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Bow structure damage analysis for hybrid coir-glass fiber composite fishing boat hull subjected to front collision load

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Abstract

Hybridization of natural and synthetic fibers has the ability to improve composite performance. It means that the combination of natural fibers such as coir, jute, bamboo, and sisal with synthetic or glass fiber can broaden the role of the composite material, especially for structural application. This study developed a finite element simulation to investigate the damage to the bow structure of the fishing boat hull, which was produced using hybrid coir-glass fiber composite (HCGFRP) material subjected to front collision load. The experimental measurement was conducted to determine the mechanical properties of four hybrid composite laminates defined based on the differences in their layers number, fiber types, and orientation angle. Moreover, a numerical simulation model was applied to the traditional fishing boat colliding with fishery harbor quay, and the scenario was defined by varying the boat speed and the types of laminates adopted on the hull structure. The results showed the damage level for the bow structure of the HCGFRP boat due to the collision accidents, while the numerical findings are expected to be used as the basic knowledge in applying the hybrid coir-glass fiber laminates composite as an alternative hull construction material. © 2022 Aulia Windyandari et al., published by De Gruyter.

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Application of sisal, bamboo, coir, and jute natural composites in structural up-gradation
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CONTENTS JOURNAL OVERVIEW

Research Articles

Abstract

Plenty of research articles are available on the static deformation analysis of laminated straight beams using refined shear deformation theories. However, research on the deformation of laminated curved beams with simply supported boundary conditions is limited and needs more attention nowadays. With this objective, the present study deals with the static analysis of laminated composite and sandwich beams curved in elevation using a new quasi-3D polynomial type beam theory. The theory considers the effects of both transverse shear and normal strains, i.e. thickness stretching effects. In the present theory, axial displacement has expanded up to the fifth-order polynomial in terms of thickness coordinates to effectively account for the effects of curvature and deformations. The present theory satisfies the zero traction boundary condition on the top and bottom surfaces of the beam. Governing differential equations and associated boundary conditions are established by using the Principal of virtual work. Navier's solution technique is used to obtain displacements and stresses for simply supported beams curved in elevation and subjected to uniformly distributed load. The present results can be benefited to the upcoming researchers.

Abstract

Using decorative elements is an inseparable aspect of Iranian architecture. Architectural ornaments in many buildings, including the minarets, represent the architect's craftsmanship. As such, the minarets in Isfahan have different types of brickwork ornamentations, such as 90-degree herringbone (Khofteh-Rasteh), basket weave bond (Hasiri), and other complex types. Additionally, the highest minarets are usually constructed in a truncated conical shape to reduce their overall weight and ameliorate their stability against the wind, and lateral forces. Therefore, while the geometric integrity of brickwork patterns should be maintained, all the ornamentations are applied on a shrinking surface area. However, the practical solutions for the construction processes in these structures haven't been sufficiently investigated. Hence, this study aims to explore the methods of brickwork projection on the minarets and analyse the changes in girih patterns at different height levels. Accordingly, after surveying the selected single minarets in Isfahan, they were modeled using drafting software applications and then analysed.

Abstract

As one of the most dangerous defects in the sandwich panel, debonding could significantly degrade load carrying capacity and affect dynamic behaviour. The present work dealt with debonding detection of the rectangular clamped hybrid sandwich plate by using ABAQUS software. The influence of various damage ratios on the linear and nonlinear dynamic responses has been studied. The finite element model was initially validated by comparing the modal response with the experimental test. Rectangular debonding was detected by comparing dynamic responses of free and forced vibrations between intact and debonded models. A wide range of driving frequency excitation corresponding to transient and harmonic concentrated loads was implemented to highlight nonlinear behaviour in the intermittent contact in the debonded models. The results showed that debonding existence contributed to the natural frequency reduction and modes shape change. The numerical results revealed that debonding affected both the steady-state and impulse responses of the debonded models. Using the obtained responses, it was detected that the contact in the debonded region altered the dynamic global response of the debonded models. The finding provided the potential debonding diagnostic in ship structure using vibration-based structural health monitoring.

Abstract

The article deals with the issue of double skin transparent facades as a new technological-operational system of transparent exterior walls. Especially of high-rise buildings, which with its operating modes ingeniously uses a renewable source of solar energy to reduce the energy needs of the building. The basic precondition for the correct function of the double skin facade is its functional aerodynamics in any climatic conditions of the outdoor climate. In the critical state of windlessness, the aerodynamic quantification of a double skin facade is the total aerodynamic resistance of the cavity, which consists of the aerodynamic frictional resistances along the length of the air flow line and local aerodynamic resistances of the cavity. The article analyses the functional aerodynamics on two frequented types of double skin facades with a narrow type and corridor type cavity. At the end it confronts functional aerodynamics with the results of their temperature, aerodynamic and energy regime obtained from in-situ experiments.

Abstract

The computation of bent isotropic plates, stretched and/or compressed, is a topic widely explored in the literature from both experimental and numerical point of view. We expose in this work an application of the generalized equations of Finite difference method to that topic. The strength of the proposed method is the ability to reconstruct the approximate solution with respect of eventual discontinuities involved in the investigated function as well as its first and second derivatives, including the right-hand side of the equilibrium equation. It is worth mentioning that by opposition to finite element methods our method needs neither fictitious points nor a special condensation of grid. Well-known benchmarks are used in this work to illustrate the efficiency of our numerical and the high accuracy of calculation as well. A comparison of our results with those available in the literature also shows good agreement.

Abstract

The flexural strength of slabs may be reduced due to accidents and environmental effects. This study focuses on the rehabilitation of the one-way reinforced concrete slab. Experimental works include five simply supported one-way reinforced concrete slabs with width, depth, and length of 400, 120, and 2200 mm, respectively. Different configurations of steel continuity between old and new concrete have been tested. Moreover, in the control specimen (steel is continued overall, the specimen and concrete are cast in one stage over the entire slab). In the other four specimens, the concrete is cast in two stages, the left and right parts representing the old concrete are cast first, and the middle part representing a new concrete is cast after that. In these four specimens, new steel is connected to old one by different configuration (original steel remain to continue, new steel connected to old one by weld, new steel connected to old one by making 90° hooks, and new steel bars is put inside bores using epoxy). After testing, the welding method of connecting new to old steel is the best one.

