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The Accident at the Fukushima Dai-ichi Nuclear Power Station -Accident Progression Behavior of the Nuclear Reactor and Lessons Learned-

by

Yoshio KANI[*1]

(Received on Jan. 18, 2012)

Abstract

On March 11, 2011, the Great East Japan Earthquake -rated a magnitude 9.0- occurred and precipitated a large tsunami that is estimated to have exceeded 14 meters in height at the Fukushima Dai-ichi Nuclear Power Station site. As a result of the earthquake, all of the operating units experienced a normal reactor shutdown within the capability of the safety design of the reactors. However the large tsunami resulted in extensive damage to site facilities and a complete loss of AC electrical power at Units 1 through 5, a condition known as station blackout (SBO). Also the DC electrical power lost its function due to the tsunami effect or exhaustion of batteries, thereby leading to loss of most instrumentation and control systems. Consequently the cooling was lost to the fuel in the reactor cores and spent fuel pools, and eventually the core meltdown occurred at Units 1 through 3. In the course of accident progression the confinement function of reactor pressure vessels and containment vessels was seriously impaired and the significantly large amount of radioactive materials was released to the environment. This paper gives an explanation on the basic philosophy of nuclear reactor safety, the event sequence of the Fukushima accident and the implication of the accident, as well as the lessons learned.

Keywords: Fukushima Dai-ichi Nuclear Power Station, Nuclear Reactor Safety, Earthquake and Tsunami, Station Blackout, Loss of Cooling

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Smart Grid and Problems

by

Hidenori AOKI[*1]

(Received on Nov. 16, 2011)

Abstract

Supplying electric power stably, safely and efficiently is essential. Fossil fuels have filled this essential need, but burning them creates carbon dioxide and causes global warming. Solutions have been researched in many countries such as energy from wind and solar power, but using renewable energy presents other issues. This paper presents these issues and introduces the smart grid, which is one of the best technologies to solve them. The smart grid will be a great help to create a low-carbon society and is being researched and developed highly in many countries.

Keywords: Smart grid, Low-carbon society, Photovoltaic power generation, Surplus power

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Judging Liquefaction Possibility and Retrofitting Method for Detached Houses Damaged by the East Japan Great Earthquake

by

Chol-Ho KIM[*1], Mamoru FUJII[*2], Kyouichi SHINAGAWA[*1], Toru TAKATA[*3] and Masahiro OGAWA[*4]

(Received on Sep. 28, 2011 and accepted on Nov. 16, 2011)

Abstract

Due to the East Japan Great Earthquake of March 11 2011, the necessity of countermeasures against liquefaction under detached houses has been increasing in Japan. In this paper, the focusing on the ground under detached houses damaged by liquefaction, the conventional liquefaction judgment method was verified using both the Swedish Wight Sounding test and Cone Penetration test results from approximately 79 sites. In addition, based on approximately 160 cases of damaged detached houses with ground reinforcement, the relationship between the damage level and inclination angle of detached houses, and applied retrofitting methods were investigated. Finally, we introduced a ground reinforcement system against liquefaction and a design method.

Keywords: Eastern Japan Great Earthquake, Detached houses, Liquefaction, Ground exploration, Groundwater level

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The 2011 Great East Japan Earthquake: Damage and Repair of Railway Bridges and Viaducts

by

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(Received on Sep. 30, 2011 and accepted on Nov. 16, 2011)

Abstract

The 2011 Great East Japan Earthquake hit railway bridges and viaducts of JR East Railways. The main M9.0 earthquake and several aftershocks over M6.0 damaged RC columns, RC piers, bearings at the girder ends and PC poles for electric cables of the Tohoku Shinkansen. Although many bridges on local lines were also damaged, the damaged parts were limited to the bearings and stoppers; no serious structural damage was observed. The damaged bridge members and poles were repaired effectively without delay. No passengers were killed nor seriously injured on the JR East Railways during the earthquake. Some bridge piers and girders collapsed or were swept away by big tsunamis. The design specifications for railway bridges had been altered after the Great Hanshin Awaji Earthquake. No catastrophic collapse of bridges in this earthquake occurred because the existing bridges were strengthened and new bridges were designed according to the altered specifications. However, some bridges were seriously damaged by tsunami and electric cable poles broken, which is a new phenomena and should be addressed in the future.

Keywords: 2011 Great East Japan Earthquake, Railway bridges and viaducts, Damage, Repair

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Development of Imaging Materials for Electronic Paper by using I/O Value

by

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(Received on Sep. 16, 2011 and accepted on Sep. 16, 2011)

Abstract

Electronic paper plays an important role in information devices, principally due to readability under high ambient light and low power consumption. At present, electronic paper uses electrophoretic displays that have small particles as movable display elements in microcapsules. The key technology in obtaining successful electrophoretic displays is utilizing appropriate surfactants for dispersing these particles. To reduce the R&D time and cost, finding useful parameters for appropriate suitable surfactants is necessary. This paper focuses on the effect of I/O values as the parameter, particularly emphasizing use in surfactants and dispersion media. Furthermore, through experimental work in magnetic electronic paper, we demonstrate how useful I/O values are.

