suction force acting on the robot due to the negative pressure built up is used by these robots for the adhesion. A robot will fall off or overturn when the pressure difference drops down a certain threshold. In contrast, if the pressure difference becomes too high, the excessive amount of frictional forces will hinder the locomotion ability. Thus, the pressure difference needs to be sustained within a desired range to ensure a robot's safety and reliability. However, the pressure difference built up by a vacuum system may unpredictably vary due to unexpected variation of air leakages due to irregularities in surfaces. The existing glass cleaning robots that use vacuum suction mechanisms for adhesion are not aware of the adhesion status, or subsequently responding to them.

Therefore, this paper proposes a design of controller for a glass cleaning robot that is capable of adapting vacuum power based on the adhesion awareness to improve safety and reliability. A fuzzy inference system is proposed here to adapt the vacuum power based on the variation of the adhesion and the present power setting of the vacuum. A fuzzy inference system was used to achieve the control goals. Since the exact underlying dynamics of the vacuum-adhesion cannot be mathematically modeled, the controller's algorithm for the robot are presented using a matlab simulation application. Matlab simulation results confirmed that the performance of a robot with proposed adhesion-awareness surpasses that of a robot with no adhesion awareness in the aspects of safety, reliability, and efficiency.

DEVELOPMENT OF A NEW MAGNETO-RHEOLOGICAL CLUTCH FEATURING TOOTH-SHAPED DISC

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Key words: *MR fluid, MR clutch, Speed control, Tooth-shaped rotor*

ABSTRACT

In this research, a new configuration of magneto-rheological clutch (MRC) with a tooth-shaped disc is proposed and investigated. In this configuration, the input shaft (driving) is connected to a tooth-shaped disc, which placed in a housing connected with the output shaft (driven). Inner face of the housing also has tooth-shaped features mating with the teeth of the disc via MRF layer. The coils are placed on two winding core separated with the housing by an air gap of 0.25mm. By using a tooth shaped disc, more active interfacing area between the disc and the housing can be achieved and a high braking torque of the clutch is expected while its sized are still kept compact.

After a review of the MRC development, configuration of the proposed MRC with tooth shaped rotor is introduced and its working principle is presented. Transmitted torque of the proposed MRC is then derived based on the Bingham rheological model of MRF. In order to estimate magnetic flux density across the MRF gaps, ANSYS finite element analysis is employed. A multi-objective optimization of the MRC considering size and transmission torque of the MRC is then conducted. From the optimal design result, performance characteristics of the proposed MRC is simulated and compared with conventional MRC. After that, experimental work on the proposed MRC prototype is conducted for validation.

FORCE CONTROL OF UPPER LIMB EXOSKELETON TO SUPPORT USER MOVEMENT USING FORCE FEEDFORWARD MODEL

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Key words: *upper limb exoskeleton, force feedforward control, PID control, equation of motion, simulation.*

ABSTRACT

The dynamics analysis and control of the upper limb exoskeleton for supporting user movement is done by using the force feedforward control model. Based on the novel proportional derivative feedforward control, this paper proposes a method to assist the user's movement for a three degree of freedom exoskeleton structure. When the user exerts force at the handle, the force is measured by a force sensor placed at the handle. These sensed forces are applied to command the actuators to support the human movement and reduce the disturbance effects of the device. This technique is well established approach in haptics for reducing the effects of inertia, damping, friction, centrifugal and Coriolis forces of haptic device (Hulin T. et. al. 2015, [8]). Simulation result shows the moving of end effector and torque controlled by robot to assist human for a desired loading motion.