Open Access | December 4, 2021

Numerical evaluation of expansion loops for pipe subjected to thermal displacements

Hartono Yudo, Sarjito Jokosisworo, Wilma Amiruddin, Pujianto Pujianto, Tuswan Tuswan, Mohamad Djaeni

Page range: 72-80

Abstract

The thermal expansion can lead to the high stress on the pipe. The problem can be overcome using expansion loops in a certain length depending on the material's elastic modulus, diameter, the amount of expansion, and the pipe's allowable stresses. Currently, there is no exact definition for the dimension of expansion loops design both for loop width (W) and loop footing height (H) sizes. In this study, expansion loops were investigated with using ratio of width and height (W / H) variations to understand pipe stress occurring on the expansion loops and the expansion loops' safety factor. Relationship between non dimensional stress on the expansion loop pipe was studied numerically by finite element software on several working temperatures of 400 o F, 500 o F, 600 o F, and 700 o F. It can be found that stress occurring on the pipes increases as the increases of W / H of the expansion loops and results in a lower safety factor. The safety factor of the expansion loops pipe has a value of 1 when the ratio of loop width and loop footing height (W / H) value was 1.2 for a 16-inch diameter pipe. Stress occurring on the pipe increases with the increase of the working temperature. Expansion loops pipe designed for 400 o F can still work well to handle thermal extension pipe occurring on 500 o F.

Open Access | January 21, 2022

Mixed convection around a circular cylinder in a buoyancy-assisting flow

Hasan Shakir Majdi, Mahmoud A. Mashkour, Laith Jaafer Habeeb, Marko Ilic

Page range: 81-95

Abstract

In this paper, the effect of mixed convection on the flow behavior and heat transfer around a circular cylinder disclosed to a vertically upward laminar air stream is numerically examine. The buoyancy-aided flow is utilized to eliminate and control the vortex shedding of the cylinder. The influence of the Grashof number, $0 \leq Gr \leq 6000$, the flow and thermal patterns, as well as the local and mean Nusselt number, is investigated at a constant Reynolds number of 100. The unsteady Navier-Stokes's equations are solved employing a finite-volume method to simulate numerically the velocity and temperature fields in time and space. The results showed periodic instability in the flow and thermal fields for a range of Grashof number $Gr \leq 1300$. Also, there is critical value of Grashof number for stopping this instability and the vortex shedding formed behind the cylinder, by the effect of heating. Thus, by increasing Grashof number between $1400 \leq Gr \leq 4000$, the periodic flow vanishes and converts into steady flow with twin eddies attached to the cylinder from the back. Furthermore, as Grashof number increases behind $Gr \geq 5000$, the flow becomes completely attached to the cylinder surface without any separation.

Open Access | January 21, 2022

Temperature-dependent mechanical properties of Al/Cu nanocomposites under tensile loading via molecular dynamics method

Mohammed Ali Abdulrehman, Mohammed Ali Mahmood Hussein, Ismail Ibrahim Marhoon

Page range: 96-104

Abstract

Al-Cu Nanocomposites (NCs) are widely used in industrial applications for their high ductility, light weight, excellent thermal conductivity, and low-cost production. The mechanical properties and deformation mechanisms of Metal Matrix NCs (MMNCs) strongly depend on the matrix microstructure and the interface between the matrix and the second phase. The present study relies on Molecular Dynamics (MD) to investigate the effects of temperature on the mechanical properties and elastic and plastic behavior of the Al-Cu NC with single-crystal and polycrystalline matrices. The effects of heating on microstructural defects in the aluminum matrix and the Al/Cu interface were also addressed in the following. It was found that the density of defects such as dislocations and stacking fault areas are much higher in samples with polycrystalline matrices than those with single-crystal ones. Further, by triggering thermally activated mechanisms, increasing the temperature reduces the density of crystal defects. Heating also facilitates atomic migration and compromises the yield strength and the elastic modulus as a result of the increased energy of atoms in the grain boundaries and in the Al-Cu interface. The results showed that the flow stress decreased in all samples by increasing the temperature, making them less resistant to the plastic deformation.

Open Access | January 24, 2022

Multi thermal waves in a thermo diffusive piezo electric functionally graded rod via refined multi-dual phase-lag model

Poongkothai Jeyaraman, Samydurai Mahesh, Rajendran Selvamani, Rossana Dimitri, Francesco Tornabene

Page range: 105-115

Abstract

In the present work, a novel analytical model is provided for wave dispersion in a piezo-thermoelastic diffusive functionally graded rod through the multi-phase lag model and thermal activation. The plain strain model for thermo piezoelectric functionally graded rod is considered. The complex characteristic equations are obtained by using normal mode method which satisfies the nonlinear boundary conditions of piezo-thermoelastic functionally graded rod. The numerical calculations are carried out for copper material. The results of the variants stress, mechanical displacement, temperature and electric distribution, frequency are explored against the geometric parameters and some special parameters graded index, concentration constants are shown graphically. The observed results will be discuss elaborate. The results can be build reasonable attention in piezo-thermoelastic materials and smart materials industry.

Open Access | February 10, 2022

Determination of the dynamic performance of natural viscoelastic composites with different proportions of reinforcing fibers

Sergei Shlykov, Rodion Rogulin, Sergey Kondrashev

Page range: 116-123

Abstract

Viscoelastic composites are strong and handle vibration damping quite well, which allows them to be used in a wide variety of applications. Thus, there is a need to determine the optimal amount of fiber to ensure high mechanical and dynamic performance with as little interference as possible. The purpose of this work is to find the most appropriate percentage of organic fiber – cellulose derived from corn stalks in a polylactic acid matrix, studying the changes in damping characteristics, tensile strength, bend-test. As parameters for comparison, the coefficient of bending and breaking strength, modules of accumulation and losses, factor C were chosen. It was found that strength indicators decrease with fiber fraction growth. While the damping factor at the glass transition temperature increases. In order to confirm the results obtained, the calculation of the C factor was used. The study investigates the damping factor's dependence on the mechanical properties. It is shown that there is a correlation between moduli and bending strength with increasing fiber fraction. The scientific novelty of this work is the study of natural viscoelastic composites with different proportions of reinforcing fibers based on mechanical and dynamic characteristics in order to create and apply biodegradable viscoelastic composites in various fields.