Keywords : Electronic paper, Electrophoretic display, I/O value, Surfactant

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Application of Efficient Multi-Objective Optimization and Network Expansion Planning

by

Yosuke HIRATA[*1] and Hidenori AOKI[*2]

(Received on Sep. 24, 2011 and accepted on Jan. 18, 2012)

Abstract

This paper presents applying multi-objective optimization methods to network expansion planning. The distribution network expansion planning minimizes system costs and distribution loss while satisfying the constraints. Problem formulation results in combinatorial optimization problems that are difficult to solve due to complexity. This research applies a genetic algorithm, which is a meta-heuristics method. The present study proposes a new method of multi-objective optimization methods; NSGA-II and SPEA2 are assumed to be the best method now. The proposed method introduces the concept of a linkage identification genetic algorithm, enabling more efficient searching than methods hitherto known.

Keywords: Distribution network expansion planning, Multi-objective optimization, Linkage identification genetic algorithm

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SVR Optimal Placement Problems in Distribution Network with Distributed Generators

by

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(Received on Sep. 24, 2011 and accepted on Jan. 18, 2012)

Abstract

This paper presents a new approach to the optimal placement of a step voltage regulator (SVR), considering the installation of distributed generators (DG) based on a genetic algorithm (GA). In this case, solving problems such as the upper and lower limits of voltage at each node and line capacity is necessary. As the load and output of DG changes, solving more than one of these problems is important. The transmission voltage is also examined. To solve these problems, the conventional GA was improved and the proposed method applied to the complex operating conditions of a distribution power system.

Keywords: Step voltage regulator, Optimal placement, Daily load variation, Voltage control, Genetic algorithm

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First Principles Calculation of the Electronic Structure and Phonon Frequencies of SbSI in Para- and Ferroelectric Phases

by

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(Received on Sep. 30, 2011 and accepted on Nov. 16, 2011)

Abstract

The electronic band structure, density of states (DOS) and phonon frequencies of the ferroelectric semiconductor SbSI in the para- and ferroelectric phase are calculated by first principle pseudopotential method using density functional theory in the generalized gradient approximation. The first principles calculation shows that SbSI has an indirect band gap in para- and ferroelectric phases. The bottom of the conduction band is located at S point, and the maximum of the valence band is at X-U point of the Brillouin zone. The calculated phonon frequencies are in good agreement with those reported by Raman scattering experiments. The calculated phonon frequencies indicate that SbSI has stable phonon structure in para- and ferroelectric phases.

Keywords: First principles calculation, Phonon frequencies, Ferroelectric semiconductor, SbSI

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Evaluation of Near-field Noise Suppression Device for Preventing Electromagnetic Interference between Electronic Circuits on PCB

by

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(Received on Sep. 30, 2011 and accepted on Nov. 16, 2011)

Abstract

Recently, many electronic circuits are mounted with high density on a printed circuit board (PCB) because of miniaturization of electronic equipment. Broad-band electromagnetic noise with high frequency components is generated from the electronic circuit which constitutes high-speed digital electronic equipment. Electromagnetic interference which often occurs between such electronic circuits causes malfunction of the electronic equipment. In this paper, a noise-suppression device aiming at suppressing a magnetic field around the PCB is proposed. The device has a simple structure which consists of a coil and a capacitor, and absorbs the magnetic field of a specific frequency by means of electromagnetic induction and resonance. This paper describes the principle of the noise-suppression device and the noise-suppression effect of the PCB in which the device was mounted.

Keywords: Near Field, Noise-suppression Device, Printed-circuit Board, Electromagnetic Induction, Resonance

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RC Beam Made of Ductile Fiber Reinforced Concrete Using Recycled Aggregate

by

Masaya NAKAMURA[*1] and Ken WATANABE[*2]

(Received on Sep. 30, 2011, accepted on Jan. 18, 2012)

Abstract

Considering global environmental issues when planning industrial projects is essential. Studies on recycled aggregate concretes have been extensively implemented in the concrete industry. Investigation concerning the applicability of Ductile Fiber Reinforced Concrete (DFRC) using recycled aggregate has been reported. DFRCs are composites of cementitious material reinforced with fibers. The material is superior to the existing fiber reinforced concrete (FRC), especially for crack-dispersing property and mechanical ductility. For applying DFRC to RC structures as an effective seismic element, understanding its basic behavior by experimentally testing at least a limited number of specimens is required. Providing proper physical explanation for experimental findings and constructing an objective mechanical model are important tasks. In the present study, we first implemented the 4-point RC beam bending test for using DFRC. Then we investigated the flexural fracture behavior of RC beams with the finite element procedure. This study found that 1) the Flexural and shear load-carrying capacities of RC beam can be upgraded due to using DFRC and 2) the Flexural maximum load of RC beam using DFRC can almost be simulated by the flexural maximum load equation that reflects the tensile strength of DFRC.