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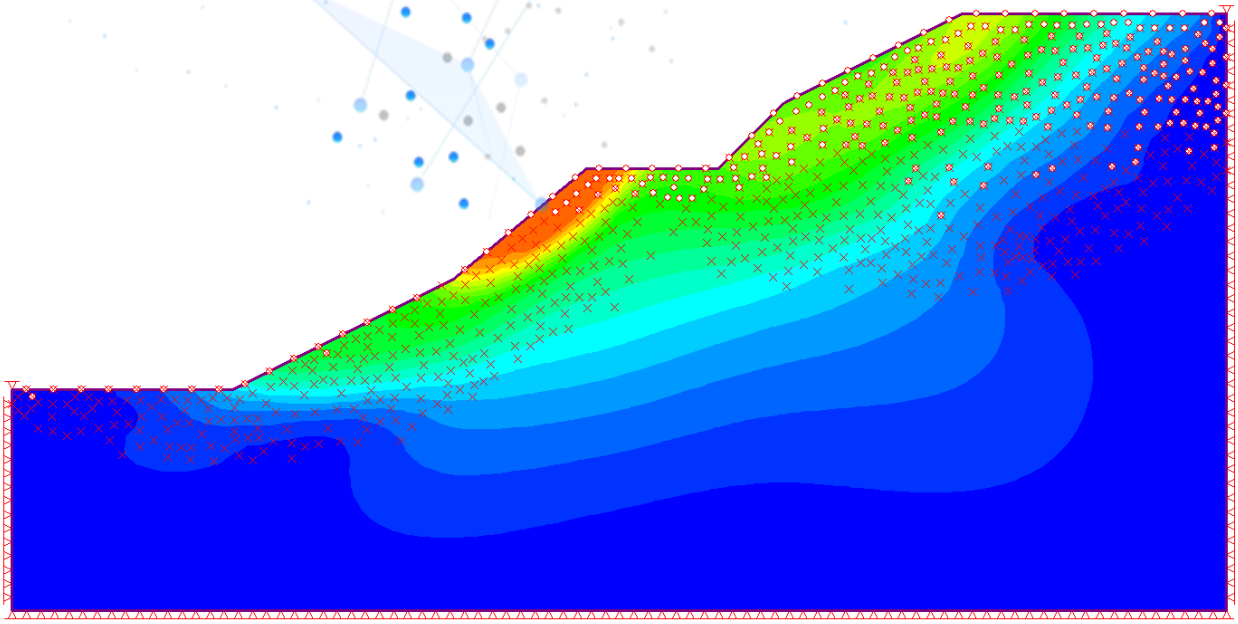

NATURAL HAZARDS MODELLING

DEVELOPMENT OF A REAL-TIME FLOOD FORECASTING TOOL: A CASE STUDY OF THE KRONG H'NANG HYDROPOWER RESERVOIR

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Key words: *Automatic HEC-HMS, KrongHnang-RTS, hydrologic model, real-time flood forecasting*

ABSTRACT

With the increase of unusual extreme rainfall and flood events in recent years, the development of flood forecasting tools that yield the high accurate results are crucial, in particular to the safe and efficient operation of the hydropower reservoir systems [1,6].

This paper presents the development of a real-time flood forecasting tool - namely *KrongHnang-RTS*, that has been applied to the operation of the Krong H'nang hydropower reservoir, located in Dak Lak province, Central Highlands of Vietnam.

The tool was coded using the Python programming language [2] and allows users to automatically collect and process the forecasted and nowcasted rainfall products, as well as to connect to the HEC-HMS hydrologic rainfall-runoff model [3,4,5]. The short-term forecasted rainfall products are extracted from the European Centre for Medium-Range Weather Forecasts (ECMWF) and are combined and adjusted with the gauged recorded rainfall products (located on the reservoir basin) to increase the reliability.

Depending upon the operation plans and the expected accuracy, results of reservoir flood forecasting can be conducted in advance from 1 to 5 days. The program was calibrated using the observed 2016 flood event, validated using the 2017 one, and has been applied to the real-time operation of the Krong H'nang reservoir since 2018.

HYDODYNAMIC ANALYSIS FOR AQUACULTURE IN BINHDINH COASTAL AREA, VIETNAM.

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Key words: hydrodynamic aslysis, sanlity, aquaculture, 2d diffusive modelling.