Open Access | March 9, 2022

Experimental and analytical study on the behavior of hybrid GFRP/steel bars in reinforced concrete deep beams

Ata El-Kareim Shoeib, Ahmed Noureldean Mohamed Arafa, Ramy Abd El-Hakeem Abd El Rady, Waleed Mohamed Fouad Tawhed

Page range: 124-145

Abstract

The deep beam is one of the essential members of high-rise buildings structures, so the deep beams are used as a transfer girder; in walls water structures, the deep beam behavior is different from the slender beam behavior; the deep beam plane section before does not remain plane after bending. In recent years, the use of FRP as a composite material in reinforced concrete structures has been growing up to cover problems by weight of structure buildings, corrosion, repairing, and construction cost. This paper presents an experimental, analytical study to assign the variation of mechanical properties of reinforced concrete deep beams using vertical and horizontal GFRP stirrups. This paper investigates the mechanical properties of test specimens for deep

beams reinforced in shear with GFRP or steel bars as web reinforcement. The deep beams are reinforced with glass fiber reinforced polymer (GFRP) in various ratios as a web reinforcement configuration (0, 0.25%, and 0.40%) rather than traditional steel web reinforcement. All tested specimens have the same span to depth ratio of 0.40 (a/d); the primary and secondary reinforcement is steel bars. The web reinforcement ratio significantly affected deep beams' load capacity and mechanical behavior. The GFRP enhancement the mechanical behavior of the reinforced concrete deep. Increasing the GFRP web reinforcement ratio enhances the deep beam load capacity. The test results compared with the traditional ACI design method strut-tie model to demonstrate the effect of web reinforcement ratio on deep beam load capacity and strut width. The test results have been verified by ABAQUS 6.13.

Open Access | March 16, 2022

The shear strength of concrete beams hybrid-reinforced with GFRP bars and steel bars in main reinforcement without shear reinforcement

Ata El-kareim Shoeib, Ahmed Noureldean Arafa, Ahmed EL-sayed Sedawy, Awad M. EL-Hashmy

Page range: 146-162

Abstract

The investigation of the structural performance of reinforced concrete members in the construction process has become a critical issue for Hybrid GFRP bars with steel bars. The ultimate concrete shear strength of reinforced concrete beams contains both GFRP bars and Steel bars in main reinforcement are a main task of work. This paper examines the effect of sharing the fiber-reinforced polymer (FRP) bars with steel bars for reinforced concrete (RC) structures on the concrete shear strength of RC beams. Fourteen RC beams without shear reinforcement were constructed and tested up to failure. The test beams included two steel-RC beams, one GFRP-RC beam, and eleven steel bars and GFRP bars (hybrid GFRP/steel)-RC beams. The main parameters were the reinforcement ratio, shear span to depth ratio, depth of the beam, concrete compressive strength, and compression reinforcement. The test results are presented in terms of crack patterns, failure modes, load-deflection, and load-strain behavior. The test results showed that hybrid GFRP/steel bars causing significant improvement in the ductility with reduction of the deformation comparing with an only steel bar in main steel in tested beams. The dowel action can play a major role in the process by which shear is carried in a beam. Finally, the initial proposal equation that calculates the shear strength of hybrid reinforced elements can serve as a guideline for the introduction of hybrid bars (GFRP and Steel) at the main reinforcement in RC beams.

Open Access | March 16, 2022

Assessment of ship structure under fatigue loading: FE benchmarking and extended performance analysis

Aprianur Fajri, Aditya Rio Prabowo, Nurul Muhayat

Page range: 163-186

Abstract

This paper presents a numerical procedure based on the finite element (FE) method using ANSYS Workbench software to analyse fatigue phenomena in ship structures. Fatigue failure prediction is used as a stress–life approach, when the stress is still in a linear area. This condition is frequently referred as high-cycle fatigue. Five geometric shapes taken from midship points on the structure of a ship are sampled. There are four types of materials: HSLA SAE 950X, medium-carbon steel, SAE 316L, and SAE 304L. The types of loading imposed on each sample include three conditions: zero-based, zero mean, and ratio. Mesh convergence analysis is conducted to determine the most effective mesh shape and size for analysing the structure. The results showed that the configuration of the geometric shapes, materials used, loading schemes, and mean stress theory affect the fatigue characteristics of the structure.

Open Access | March 24, 2022

Generate high data rate of optical carries by using nanomaterial graphene in slab waveguide

Saib Thiab Alwan, Omar Abdulkareem Mahmood, Tahreer Mahmood

Page range: 187-192

Abstract

Single mode is one of the most practical applications in microwave propagations because of its high mode resolution and low transmission loss. In this paper, the single mode graphene material was implemented in slab waveguide to study the performance and optical properties of graphene material; the parameters that affect these models were found to be the cut-off frequency, attenuation wavenumbers, modes numbers, skin depth, angles incident, and propagation wave numbers. The effectiveness of these factors was simulated and analyzed using MATLAB software program. In this paper, the carriers were generated using nano-graphene; the optical carrier source provided seven carriers with the frequency spacing of 4.9682 GHz. After splitting the carriers using optical demultiplexer, these carriers were modulated independently using optical Quadrature phase shift keying (QPSK) modulators at symbol rate equal to 4.9682 Gsymbol/s; this matches the frequency spacing of the carriers. Under this argument, the total data rate was equal to 2*7*4.9682 Gsymbol/s = 69.5548 Gbit/s, and the total bandwidth was 34.774 GHz. These carriers were found to work in optical communication with high data rate.