Keywords: Recycled aggregate, Fiber reinforced concrete, Ductile-fiber-reinforced concrete, RC Beam

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Estimating the Compression Softening of Ductile-Fiber-Reinforced Cementitious Composite Using Recycled Fine Aggregate and Shirasu

by

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(Received on Sep. 29, 2011 and accepted on Nov. 16, 2011)

Abstract

Ductile-fiber-reinforced cementitious composites (DFRCCs) have recently been developed, which showing performance largely superior to current fiber-reinforced concretes. DFRCCs are composites of cementitious material reinforced with fibers, which have multiple cracking characteristics and greatly improved toughness during bending, tension, and compression fractures. The research literature includes efforts to use them as energy absorbing devices of structures too. In order to apply DFRCCs to RC structure members and analytically evaluate the response characteristics, understanding DFRCC behavior for compressive loading is necessary. In the study, we first conducted uniaxial compressive tests of DFRCCs using natural fine aggregate, recycled fine aggregate and shirasu fine aggregate. We then estimated the bi-linear compression softening behavior of DFRCCs. Finally, the material constants of bi-linear compression softening behavior were formulated with the compressive strength of DFRCCs. The conclusion is that the compressive strength of DFRCCs can be used to estimate the bi-linear compression softening behavior of DFRCCs.

Keywords: Compression softening behavior, Recycled fine aggregate, Shirasu, DFRCC, FEM

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Destruction Mechanism of the Pile-Tip Protection Using Ductile-Fiber-Reinforced Cementitious Composite

by

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(Received on Sep. 30, 2010 and accepted on Jan. 18, 2012)

Abstract

Ductile-fiber-reinforced cementitious composite (DFRCC) is a material with highly improved ductility against flexural tensile and compressive failure. The mortar used for pile-tip protection is a brittle fracture material. Applying DFRCC to pile-tip protection may greatly contribute to improving the bearing capacity. In this study, to examine applying DFRCC to pile-tip protection, experiments and finite element analysis on pile-tip protection of precast pile were conducted. The study found that using DFRCC for pile-tip protection improves the bearing capacity under different support conditions.

Keywords: Pile-tip protection, Lateral pressure, DFRCC, FEM analysis, Support conditions

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Experimental verification of Tuned Cradle Mass Damper

by

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Abstract

The tuned cradle mass damper (TCMD) relies on the motion of a swing mass on a curved surface to dissipate structural vibration energy. The objectives of this study are to obtain constant swing speed of the TCMD and verify its performance through experiments when the structure is under free and forced vibration. In order to obtain a constant speed of the device, the variable radii of the curved surface were calculated by using simple pendulum dynamics. For this study, the damper was installed on an one-story simple rigid frame model with a frequency of approximately 1 Hz .

Keywords: tuned mass damper, free vibration, forced harmonic vibration

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Two Dimensional Collapse Analysis of Steel Truss Bridges

by

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(Received on Aug. 31, 2011 and accepted on Nov. 16, 2011)

Abstract

Deteriorated steel truss bridges have caused catastrophes in the USA and Japan. Collapse analysis is implemented for three continuous steel truss bridges, using large deformation elastic plastic analysis. The analysis is to clarify how intensity and distribution of live loads affect structural safety and ductility for two truss bridge models. Although the collapse process differs depending on live load distribution and span length, both truss bridges collapse due to buckling. The ductility of Model Bridge B with a span ratio of 1:1.3:1 is larger than that of Model Bridge A with a span ratio of 1:2:1.

Keywords: Collapse of steel truss bridge, Large deformation elastic plastic analysis, Ductility, Structural safety

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Soil Consolidation Parameters Using Incremental Loading(IL) and Constant Rate of Strain(CRS) Oedometric Consolidation Tests

by

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(Received on Sep. 30, 2011 and accepted on Jan. 18, 2012)

Abstract

The influence of the secondary compression included in the results of constant rate of strain (CRS) tests is investigated by both CRS and incremental loading (IL) oedometric consolidation tests. The compression index and coefficient of consolidation obtained from the CRS tests conducted at the strain rate of 0.02 %/min are affected by secondary compression. As a result of examining the consolidation behavior in the CRS tests by one-dimensional consolidation FE analysis considering the secondary compression, it was clarified that 1) although consolidation curves are calculated close to the measured value depending on the choice of strain rate, coefficients of consolidation calculated from the water pressure at the bottom greatly differ from the measured value and that 2) consolidation curves calculated vary depending on the strain rate when the maximum drainage distance of the specimen changed.

Keywords: One-dimensional Consolidation, Coefficient of consolidation, CRS test, FE analysis

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Micro-Bubble influence on Pipe Friction Loss

by

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(Received on Sep.30,2011 and accepted on Jan.18, 2012)

Abstract

The effect of friction loss reduction due to Micro-Bubble is now being intensively researched, using flat plates, etc. In order to put Micro-Bubble into practical use, comprehending Micro-Bubble behavior under various conditions is necessary. In this study, the effects on pipe frictional loss by Micro-Bubble have been investigated. Experiments were implemented under seven conditions: changes in the amount of Micro-Bubble, irradiation of supersonic wave, surfactant interfusion, fluid purity changes, temporal changes of pipe friction, changes of water temperature and changes in pipe diameter. The results show that the pipe friction loss decreased up to 24% and this reduction effect is higher when more bubbles adhere to pipe wall. Supersonic wave radiation doubles the Micro-Bubble reduction effect. The efficiency of friction loss reduction depends on the size of the Micro-Bubble that adhere to the pipe's wall. The Micro-Bubble friction loss reduction effect generated in tap water is higher than the Micro-Bubble friction loss reduction effect generated in pure water. The Micro-Bubble friction loss reduction effect changes from changing the pipe diameter.