ABSTRACT

Binh Dinh is a province in the SouthCentral Coast with a long coastline, many lagoons, this place is suitable for brackish water aquaculture and fishing, economic development of the sea. However, with the current impacts of climate change, sea level rise and drought, the risk of saline intrusion from lakes and coastal lagoons has caused many serious impacts on the process of water aquaculture brackish, threatening the lives of people in the seaside. Therefore, it is necessary to build a model of forecasting and early warning to help the region have necessary solutions. The study and assessment of hydrodynamic regimes and spread of salty using Mike 21 FM model basic has simulated hydrodynamic regime and spread of salty for a number of effective time points via calibration and verification the model (2010 and 2016). The model parameters is an important data for warning and forecasting, supporting the development of saline zoning maps, enhancing resilience under the impacts of natural disasters and climate change.

APPLICATION OF LONG SHORT-TERM MEMORY (LSTM) NETWORKS FOR RAINFALL-RUNOFF SIMULATION IN VU GIA–THU BON CATCHMENT, VIETNAM.

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Key words: *Long short-term memory (LSTM), flood forecasting, Vu Gia-Thu Bon catchment*

ABSTRACT

The amplitude of rainfall in Vu Gia-Thu Bon catchment changes significant-ly between the rainy season and dry season and total rainfall in the rainy season contributes from 65 to 80 percent of the annual rainfall. Therefore, floods are becoming serious in this area. Floods have destroyed critical facilities, such as infrastructure and housing. This research has proposed to use the Long Short-Term Memory (LSTM) networks to forecast flow in the catchment. Inputs include the daily runoff data at Nong Son station and the daily rainfall at Tra My, Tien Phuoc, Hiep Duc and Nong Son station; Out-puts are the runoff data at Nong Son station from 1991 to 2010. The model does not use other hydrologic, meteorological and geological data, which have low quality at the catchment. The research considers many scenarios with different training parameters to find the optimal LSTM model. The selected LSTM model performs well when the values of RMSE and NSE are about 311 m^3/s and 0.5 respectively. Therefore, the selected LSTM model has the ability to forecast discharge based on limited inputs in the catchment.

EVALUATE THE EFFECT OF THE VARYING OF THE END-EFFECTOR POINT TRAJECTORY ON THE JOINT JERK OF THE REDUNDANT ROBOT SYSTEMS

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Key words: *Joint jerk, industrial robots, redundant system, trajectory*

ABSTRACT

This paper focuses on investigating the joints jerk of industrial serial robots with 6 degrees of freedom under the varying of the end-effector point trajectory in the workspace. The jerk is determined by solving the inverse kinematics problem of the redundant system. This problem is solved based on the algorithm for adjusting the increments of the generalized vector. The efficiency of this algorithm is shown through the error between a given trajectory and the recalculated trajectory through the forward kinematics problem. The result of this study allows us to evaluate the effect of the change of trajectory on the kinematics characteristics of the robot in general and the jerk of the joints in particular. On the other hand, these results can be used as the basis for trajectory design, develop algorithms to reduce joint jerk, increase the system life, and improve the motion accuracy of the redundant robot.

BEHAVIOR OF MONOLITHIC PRESTRESSED CONCRETE SLAB TRACK AT HIGHWAY-RAILWAY GRADE CROSSINGS

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Key words: *slab track, monolithic prestresed concrete, highway-railway grade crosssings, finite element method*

ABSTRACT

This paper presents simulation calculations and experimental measurements to analyze the structural behavior of the prestressed concrete slab (PSCS) track at highway-railway grade crossings in Vietnam. Simulation calculations are performed by the finite element method. Measurement experiments were conducted in the laboratory and on the site. The results will show that the structure of the PSCS meets the requirements of stability and strength under loads of truck and train in Vietnam