Open Access | March 24, 2022

Study of changes in concrete durability during the operation of buildings

Sergey Udodov, Dmitry Gura, Grigoriy Charikov

Page range: 193-201

Abstract

The purpose of this study is to select the best methodologies for determining the condition of concrete structures. Semi-destructive concrete exposure methods were used to determine resistance parameters: the impact echo test to determine internal structure, the Figg test for air permeability, the initial surface adsorption test for water adsorption, titrimetric for chloride amounts, and a chemical and physical method to determine carbonation levels. In addition, two situations were simulated: a fire and a pipe burst and their impact on the condition of reinforced concrete structures. It was shown that the exposure to temperatures decreases the level of acidity, resulting in increased corrosion of steel. During a pipe burst, the amount of chlo-rides increases, which affects the reinforcement, oxidizing it. A search for possible correlation between concrete structure and carbonation, air permeability and water adsorption was also carried out. It was found that there is an almost linear dependence of these parameters on the presence of cracks, the deterioration of the structure leads to an increase in the transport properties of concrete, which becomes a danger to steel.

Open Access | April 5, 2022

Calculation method of stability bearing capacity of transmission tower angle steel considering semi-rigid constraint

Feng Qiu, Junxia Qiu, Heng Feng, Huajie Wang, Hongliang Qian, Xiaofei Jin, Kaiyuan Wang, Feng Fan

Page range: 202-211

Abstract

The angle steel member is the most commonly used component form of the transmission tower structure. Considering its connection characteristics, we must deal with its stability analysis under semi-rigid constraint conditions for the proper study of the overall structure's mechanical performance. Therefore, in order to establish a simple and high-precision method suitable for the ultimate bearing capacity analysis of the transmission tower, we build the refined finite element models of typical steel tower joints, analyze its moment-rotation curve and utilize simulation technique of spring elements to acquire the calculation method of its single angle stability bearing capacity, which is considering initial imperfection and residual stress. Furthermore, we analyze its bearing capacity under different constraint conditions such as rigid, semi-rigid and articulated connection. The results show that it is necessary to consider joint stiffness in the bearing capacity analyses. Finally, it's confirmed that the calculation results of this method agree well with the experimental data, which validates its high accuracy. Therefore, the method provides technical support for high efficient component stability simulation in overall stability analyses of the transmission steel tower.

Open Access | April 10, 2022

Numerical and experimental investigation of two phase flow geometrical characteristics

Hyder M. Abdul Hussein, Sabah T. Ahmed, Laith Jaafer Habeeb

Page range: 212-226

Abstract

This paper presents an experimental and numerical analysis of the effect of the geometric parameter on the two-phase flow (white kerosene-water) flow pattern system. The investigation was carried out using three lengths (1, 2 and 3) m of rectangular horizontal smooth channel and three channel heights of (5, 7.5 and 10) cm respectively. The flow conditions for the input water velocity (0.2 m/s) and the input kerosene velocity (0.1 m/s) for both measurements have been investigated. Two-inlet techniques have been employed. Firstly, at the inlet, the kerosene was on top of the bath. Then, second, from the center, the kerosene inlets (water is above and below the kerosene). A numerical verification analysis was introduced using the ANSYS software using the method of volume of fluid (VOF) and mixture multiphase flow modeling coupled with the normal k- ε turbulence schemes. A collection of seven methods of CFD types is explored by running 224 instances. Comparisons were made between numerical and experimental works.

Open Access | April 13, 2022

Experimental investigation of composite steel–concrete beams using symmetrical and asymmetrical castellated beams

Hayder Wafi Al-Thabhawee

Page range: 227-235

Abstract

This study aims to investigate the behavior of concrete slabs acting compositely with symmetrical and asymmetrical castellated beams. Stud connectors are used to connect the concrete slab and steel section. The use of castellated steel beams to build up composite steel-concrete beams is now common practice in building construction. Five simply supported composite beams were examined under two-point loading. Two specimens built up from standard steel beams were used as control specimens and three specimens were built up from castellated steel beams. One of these specimens was built up using a castellated steel beam with an asymmetrical cross-section fabricated from two different standard sections (IPE120/HEA120). The concrete slab of all composite specimens had the same dimensions and properties. The experimental results showed that strength and rigidity were considerably greater for composite castellated steel beams compared to composite beams built up from the parent sections. The ultimate load capacity of a composite castellated beam fabricated from an IPE120 section was 46% greater than that of a composite beam built up using the parent beam, and the ultimate load capacity of a composite castellated beam fabricated from a wide-flanged HEA120 section resulted in an increase of 21% over the parent beam control specimen. The ultimate load capacity of the composite specimen built up using the asymmetrical castellated beam (IPE120/HEA120) achieved increases of 69% and 12%, respectively, compared to the control specimens built up from standard sections.

Open Access | April 13, 2022

Bow structure damage analysis for hybrid coir-glass fiber composite fishing boat hull subjected to front collision load

Aulia Windyandari, Ojo Kurdi, Sulardjaka, Mohammad Tauviqirrahman

Page range: 236-257

Abstract

Hybridization of natural and synthetic fibers has the ability to improve composite performance. It means that the combination of natural fibers such as coir, jute, bamboo, and sisal with synthetic or glass fiber can broaden the role of the composite material, especially for structural application. This study developed a finite element simulation to investigate the damage to the bow structure of the fishing boat hull, which was produced using hybrid coir-glass fiber composite (HCGFRP) material subjected to front collision load. The experimental measurement was conducted to determine the mechanical properties of four hybrid composite laminates defined based on the differences in their layers number, fiber types, and orientation angle. Moreover, a numerical simulation model was applied to the traditional fishing boat colliding with fishery harbor quay, and the scenario was defined by varying the boat speed and the types of laminates adopted on the hull structure. The results showed the damage level for the bow structure of the HCGFRP boat due to the collision accidents, while the numerical findings are expected to be used as the basic knowledge in applying the hybrid coir-glass fiber laminates composite as an alternative hull construction material.