Key Words: Micro-Bubble, Pipe friction loss, Friction reduction, Supersonic Wave, Visualization

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The Flow Characteristics of Three-Dimensional Flow Around Square Cylinders With Grooves

by
Takumi IKEDA[*1] and Hiroo OKANAGA[*2]

(Received on Sep. 29, 2011 and accepted on Nov. 16, 2011)

Abstract

The objective of this study is to understand the aerodynamic characteristics of three-dimensional flow around square cylinder with grooves. This study clarifies the effects of the drag reduction using the grooves of square cylinders. Experimental investigations on the flow around square cylinders were implemented in the range of $5.6\times10^4 \leqq Re \leqq 1.69\times10^6$. Drag coefficient was lower with 3D flow than 2D flow.

Key Words : Square cylinder with grooves, Drag coefficient, Three-dimensional flow

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Flow Visualization around square cylinder with grooves —Effect of depth of grooves, width of grooves and interval of grooves—

by
Tomoaki AOYAMA[*1], Hiroo OKANAGA[*2]

(Received on Sep.29, 2011 and accepted on Nov.16, 2011)

Abstract

The objective of this study is to understand effect of depth of grooves, width of grooves and interval of grooves on square cylinder to the flow characteristics. Experimental investigations on the flow around square cylinders were carried out at $Re=7.4\times10^4$. In addition, the flow visualization by Spark tracing method has been carried out. From the results, the drag coefficient decreased up to 22% compared to the square cylinders, as the interval of grooves increased. Moreover, rather than increasing the width of the groove, increasing the groove interval is more effective to reduce the drag coefficient.

Key Words : Square cylinder with grooves, Drag coefficient, Spark tracing method

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Regenerative Brake on the Skid Control of Small Electric Vehicle

by

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(Received on Sep. 30, 2011 and accepted on Jan. 18, 2012)

Abstract

In recent years, electric vehicles (EV) have been becoming important as one solution for environmental problems such as global warming and reduced oil reserves. The in-wheel motor system is one EV driving system. This system has a motor in the driving tire wheel, presenting advantages of less transfer energy loss from motor to driving tire, small vehicle mass and extensive cabin space. However, the space in a driving wheel is insufficient to install a hydraulic brake unit. Some small EV employ a compact mechanical brake system for driving tires instead of hydraulic brakes. Although the mechanical system is compact, the system stiffness is smaller than that of hydraulic brakes, and the response performance of the braking force of the mechanical system is low. Skid control of small EV employing the mechanical brakes is difficult. The small electric vehicles do not employ anti-lock braking device. Most small EV only provide seat belts as safety equipment. The aim of this research is to establish skid control of small EV with hydraulic-mechanical hybrid brakes, and improve safety.

Keywords: Small electric vehicles, Anti-lock braking system, Regenerative brake

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Vibroacoustic Coupling Phenomenon between an Excited Plate and Internal Sound Fields of a Connected Cylindrical Structure

by

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(Received on Sep. 30, 2011 and accepted on Jan. 18, 2011)

Abstract

To apply acoustic energy to industrial fields, amplification is essential and vibroacoustic coupling is one of the best ways of amplifying acoustic energy. This paper describes vibroacoustic coupling between the plate vibrations and the internal sound fields of a cylindrical structure connecting two cylinders with thin plates. The coupling phenomena are theoretically and experimentally investigated by considering the behavior of the plates and the acoustic characteristics of the internal sound fields with variations in cylinder length, when an external harmonic force is applied to one end plate. The acoustic characteristics are evaluated based on the sound pressure level, which is maximized while changing the phase difference between the plate vibrations. The plate vibration behavior is investigated by varying the phase difference with the cylinder length.

Keywords: Vibroacoustic coupling, Connected cylinder, Plate vibrations, Internal sound filed, Phase difference

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Axisymmetric Air Jet Flow Characteristics

by

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(Received on Sep. 30, 2011 and accepted on Nov. 30, 2011)

Abstract

Conventional research has clarified the similarity of the velocity profile in the axisymmetric jet fully developing region. However, obtaining a similar profile with a method equal to fully developing region is not possible, since the velocity profile change is early intense due to the existence of the potential core region in the region. In this study, the velocity profile in the initial region of the axisymmetric air jet was measured by intelligent hot-wire (IHW) and the profile similarity was examined. Obtaining a method for similarity showing the velocity profile in the initial region of the jet was possible. The profile being approximately cut in the Gaussian curve was clarified by examining that a similar velocity profile is shown by the equation. The results demonstrated that the velocity profile was shown by the Gaussian curve.