SURROGATE MODEL-BASED SEISMIC FRAGILITY ANALYSIS OF MULTI-SPAN REINFORCED-CONCRETE BRIDGES

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ABSTRACT

This paper aims to present an efficient framework for seismic fragility analysis of multi-span reinforced-concrete bridges; the framework is based on a Kriging-based surrogate model that approximates the structural response with respect to the structural and ground motion uncertainties and allows using a few numbers of ground motion records. To facilitate the comparison with traditional methods, a two-span reinforced concrete bridge available in the literature is taken as a case study, whose three-dimensional finite element model is established by the OpenSees software framework. Twenty records from different sources are selected and Latin hypercube method is applied as the sampling method for generating the samples in order to account for the uncertainty of modeling parameters. The Kriging-based surrogate model is then established on the structural response obtained from nonlinear time history analysis results. Component fragility curves for critical failures modes of the bridge are finally derived by implementing Monte Carlo simulation on the obtained Kriging model. The results demonstrate the efficiency of the proposed framework in well interpolating the structural response and properly developing the seismic fragility curve of the examined case study allow using a few numbers of ground motion records.

Keywords: fragility curve, Kring metamodeling, surrogate model, reinforced concrete bridge, nonlinear model, time history analysis.

A MESHFREE METHOD BASED ON INTEGRATED RADIAL BASIS FUNCTIONS FOR 2D HYPERELASTIC BODIES

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Key words: *Integrated radial basis function, meshfree method, hyperelasticity*

ABSTRACT

This paper presents a meshfree method based on integrated radial basis functions (iRBF) for hyperelastic bodies with compressible and nearly-incompressible behavior. The neo-Hookean model is used for hyperelastic material and the nonlinear elastic behavior of 2D bodies are simulated under finite deformation state with total Largange formulation. In the approximation of field nodes, the present iRBF shape functions are constructed through integration. With the property of damping out or at least containing an inherent inaccuracy, the iRBF produces a greatly improved approximation of its derivatives [1, 2]. Moreover, the meshfree numerical approach shows its advantage to analyze large deformation problems by the feature of “free of mesh”, especially it does not suffer from the volumetric locking. To verify the accuracy of the proposed approach, a number of numerical examples are performed and the obtained results are compared with the reference solutions given by other methods [3].

TURNING ELECTRONIC AND OPTICAL PROPERTIES OF MONOLAYER JANUS Sn- DICHALCOGENIDES BY BIAXIAL STRAIN

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Key words: *Ideal strength, first-principles, optical absorption, transition metal dichalcogenides.*

ABSTRACT

We investigated mechanical, electronic, and optical properties of monolayer Janus SnSTe and SnSeTe with 1T structure under biaxial tensile strain using first-principles calculations. We found that both SnSTe and SnSeTe are metallic at the equilibrium state. SnSTe is semiconductor at the biaxial strain of 4% with bandgap by 0.03 eV, while the biaxial strain by 6% for SnSeTe. The biaxial tensile strain effectively modulates the optical absorption of Sn-dichalcogenides. In addition, ideal strengths of SnSTe and SnSeTe were also investigated. Our obtained results provide useful information for applications in nano-electromechanical, optoelectronic, and photocatalytic devices based on the monolayer Janus SnSTe and SnSeTe.

ELECTROMECHANICAL PROPERTIES OF MONOLAYER SN-DICHALCOGENIDES

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Key words: *Artificial muscles, ideal strength, density functional theory.*

ABSTRACT

We investigate electromechanical properties of monolayer SnX_2 (X = Se, Te) with 1T structure as a function of charge (electron and hole) doping by using first-principles calculations. We find that the monolayer $SnSe_2$ shows a semiconductor-metal transition for the case of heavy electron doping, while $SnTe_2$ retains the metallic properties under both electron and hole dopings. The actuation strain of SnX_2 in the case of electron doping is substantially larger than those of hole doping. Moreover, the effect of charge doping on ideal strength and ideal strain of the monolayer SnX_2 is also discussed.