Open Access | April 13, 2022

Effect of the selected parameters in idealizing material failures under tensile loads: Benchmarks for damage analysis on thin-walled structures

Aditya Rio Prabowo, Ridwan Ridwan, Tuswan Tuswan, Jung Min Sohn, Eko Surojo, Fitrian Imaduddin

Page range: 258-285

Abstract

The development of the global economy has led to a rise in ship traffic. As a result, the risk of accidents, such as collisions between ships and grounding, has also increased. Different failure criteria to capture these accidents have been introduced by researchers. Therefore, the purpose of this study was to determine the essential distinction between these failure criteria. The simulations suggest that failure criteria based on the maximum stress result in a slightly higher rupture strain value, greater crack propagation, and higher internal energy than those based on the maximum strain. Furthermore, using a larger mesh size compared with the size of the test specimen appears to greatly affect the validity of the simulation results.

Open Access | May 6, 2022

Three-dimensional numerical study of the reactive powder concrete segments in tunnel lining

Hajer Satih Abbas, Maadh Imad Salman Al-Rubaye, Sarra'a Dhiya'a Jaafer, Bassam farman bassam, Abdelmajeed Alkasassbeh

Page range: 286-294

Abstract

The tunnel lining systems act as lines of defence against the forces and geotechnical situations. The use of precast concrete tunnel linings (PCTLs) has been escalating due to its effective and economical installation process. The tunnels usually suffer from the premature deterioration due to corrosion of the reinforcement and thus need maintenance. Corrosion leads to the distress in PCTL leading to the cracking and finally the scaling of concrete. This study aims to assess the structural durability performance of reactive powder concrete (RPC) as the material of tunnel lining segments compared to reinforced concrete (RC) and high performance concrete (HPC). The numerical findings indicated that the maximum load capacity of PRC-PCTL segments was greater than that of the corresponding RC and HPC segments. Regarding the findings, PRC is a very significant option for conventional segments. The high strength of PRC can decrease the thickness of the PCTL segments, resulting in the decreased material cost. Also, PRC-PCTL segments can eliminate the laborious and costly production of RC segments and mitigate the corrosion damage and thus enhance the service life of lining segments.

Open Access | May 6, 2022

Optimization of mechanical wear resistance for recycled (Al-Mg-Si) reinforced SiC composite material using PM method

Salman Hussien Omran, Murtadha M. Al-Masoudy, Omar H. Hassoon, Mohammed A. Fayad

Page range: 295-303

Abstract

Recently, the increasing demand for advanced materials around the world led to search on require and optimal materials characteristics. An alloy (Al-Mg-Si) named hindalium was used in this study which made from aluminum recycling (aluminums sandwich panel plates). In addition, powder technology was applied to investigate the effect of adding silicon carbide (SiC) particles on the composite properties that enter in fabricate of disc brake rotors. The main reason to use this technology is a single material cannot meet the demands of an extreme engineering setting that encourage towards necessitating the use of composites. Metal matrix composites are a type of material that has a lot of potential for components and structural applications that require a lot of unique modulus, strength, and durability as well as in the same time being light in weight. The composites materials of metal base with good properties are becoming now widely used in several industrial sectors due to their high mechanical properties and resistant to wear. Al-Mg-Si alloys are a common material category because of their inherent hardness, and corrosion resistance. The properties of hardness, wear rate, and microstructure are the physical and mechanical tests were performing in this study. It is indicated that the modeling with using a Genetic Algorithm is the best solution to choose the samples that have been prepared. According to the results, it was observed that the hardness increased by 14% at 15%SiC content and the wear rate decreased by 17% as comparing with the base alloy used in this study.

Open Access | May 17, 2022

Mechanical and chemical bond for composite action of precast beams

Rana F. Yousef, Muna M. Al-Rubaye, Haitham H. Muteb

Page range: 304-319

Abstract

For utility of economical and practical construction, precast concrete is used due to its advantages such as reliability, durability, and higher quality. The appropriate selection of connection between the precast elements can have a significant influence on both the structural performance and long-term durability of such precast system. In this study, the effects of different connecting techniques on the performance of the precast composite flanged beams were experimentally and numerically investigated. The experimental program included testing up to failure under flexural loading conditions three groups of composite specimens: reference group, mechanical connecting group and chemical connecting group. The numerical assessment was done by using a finite element analysis to get a better insight and analyze the response of tested composite beams that available in the software package ABAQUS. The experimental results showed the advantageous effects of using mechanical connecting technique, as evident from improvement of the ultimate capacity or ductility of the precast composite beams. The results also showed that the predicted structural behavior using finite element analysis in terms of ultimate carrying loads, load-midspan deflection curves and crack patterns of the composite beams was in good agreement with the experimental data.

Open Access | May 28, 2022

A quadrilateral flat-shell element for the static and dynamic analysis of composite and sandwich cylindrical, spherical and conical shell panels

Vaishali Atulkumar Dagade, Shripad Kulkarni

Page range: 320-344

Abstract

A quadrilateral flat-shell element is developed for analysing the deflections, stresses and natural frequencies along with their allied mode shapes of cylindrical, spherical, and conical shell panels made up of layered composite and sandwich material. The developed element (DKZigTS1) is based on zigzag theory and has seven local as well as global DOF per node. The concept of obtaining transformation matrix is used for transforming actions and reactions from local to global direction to convert the plate bending into a flat-shell element. The two separate coordinate systems are used to transform rotational and translational degrees-of-freedom (DOF), from local to global direction. The local translational DOF are transformed to global Cartesian coordinates (x, y, z) and the local rotational DOF are transformed to the surface coordinate system (ξ 1 , ξ 2 , ξ 3), in which ξ 3 is perpendicular to the surface. The DKZigTS1 element gives fairly accurate results that align with the 2D analytical and the 3D elasticity solutions, reported in the literature for moderately thick and thick shell panel. The present results are also in good agreement with the 3D finite element solutions for shallow and deep shell panels having various material properties, boundary restrained environments, and geometrical shapes considered in this study.