Keywords: Flow characteristics, Axisymmetric jet, Air jet, Initial region, Similarity of velocity profile

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Buckling Analysis of Composite Laminated Cylindrical Shells with Liquid Pressure under Axial Compression

by

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(Received on Sep. 30, 2011 and accepted on Jan. 18, 2012)

Abstract

Advanced fiber-reinforced laminated composite materials have been used for structural members in multiple fields because of their high specific strength and specific stiffness. In general, composite laminated cylindrical shells behave differently from homogeneous orthotropic cylindrical shells due to their anisotropy and asymmetric lamination. In this paper, we use the finite element method to describe the buckling strength of cross-ply laminated cylindrical shells with liquid pressure under axial compression. We analytically clarified the effects of factors such as liquid density, liquid level, stacking sequence, number of layers and cylinder buckling mode on the buckling strength.

Keywords: Structural analysis, Composite materials, Laminated cylindarical shells, Buckling, Liquid pressure, Axial compressive load, Finite element method

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Impact Absorbing Characteristics of Engine-Hood Structures Using ZETA-Stiffened Panel Considering Head Impact Position

by

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(Received on Sep. 30, 2011 and accepted on Jan. 18, 2012)

Abstract

Motor vehicles on the market have been required to undergo the pedestrian head protection test since 2004 and engine-hoods need to meet the required standards for pedestrian head protection performance in addition to primary performance. The engine-hood of motor vehicles is evaluated by the pedestrian head protection performance test according to the head injury criteria (HIC) which is calculated by 3-dimensional acceleration generated against the head. All car manufacturers are recently required to consider protecting pedestrian heads when developing the engine-hood. It is important to control the acceleration time history at the initial stage and late stage for pedestrian head protection. The engine-hood for pedestrian head protection needs to control local rigidity and whole rigidity by just one structure. To solve this problem, we focus on inner panels which have a dominant role in absorbing energy. This study also aimed at evaluating the impact characteristics of inner panels adopting ZETA-stiffened panels to improve pedestrian head protection by numerical analysis. As a result, it was found that the inner panel could complement the performance of outer panel. In addition, the ZETA-stiffened panel structure help to control the amount of displacement and it was effective in the reduction of HIC.

Keywords: Engine-hood (Bonnet), Pedestrian protect, Head injury criteria (HIC), Impact position, Acceleration, ZETA-stiffened panel structure (Miura-ori structure)

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A Study on Impact Response Characteristics of Heads in Pedestrian Accidents with Automobile Engine-Hood Structures

by

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(Received on Sep. 30, 2011 and accepted on Nov. 16, 2011)

Abstract

Motor vehicles on the market have been required to undergo the pedestrian head protection test since 2004; engine-hoods need to meet the required standards for pedestrian head protection performance in addition to primary performance. The engine-hood quality is evaluated by Head Injury Criteria (HIC) derived from 3-dimensional acceleration generated against the head. Based on HIC measurements, the authors tried to improve performance by using a hood with a two panel structure. This study uses numerical analysis to examine the impact response characteristics of the pedestrian head. We focus on brain concussion and skull fractures as severe injuries in engine-hood collisions. The results demonstrate the dynamic deformation behavior of the engine-hood and the head injury mechanism.

Key Words: Engine-hood, Pedestrian protect, Head Injury Criteria (HIC), Concussion, Skull fracture, Negative pressure, Mises stress

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Secondary Buckling Analysis of Quasi-Isotropic Laminated Plates with Initial Deflection Subjected to Biaxial Compressive Loads

by

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(Received on Sep. 30, 2011 and accepted on Jan. 18, 2012)

Abstract

Advanced composite materials including those using carbon fiber reinforced plastic (CFRP) are being increasingly used in engineering applications including aerospace, mechanical, marine and automotive engineering because they offer excellent properties such as high specific strength and specific stiffness. Many researchers have examined postbuckling behaviors of thin laminated plates under uniaxial compression, but few have examined the secondary buckling phenomenon for thin laminated plate that occurs with further load increases. In this paper, the second variation of total potential energy is used to determine the stability condition of carbon-epoxy quasi-isotropic laminated plates with initial deflection under biaxial compressive loads that are simply supported along four edges. The necessity of secondary buckling is proven analytically, and the effects of various factors including lamination constitution, biaxial compressive load ratios and initial deflection are clarified.

Keywords: Structural analysis, Composite materials, CFRP, Secondary buckling, Quasi-isotropic, Biaxial-compressive loads, Initial deflection

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Visualization of compressible vortex discharged from open-end of shock tube

by

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(Received on Sep. 30, 2011 and accepted on Nov. 16, 2011)

Abstract

Study of supersonic compressible vortex ring can contribute to improved dynamic performance aerospace, environmental compatibility, fuel efficiency, and a clarification of turbulence phenomena. This research is the basic research to understand internal structure of the compressible vortex ring in supersonic. We compared visualization of the compressible vortex ring in supersonic with the numerical results to verify that be able to observe phenomena caused by the effect of the vortex ring with our shock tube and optical system. The vortex rings were generated at diaphragm-type shock tube with open-end. We experimented on two conditions: incident Mach number is 1.5 ± 0.02 and 1.69 ± 0.01. And, we use shadowgraph method for visualization.