THE EFFECT OF POROSITY ON THE ELASTIC MODULUS AND STRENGTH OF PERVIOUS CONCRETE

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Key words: *Pervious concrete, porosity, elastic modulus, strength*

ABSTRACT

Pervious/porous material is composed of a solid structure that is continuously arranged in an orderly or random way, forming a framework and between them exists empty spaces called pores filled with fluid (liquid, gas). One of the important applications of porous materials in the construction industry is high porous concrete that used to make surface pavement with natural water permeation capacity. This solution is called Sustainable Drainage Systems (SUDS).

In this paper, a novel micromechanical model is developed to predict the relationship between the porosity and the strength of the previous concrete materials. Based on the three-phase composite sphere assemblage model with coated pore-concrete inclusions embedded in a fictitious effective medium, the strain, stress mean fields and the effective properties of material are constructed. Moreover, illustrative applications are reported by comparing the theoretical predictions with the previous experimental review to show pertinence of model.

According to the obtained results, it can be concluded that due to the additional information on the maximum porosity and elastic modulus of the material, the new approximation model is better suited to experimental results than some of the published analytical models, which demonstrates the effectiveness of this research.

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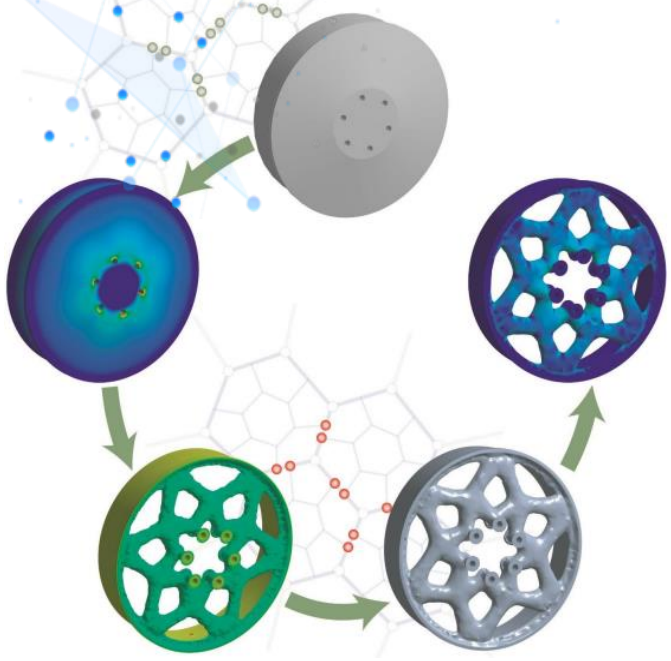

OPTIMIZATION AND INVERSE PROBLEMS

STRUCTURAL DAMAGE IDENTIFICATION OF PLATES USING TWO-STAGE APPROACH COMBINING MODAL STRAIN ENERGY METHOD AND GENETIC ALGORITHM

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Keywords: *Damage identification, vibration, plate, modal strain energy, genetic algorithm.*

ABSTRACT

The occurrence of damages is inevitable during service life of structures. If the damages are not detected timely, they will cause catastrophic incidents for the safety of not only self-structures but also the humans and society. One of the promising ways to guarantee the structural safety and integrity is to enact structural health monitoring (SHM) in a regular periodic manner and to detect critical damage in its early stage. Recently, vibration-based damage identification technologies have been widely used in mechanical, aerospace, and civil applications.

In this study, a two-stage approach combining modal strain energy method and genetic algorithm (GA) to identify the location and the extent of damage in plate-like structures is developed. In the first stage, a criteria based on the change in modal strain energy namely Modal Strain Energy Damage Index (MSEDI) is utilized to determine the damage's location. The modal strain energy is determined by using the modal analysis of plate-like structures in both states, before and after the occurrence of damages. In the second stage, the GA is employed to minimize the objective function with the variables relating to the vector of thickness reduction of the potential damaged elements, which are the result of the previous stage. The objective function is also based on modal strain energy. The effectiveness of the proposed method is analyzed and evaluated by numerical simulations for a plate with various damaged scenarios. The results show that the proposed method has the capability of exactly identifying the occurrence, the location and the severity of damages in plate-like structures.