Open Access | June 6, 2022

Nano reinforcement technique as a tool for enhancement the mechanical and fatigue properties

Abdulwahab AL-Mushehdany, Mazin Mahmood Yahya, Esraa Kadhim Ibrahim, Hussain Jasim M. Alalkawi

Page range: 345-351

Abstract

For the past three decades, AA7075 based metal matrix composite materials showed more attraction due to their enhanced mechanical and fatigue properties. The mechanical and fatigue behaviour of nano composites needs more investigation for their applications. In the present study, stir casting route based AA7075 reinforced with nano – sized, Al 2 O 3 particles (average size 35 nm). The evaluation of mechanical and fatigue properties in the nano cast composites and matrix were carried out at room temperature (RT). The composites and base metalwere subjected to high and low cycle fatigue. Scanning Electron Microscope was used to estimate fatigue behaviour of nano composites samples. The mechanical and fatigue properties was enhanced by the nano Al 2 O 3 , when compared to the matrix. The microsite evaluation showed uniform distribution of Al 2 O 3 particles into the matrix and few porosity was recorded. The improvement of the properties above is attributed to the grain refinement and to the distribution of the Al 2 O 3 .

Open Access | June 6, 2022

Penalty partial reduced selective integration: a new method to solve locking phenomena in thin shell steel and concrete structures

Roberto Nascimbene

Page range: 352-364

Abstract

The shell structures are commonly used in many civil and industrial and long-span logistic applications. In this research we simply start by applying a degenerated finite element continuum approach. Then we propose a new alternative formulation by splitting the shear energy into two main components, the first one exactly integrated, whereas the second reduced integrated in a proper way. In this numerical and analytical research we present this advanced new approach (herein named penalty partial reduced selective integration) by adding weight coefficients to the splitting energy terms. As a consequence of this formulation, the unwanted locking events are definitively eliminated. A wide range of real and analytical examples, from scientific literature and practical engineering shell design situations, are analyzed and deeply investigated to better understand the level of accuracy and effectiveness of the formulation proposed. Furthermore, comparisons withwell defined and established shell finite elements are made just to yield insight into the predictive capability of the penalty partial reduced selective integration, herein proposed and studied. Hence many examples are used to test this new formulation in order to analyze the numerical behavior of the approximate solution in dependence of the splitting parameters. A simple kind of methodological rules for choosing these numerical non-dimensional parameters are also given.

Open Access | June 15, 2022

Thermal fatigue analysis of different nano coating thickness by air plasma spraying in diesel engine thermal barrier coating

Qusay Adnan Mahdi, Ibtihal A. Mhmood, Mahmoud A Mashhour

Page range: 365-381

Abstract

The use of Atmospheric Plasma Spraying (APS) and yttria stabilized zirconia (YSZ) nanostructured coatings has been applied to the bond layer of NiCrAlY coated engine cylinder heads, pistons, and valve substrates. Thermal barrier coatings (TBCs) have been utilized to increase the engine performance in the design of combustion chamber components for internal combustion engines. ASTM-C-633-01 standard has been employed to conduct the bonding strength testing. It was also considered and directed to estimate the coating's thermal performance by evaluating its insulation value and conducting a thermal insulation durability assessment. Field emission scanning electron microscope (FESEM) and X-ray diffraction (XRD) were used to look at the nano powders and coatings' microstructures and phase compositions. In YSZ, it was discovered that the topcoat of samples had a tri-modal pattern of nano sized particles engaged by the powder, micro-columnar grains generated from the re-solidification of the molten part of the powder, and almost equiaxed grains, which were a unique construction feature. The results demonstrated the creation of nano zones in one of three nanostructured coating zones and improved the top coating properties, including bonding strength and thermal insulation capacity. The high temperature of the diesel engine caused fatigue failure in the intake and exhaust valves.

Open Access | June 15, 2022

CFD Comparison of multiphase models in the pool boiling state

Suleiman MJ. Enjadat

Page range: 382-389

Abstract

With the development of simulation technology and programs, it became necessary to study the models that control equations' solutions and influence the results. The models having control over solving equations of multiple phases and materials are investigated. They include (Volume of Fluid (VOF), mixture, Eulerian) controlling the governing equations. The study was conducted depending on the boiling point of the water. The activation of these three models is carried out to find out which one is better for solving the issue of boiling compared to previous numerical and empirical research with the study of the surface tension coefficient that affects the behavior of phases in a contaminated manner. The best model explored in the case of boiling is VOF for the merging of steam bubbles, the velocity of flows 0.257 m/s for both water and steam, and the phase transition. The effectiveness of the VOF model is mirrored by higher efficiency and accuracy of the solution with velocity 0.257 m/s and volume fraction 0.9997. The activation of the surface tension factor 0.072 property simulates the real conditions surrounding the materials used in boiling, but it significantly increases the turbulence and distribution of gas bubbles.

Open Access | July 23, 2022

Viscoelastic behavior of glass fiber reinforced rubber-modified epoxy

Adnan Abbass Al-Azzawi

Page range: 390-395

Abstract

Epoxies as a thermoset polymer have got a great attention in different applications. To elaborate their employing and surmount their brittleness, many polymers were blended with them. The results confirm that the good mechanical properties are obtained when 6wt% of Polysulfide Rubber (PSR) is blended with epoxy and reinforced with fiber glass. The effect of rubber and glass fiber on the viscoelastic properties of epoxy were investigated using creep-recovery data under different stress levels (5, 10, 15 and 20 MPa) and temperatures (30, 50, 70 and 90°C). Polysulfide addition caused larger creep and creep recovery. In addition, the creep resistance of glass fiber reinforced blend was significantly enhanced.