Keywords: Vortex, Embedded shock, Secondary vortex ring

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Shock Mach number prediction under massive boundary layer effect

by

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(Received on Sep. 30, 2011 and accepted on Nov. 16, 2011)

Abstract

The authors conducted an experimental study to obtain characteristics of a shock tube which scale factor was set at 236, same as micro shock-tubes. For estimating a shock Mach-number, a theoretical study was conducted by Mirrels's shock-tube theory and White's boundary layer effect theory. Since a boundary layer in the shock tube could not be measured, the calculation assumed the boundary layer to be fully laminar and fully turbulent. Experimental study which varied high-pressure room pressure from 0.2 MPa to 1.8 MPa was conducted with an area-change shock tube, 3000 mm in a low-pressure section length, and 30-by-40 mm in a test section. Shockwave Mach number was obtained respectively. Theoretical results were shown like a logarithmic function at a coordinate which axis of abscissa was pressure and ordinate was shock-wave Mach number. An experimental-results value was determined between theoretical-laminar value and theoretical-turbulent value in the coordinate. It was found that the theory can estimate shock Mach-number within 10.4 % of its value in scale factor 236. The result is of use for developing Needle-less injections.

Keywords: Area change shock tube, Micro shock tube, Boundary layer, Attenuation, Aerodynamic sink.

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Visualization of Interaction between Planar and Spherical Shock Waves

by

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(Received on Sep. 30, 2011 and accepted on Nov. 16, 2011)

Abstract

This report describes interaction between planar and spherical shock waves. Airplanes need to improve fuel use due to soaring fuel prices. To increase mileage, supersonic drag uses reduce interaction between the bow shock and spherical shock wave laser breakdown. Laser breakdown is used to generate spherical shock waves in the shock tube test section with a pulsed Nd:YAG laser with 300 mJ energy and 1064 nm wave length. A planar shock wave with a 2.32 incident Mach number, interacting with a spherical shock is spherical shock waves is visualized with a shadowgraph method. In this study, the aerodynamic drag reduction as basic research with a supersonic shock wave interference, high precision for time control of the shock wave interference is examined. Visualization interfering with the plane shock wave generated by using a shock tube with time within the blast radius spherical shock wave confirmed the spherical shock wave of r-t diagram based on measurement.

Keywords: Laser breakdown method, Laser-induced shock waves, Blast wave, Supersonic drag reduction

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Using a Small Shock Tunnel to Generate Mach 2.5 Flow and Flow Visualization around Supersonic Intake

by

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Abstract

This report describes generating Mach 2.5 flow and flow visualization around the supersonic intake.

To keep the stable combustion of ramjet engine, supersonic intake should capture enough air and should be a certain level of pressure recovery. When shock wave oscillation (buzz) occurs at supersonic intake, ideal air mass flow and ideal pressure recovery are difficult to obtain. At worst, buzz leads to structural damages of a ramjet engine. Unknown portion remains in the mechanism of buzz generation. Therefore, this report's objectives are to confirm generating Mach 2.5 flow and to obtain supersonic intake characteristic for initial experiment of basic supersonic intake study.

The experiment carried out by small shock tunnel, which used the small shock tube. Flow visualization was conducted with shadowgraph method and schlieren method. The experiment was carried out on two patterns. Condition (1) was correct expansion state at the Laval nozzle. Condition (2) was most high pressure condition at the shock tube high pressure room. The experiment results were evaluated with the numerical results calculated with the Navier-Stokes equation. The numerical calculation used Weighted Average Flux (WAF) method and Adaptive Mesh Refinement (AMR).

From the visualization results, we confirmed generating Mach 2.5 flow by small shock tunnel. However, the numerical calculation results were different from particular experiment result at supersonic intake result. Experiment result was subcritical state. Numerical calculation result was supercritical state. This causes considered back pressure effect. Therefore, we should reduce that back pressure by enlarging the dump tank of the shock tube.

Keywords: Supersonic Intake, Buzz, Shock Tube, Shock Tunnel, Flow Visualization

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Contents

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Poly-Crystalline Silicon Germanium Prepared by Aluminum-Induced Crystallization

by

Masahiro YAJIMA[*1], Isao NAKAMURA[*2] and Masao ISOMURA[*3]

(Received on Mar. 30, 2012 and accepted on July 11, 2012)

Abstract

We have studied poly-silicon-germanium (poly-SiGe) prepared by aluminum-induced crystallization (AIC) from amorphous silicon-germanium (a-SiGe)/aluminum (Al) layer structures on glass substrates. This report describes the effect of the thickness of a-SiGe and Al layers on the AIC. The thickness of Al layers evaporated on the glass substrates was 2000-3200 Å. The a-SiGe was deposited on the oxidized Al surface by radio-frequency (RF) magnetron sputtering, and its thickness was 2000-2800 Å. The AIC temperature was set at 450°C. Island structures of crystalline SiGe were formed by the layer-exchange due to AIC, and were locally observed when Al thickness was 2000 Å because the layer-exchange was partially caused by a small amount of Al. The island structures covered almost the entire surface since the amount of aluminum was sufficient when Al thickness was 2800 Å. Al was segregated between island structures due to the large quantity of Al when Al thickness was 3200 Å. The optimal thicknesses of SiGe and Al were 2800Å and 2800 Å, respectively, for uniform layer-exchange.