FUZZY STRUCTURAL IDENTIFICATION OF BAR-TYPE STRUCTURES USING DIFFERENTIAL EVOLUTION

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Key words: *Structural identification, fuzzy model updating, differential evolution, nearest neighbor comparison*

ABSTRACT

Structural identification techniques use experimental data to update the actual stage of a structure. However, experimental data are contaminated with noises, which may affect the accuracy of the identified results. Nevertheless, uncertainty quantification methods can be utilized to identify the uncertainty in the updated parameters. In this paper, a non-probabilistic method based on the fuzzy set theory is applied to identify the member stiffness of bar-type structures. Uncertainties associated with the measured outputs are described as fuzzy quantities, and the identification procedure is formulated as a constrained optimization problem at each α-cut level. The membership functions of the stiffness parameters are determined by the differential evolution with nearest neighbor comparison (DE-NNC). Two structural examples, including a planar truss, and a planar frame, are investigated to show the effectiveness of the fuzzy structural identification procedure.

BUILDING INFORMATION MODELING FOR SUSTAINABLE DESIGN AND MULTIDISCIPLINARY DESIGN OPTIMIZATION

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Key words: *BIM, MDO, Sustainable Design*

ABSTRACT

The purpose to achieve sustainable design and meet the climate change now can be reached with the help of advances in computer software in particular and ICT in general. The quality of Multidiscipline Building Information Model (BIM Model) including computable architectural model, structural model, MEP model, cost estimation and facility management oriented model is crucial for the productivity, performance of all related disciplines. This article illustrates the Computable BIM Model for Architecture, Structure, Mechanical – Electrical – Plumbing (MEP) to help architects, designers do sustainable design such as acoustic comfort, lighting design on effective cost manner with many rapid design options from the conceptual design phase, to facilitate wind load simulation, predict structural behaviour under fierce conditions, to estimate heat load, HVAC systems performance for energy saving and sustainable design.

MVAC SYSTEM OPTIMIZATION USING BUILDING INFORMATION MODELING

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Key words: *BIM, MDO, MVAC*

ABSTRACT

MVAC systems always contribute significant portion in building energy consumption, but the exact estimation for MVAC costs is always challenge. The purpose to achieve the optimum design, then reach to optimal operation cost requires a sustainable design. The impossible tasks now can be carried with the help of computer software and numerical algorithms. With the help of advances in computer software in particular and ICT in general, the Multidiscipline Building Information Model (BIM Model) including computable architectural model, structural model, MEP model, cost estimation and facility management oriented model is crucial to help architects, designers do sustainable design such as acoustic comfort, lighting design on effective cost manner with many rapid design options from the conceptual design phase, to facilitate wind load simulation, predict structural behaviour under fierce conditions, to estimate heat load, HVAC systems performance for energy saving and sustainable design. MVAC Systems are investigated in this paper using Energy Plus, Simergy, Trace 700 also compared with constitutive equations to figure out the optimized outcome.

APPLICATION OF ARTIFICIAL INTELLIGENCE FOR STRUCTURAL OPTIMIZATION

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Key words: *Optimization, artificial intelligence, differential evolution, neural network*

ABSTRACT

The conventional structural design is frequently implemented using the "trial-and-error" method in which the final result strongly depends on the designers' experience. The design process can be significantly improved by adopting some artificial intelligence technologies. The paper presents an AI-based approach that combines Differential Evolutionary (DE) optimization algorithm and Artificial Neural Network (ANN) for finding the optimal structural solution. In more detail, an ANN model is built to simulate the behavior of the structure. The whole model is trained by a number of data points that are generated using the Latin Hypercube Sampling method. The trained model is then used to completely eliminate the finite element analysis during the optimization process. By using AI techniques, the computation cost could be significantly reduced. The efficiency of the proposed approach is tested in the 47-bar planar tower with discrete variables. The numerical results show that the proposed approach is accurate, robust, and faster than traditional optimization.