Open Access | September 12, 2022

An overset mesh approach for a vibrating cylinder in uniform flow

Farouk Omar Hamdoon, Alaa Abdulhady Jaber, Enass H. Flaieh

Page range: 396-402

Abstract

This paper has numerically investigated twodimensional laminar flow over a vibrating circular cylinder. Numerical simulation is performed using the dynamic overset mesh method available in commercial software ANSYS FLUENT 19.0. A simple harmonic motion is applied to simulate the cylinder vibration using the user-defined function (UDF) tool in FLUENT. To examine the accuracy and the capability of the present overset mesh approach, two test types of cylinder vibration are simulated: crossflow and inline vibrations. All simulations are performed at a constant Reynolds number (Re = 100) to predict the occurrence of synchronization or lock-in phenomenon. For the case of crossflow vibration, it is observed that lock-in occurs with cylinder oscillation frequency near the Strouhal frequency of the fixed cylinder. However, for the inline vibration, lockin occurs near twice the Strouhal frequency of the fixed cylinder. Furthermore, in the case of crossflow oscillation, the frequency content in the lift coefficients' time history is successfully linked to the phase portraits' shape and the vorticity field. The simulation results are consistent with the available published data in the literature. This indicates that the present numerical technique is valid and capable of modeling flows with moving structural systems.

Open Access | September 25, 2022

Size-dependent nonlinear vibration analysis of nanobeam embedded in multi-layer elastic media and subjected to electromechanical and thermomagnetic loadings

Gbeminiyi Musibau Sobamowo

Page range: 403-424

Abstract

In this work, magneto-electro-mechanical size-dependent nonlinear vibration analysis of nanobeam embedded in multi-layer of Winkler, Pasternak, quadratic and cubic nonlinear elastic media is presented. A nonlinear partial differential equation of motion is derived using Von Karman geometric nonlinearity, nonlocal elasticity theory, Euler-Bernoulli beam theory and Hamilton's principle. Additionally, the efficiency of multiple scales Lindstedt-Poincare method for the strong nonlinear and large amplitude systems is presented. It is established that the results of multiple scales Lindstedt-Poincare method are in good agreements with the numerical and exact solutions for the strong nonlinear problems. However, the classical multiple scales method fails and gives results with very large discrepancies form the results of the numerical and exact solutions when the perturbation parameter is large, and the nonlinearity terms are strong. The high accuracy of the results of multiple scales Lindstedt-Poincare method and its excellent ability to produce accurate results for all values (small and large) of perturbation parameter and the nonlinearity terms show the superiority of the multiple scales Lindstedt-Poincare method over the classical multiple scales method. Further results present the effects of the model parameters on the dynamic behaviour of the nanobeam. It is hoped that the present study will advance nonlinear analysis of the engineering structures.

Open Access | October 18, 2022

Optimization of fatigue life in laminated composite plates

Bassam Ali Ahmed

Page range: 425-441

Abstract

With the development of fiber technology on which the composite materials depend mainly was necessary to improve the rigidity, durability, and heat transfer in the areas of heating and cooling technologies. The effect of the fatigue phenomenon on composite materials using carbon fibers is studied. In this research paper, work was performed to study the improvement in the bearing capacity of the stress test sample with the addition of carbon fibers at different angles. The stresses affecting the test specimen are cylindrical with a length of 10 cm. The results proved that the best arrangement of the carbon fibers in the form of triple layers starting from the center of the cylinder circle to the outside was the share of the arrangement layer 45, 0, 0, where the lowest value was the number of fatigue life cycles, 2349 cycles in the bending test, as the amount of stress that this case reached was 6.1×10 8 Pa compared to the rest of the studied cases.

Open Access | November 20, 2022

Effect of shot peening on the critical buckling load of stainless steel 304 columns immersed in sea water

Amjed M. Bader, Dhia A. Alazawi, Hussain J. M. Al-Alkawi, Saad T. Faris

Page range: 442-450

Abstract

A machine part subjected to an axial compressive load is called strut. But, a vertical strut is known as a column. The machine members that must be investigated for the column action are connecting rods, piston rods, screw jack, etc . When a column is subjected to a compressive load and this load is gradually increased, a stage will be reached when the column will be subjected to ultimate load. Beyond this, the column will fail by crushing, and the load will be known as crushing load. When the column is short or intermediate, sometimes this column fails by bending, i.e. buckling. When the column is long, the value of buckling load is low for long columns and is relatively high for intermediate columns. The present investigation focuses on the testing and evaluation of the mechanical end buckling columns (samples) using 304 stainless steel under dry, corrosion, and combined dry with shot peening (SP) process. The buckling behavior of the axial compressive load has been studied experimentally and theoretically using Euler and Rankin theories. The results obtained from the above study manifested that the column, whose slenderness ratio (SR) is more than 120, is denoted as the long column, and the Euler theory can be successfully used. But, when the SR is less than 120, the column is known as an intermediate one. The mechanical and buckling properties exhibited a reduction due to the corrosion media and a reasonable improvement when using SP.

Open Access | October 27, 2022

Regression dependences in bending reinforced concrete beam with cracks

Zhmagul Nuguzhinov, Omirkhan Khabidolda, Zhetpisbai Bakirov, Syrlybek Zholmagambetov, Alexey Kurokhtin, Daniyar Tokanov

Page range: 442-451

Abstract

The work is devoted to determining the stress parameters of flexible reinforced concrete beams with cracks. The problem is solved using LIRA-SAPR using beam finite elements, taking into account the nonlinear relationship between deformation and stress in concrete. In the course of solution, a step-by-step loading method is used with the use of an iterative process at each step. To obtain the dependence of the stress parameters on varied factors, a rational planning matrix for a multifactor computer simulation was compiled to determine the stress parameters in bent rectangular reinforced concrete beams with a crack. According to this plan, computer simulations were conducted for concrete beams of C20/25 and B32/40 class. The obtained dependences enable to evaluate the operability of the considered structural elements for both groups of limiting states. They can be used to determine the parameters of fracture mechanics and evaluate the crack resistance of a beam.