Keywords: silicon germanium, solid phase crystallization, aluminum-induced crystallization

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Generation of Nitrate Ions in Distilled Water Irradiated with Atmospheric-Pressure Plasma Jet

by

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(Received on Mar. 22, 2012 and accepted on Jul. 11, 2012)

Abstract

An argon atmospheric-pressure plasma jet was directly irradiated onto distilled water. A peak appeared at approximately 200 nm in the absorption spectrum of the distilled water after 1 min of irradiation, and the peak intensity increased with plasma jet irradiation time. The electrical conductivity of the distilled water increased from 0.496 mS/m to 9.29 mS/m and its pH decreased from 5.8 to 3.3 with increasing irradiation time after 10 min of irradiation, indicating an increase in the hydrogen ion (H^+) concentration in the distilled water. The temperature of the distilled water increased with increasing irradiation time from 22.4℃ to 25.3℃ after 10 min of irradiation. A comparison of the absorption spectrum of the irradiated distilled water with that of nitrate ions (NO_3^-) in a sodium nitrate ($NaNO_3$) aqueous solution indicated that the peak near 200 nm was due to NO_3^-. This finding was also supported by the result of capillary electrophoresis (CE) measurements. The results of flow injection analysis (FIA) indicated that the NO_3^- concentration of the distilled water increased with increasing irradiation time from 0 mM to 0.26 mM after 10 min of irradiation. It was considered that NO_x was generated as a result of the reaction between the electrons in the plasma and the N_2 and O_2 in air. NO_x then reacted with H_2O molecules in the distilled water to generate HNO_3, which was ionized to generate H^+ and NO_3^-.

Keywords: atmospheric-pressure plasma, distilled water, nitrate ion, absorption spectrum, capillary electrophoresis

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Passive Control of a Simple Structure Using Tuned Cradle Mass Damper

by

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(Received on Mar. 19, 2012 and accepted on Jul. 11, 2012)

Abstract

Tuned cradle mass dampers (TCMDs) use the motion of a swing mass on a curved surface to dissipate structural vibration energy. In this study, we developed a TCMD that has a rotary mass with constant swing speed. We verified its performance by performing experiments for a structure undergoing free vibration. The damper was installed in a simple one-story rigid-frame model with a frequency of approximately 1 Hz.

TCMDs have the advantages of being simple, compact, and easy to maintain. A recently developed TCMD employs a rail with a variable radius curve to achieve a constant rotary speed by simple pendulum dynamics. A simple function for adjusting the swing speed of TCMDs to the natural frequencies of a structure is also discussed.

Keywords: passive control, cradle mass dampers, rotary mass, free vibration

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The Relationship between Surface Structure and Aerodynamic Characteristics of Official Soccer Ball

by

Takuya KIMURA[*1] and Hiroo OKANAGA[*2]

(Received on Mar. 16, 2012 and accepted on Jul. 11, 2012)

Abstract

The application of fluid mechanics to ball movement and the surface of a soccer ball is important for the development of sports, and various studies on ball movement have been conducted. However, the relation between the number of panels of a soccer ball surface and its aerodynamic behavior is not fully understood.

We conducted an experiment to study the difference in aerodynamic behavior for varying numbers of panels of a soccer ball surface and discuss the results by conducting simulations and wind tunnel experiments.

Keywords: flow visualization, soccer ball, drag coefficient, lift coefficient

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Aerodynamic Characteristics of Surface Structure of Sphere in Laminar Boundary Layer

by

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(Received on Mar. 16, 2012 and accepted on May 17, 2012)

Abstract

It is known that the aerodynamic characteristics of a sphere in the critical region depend on the surface structure. The purpose of this study was to clarify the effect of surface structural changes on the aerodynamic characteristics of a sphere in a laminar boundary layer. Experiments were carried out by numerical analysis and visualization around the sphere. Visualization images were taken by a high speed-camera at a 500 fps with two green laser sheets of 50 mW and 200 mW using water mist or ORGASOL. The results of these experiments and numerical analyses showed that, the flow field of a sphere is different in the laminar boundary layer due to the effect of the surface structure.

Keywords: sphere, flow visualization, computational fluid dynamics, PIV

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The Three-Dimensional Flow Characteristics around a Square Cylinder with Grooves (Effect of Aspect Ratio)

by

Takumi IKEDA[*1], Mitsutaka IDOGAWA[*2] and Hiroo OKANAGA[*3]

(Received on Mar. 16, 2012, and accepted on Jul. 11, 2012)

Abstract

The objective of this study was to understand the aerodynamic characteristics of the three-dimensional flow around a square cylinder of various lengths. Experimental investigations on the flow around square cylinders were carried out at $Re = 12.2 \times 10^5$. Flow visualizations with the spark tracing method and suspension method of the flow were also implemented. The variations of aerodynamic characteristics were clarified by changing the aspect ratio of the square cylinder with grooves in the three-dimensional flow. A smaller aspect ratio of the square cylinder reduced, the influence of the grooves on the drag reduction.