Research Article

Pravin V. Avhad and Atteshamuddin S. Sayyad*

On the deformation of laminated composite and sandwich curved beams

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Abstract: Plenty of research articles are available on the static deformation analysis of laminated straight beams using refined shear deformation theories. However, research on the deformation of laminated curved beams with simply supported boundary conditions is limited and needs more attention nowadays. With this objective, the present study deals with the static analysis of laminated composite and sandwich beams curved in elevation using a new quasi-3D polynomial type beam theory. The theory considers the effects of both transverse shear and normal strains, i.e. thickness stretching effects. In the present theory, axial displacement has expanded up to the fifth-order polynomial in terms of thickness coordinates to effectively account for the effects of curvature and deformations. The present theory satisfies the zero traction boundary condition on the top and bottom surfaces of the beam. Governing differential equations and associated boundary conditions are established by using the Principal of virtual work. Navier's solution technique is used to obtain displacements and stresses for simply supported beams curved in elevation and subjected to uniformly distributed load. The present results can be benefited to the upcoming researchers.

Keywords: fifth-order polynomial, laminated and sandwich, curved beams, static analysis

1 Introduction

Laminated composite curved beams/arches are widely used in aerospace, automobile, ships, civil and mechanical industries due to their superior properties such as high stiffness-to-weight ratios as well as the high strength-to-weight ratio. Therefore, it is significantly important to investigate the accurate static behaviour of curved beams subjected to static loading. Various laminated beam theories are available in the literature which can be extended for the analysis of curved beams such as classical beam theory [1], Timoshenko beam theory [2], Higher order beam theories [3, 4, 5], etc. In this section literature on various beam theories available in the literature and their applications in various problems are reviewed.

Reddy [6] has developed a well-known third order shear deformation theory for the analysis of laminated composite beams which is further extended by Khdeir and Reddy [7, 8] for the analysis of cross-ply laminated beams/arches. Kant and Manjunath [9] have presented a static analysis of symmetric and unsymmetric laminated composite and sandwich beams based on a C^0 continuity finite element using various refine higher order beam theories. Kant *et al.* [10] have developed semi-analytical elasticity bending solutions for laminated composite beams. Li *et al.* [11] have studied the free vibration analysis of laminated composite beams of different boundary conditions using various higher-order beam theories and spectral finite element method which is also used by Nanda and Kapuria [12] for the wave propagation analysis of laminated composite curved beams. Luu *et al.* [13] investigated non-dimensional deflection and critical buckling loads of shear deformable laminated composite curved beams using the NURBS-based isogeometric method. Ye *et al.* [14] and Mohamad *et al.* [15] studied vibration analysis of laminated composite curved beams of various boundary conditions. Jianghua *et al.* [16] have presented the static and vibration analysis of laminated composite curved beams using a domain decomposition approach. Zenkour [17] has developed a new shear and normal deformation theory for the static analysis of cross-ply laminated composite and sandwich beams. Karama *et al.* [18] have developed an exponential shear deformation theory for the bending, buckling, and free vibration analysis of multi-layered laminated composite beams. Piovan *et al.* [19] have analyzed composite thin-walled curved beams with open and closed cross-sections. Hajianmaleki and Qatu [20] have applied Timoshenko beam theory for the static and free vibration analysis of generally laminated

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Research Article

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A study on the construction technology of the Seljuk minarets in Isfahan with focus on their geometric brick pattern

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Abstract: Using decorative elements is an inseparable aspect of Iranian architecture. Architectural ornaments in many buildings, including the minarets, represent the architect's craftsmanship. As such, the minarets in Isfahan have different types of brickwork ornamentations, such as 90-degree herringbone *(Khofteh-Rasteh)*, basket weave bond *(Hasiri)*, and other complex types. Additionally, the highest minarets are usually constructed in a truncated conical shape to reduce their overall weight and ameliorate their stability against the wind, and lateral forces. Therefore, while the geometric integrity of brickwork patterns should be maintained, all the ornamentations are applied on a shrinking surface area. However, the practical solutions for the construction processes in these structures haven't been sufficiently investigated. Hence, this study aims to explore the methods of brickwork projection on the minarets and analyse the changes in girih patterns at different height levels. Accordingly, after surveying the selected single minarets in Isfahan, they were modeled using drafting software applications and then analysed.

Keywords: minarets of Isfahan, use of brick tile (girih) on curved façade, geometry in architecture, brickwork, geometric pattern

1 Introduction

The minaret is an architectural type with symbolic significance in the Middle East. The exterior surface is usually ornamented with brickwork patterns that are designed through mathematical and geometric calculations. Because of the minaret's overall shape, the brick patterns are constructed on a greater surface area at the bottom compared to the available surface at the upper parts. In other words, the cross-section diameter is gradually decreased during the construction; consequently, the surface area will be reduced as well. As a result, in projecting these brickworks on a shrinking surface, retaining the geometric integrity of these patterns could become very challenging. Nevertheless, even though the cross-section diameter is decreasing, the overall design should cover the exterior façade completely. Similarly, in implementing these patterns on the minaret, the pattern should be put together around the surface accurately and appropriately; that is, an implemented design without overlapping parts at different height levels. Besides, the integrity of geometric order in the implemented patterns should be successfully maintained.

Therefore, this study aims to answer these questions:

- How a two-dimensional brickwork pattern on the minaret's three-dimensional curved surface could be implemented without losing the integrity of geometric order?
- What practical solutions have been developed to maintain the geometric integrity on the minaret's cone-shaped surface?

1.1 Research background

Most previous studies about girih patterns are concerned with two-dimensional planes. So, this study is one of the earliest endeavors in analysing and addressing the challenges regarding the implementation of these patterns in three-dimensional structures and the practical solutions thereof. In previous studies about the application of girih in brickwork and the architectural geometry, traditional craftspeople (such as Lorzadeh, Maher-ul-Naghsh, and Sha'rbaf) and architects (such as Pirniya and Bozorgmehri) have discussed the implementation of girih patterns thoroughly [1]. In other studies, girih patterns have been seen concerning connections to mathematics [2]. Moreover, the similarity of

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