Keywords: square cylinder with grooves, drag coefficient, three-dimensional flow, flow visualization, spark tracing method, aspect

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Suppression of Radiated Noise from an Enclosure with Multiple Outlets by Means of Absorbing Materials

by

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(Received on Apr. 6, 2012 and accepted on May 17, 2012)

Abstract

This paper describes a method of controlling the noise radiated from multiple outlets of an enclosure by appropriately arranging absorbing materials. There are two steps in the method. First, the sound pressure and acoustic particle velocity in the enclosure are calculated by numerical simulation. Next, we examine the arrangement of the absorbing materials to decrease the acoustic energy of the radiated sound from the outlets based on the numerical results of the FDTD method. The numerical results show that there are peaks caused by the natural frequencies of the enclosure and the peak caused by the resonant frequency in the characteristics of sound pressure levels measured at the center of each outlet. The numerical results reveal that if the absorbing materials are appropriately arranged, the sound pressure levels at the natural frequencies can be controlled. Experimental results also show the same tendency.

Keywords: absorbing material, FDTD method, acoustic energy

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Fundamental Characteristics of Vibroacoustic Coupling Phenomena between Cylindrical Shell Vibration and Internal Sound Field

by

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(Received on Mar. 30, 2012 and accepted on Jul. 11, 2012)

Abstract

In the present study, we consider a thin cylindrical shell and investigate vibroacoustic coupling between the shell vibration and the internal sound field when an external point force is applied to the shell wall. In order to understand this coupling phenomenon, characteristics of the shell vibration are considered from the viewpoint of the natural frequency and the vibration mode, which are induced by the Rayleigh-Ritz method. These theoretical results are demonstrated through the experimental modal analysis, using apparatus of which emulates the analytical model. The vibroacoustic coupling phenomenon is estimated by an excitation experiment, in which the same experimental apparatus is used and the acceleration on the shell wall and the sound pressure level inside the cylindrical shell are measured. These experimental results reveal that the proximity of the natural and resonance frequencies and the similarity between the vibration and acoustic modes are significant for the occurrence of vibroacoustic coupling, in particular, the lock-in phenomenon occurs even if both frequencies have a little difference. Moreover, vibroacoustic coupling is expected to occur easily upon applying a point force of the higher frequency based on the estimation of a modal density as for the acoustic mode.

Keywords: vibroacoustic coupling, cylindrical shell, internal sound field, modal density

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Effect of Lamination Constitution on Post-Buckling Behavior of Symmetrically Laminated Plates Subjected to Biaxial Compressive Loads

by

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(Received on Mar. 30, 2012 and accepted on Jul. 11, 2012)

Abstract

Advanced composite materials including those using carbon fiber reinforced plastic (CFRP) are being increasingly used in engineering applications including aerospace, mechanical, marine and automotive engineering because they offer excellent properties such as high specific strength and specific stiffness. Many researchers have examined the postbuckling behaviors of thin laminated plates under uniaxial compression, but few have examined the secondary buckling phenomenon for thin laminated plate that occurs as the load is increased further. In this paper, the second variation of total potential energy is used to determine the stability condition of carbon-epoxy symmetrically laminated plates under biaxial compressive loads that are simply supported along four edges. The necessity of secondary buckling is proven analytically, and the effects of various factors including lamination constitution and biaxial compressive load ratios are clarified.

Keywords: structural analysis, composite materials, CFRP, secondary buckling, symmetrically-laminated, lamination constitution, biaxial compressive load ratios

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Stability Analysis of Small Electric Vehicle (Effect of Hysteresis of Friction Brake Force for Regenerative Braking Force)

by

Hirohiko OGINO[*1], Muhammad Izhar Ishak[*2] and Yasuo OSHINOYA[*3]

(Received on Mar. 16, 2012 and accepted on Jul. 11, 2012)

Abstract

This paper proposes an active safety device for skid control of a small in-wheel electric vehicle that uses a hybrid hydraulic-mechanical brake system. Past research has shown that by using a hybrid hydraulic-mechanical brake system, a small electric vehicle can accommodate an anti-lock brake system (ABS). When skidding occurs, especially on an icy road, ABS will maximize the slip ratio and cornering force during braking, thus assuring stable control of the vehicle and minimizing the risk of accident. In general, the friction force generated at the contact plane between tire and road has a hysteresis characteristic for braking pressure. Therefore, before we can determine the ABS control method, we must investigate the effect of the hysteresis on the control of braking pressure and regenerative braking force. The inertial moment of the tire affects to the hysteresis characteristics, so we experimentally measured the inertial moment of a tire when not driving and during driving. The effect of the hysteresis of friction force of a small electric vehicle during braking on dry asphalt and icy road was calculated by simulation.

Keywords: Small Electric Vehicle, Antilock Brake System, Regenerating Brake Force, Hysteresis

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Eigenvalue Analysis of Inflatable Tube by Simple Method of Modeling Crease

by

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(Received on Mar. 30, 2012 and accepted on May 17, 2012)

Abstract

We studied an inflatable space structure in order to create an ultra-lightweight space structure. The inflatable tube is an important basic structural element of inflatable structures because it has excellent packaging efficiency. However, an inflatable tube may undergo buckling during use due to a drop in internal pressure. Moreover, the change of eigen-frequency due to transformation of the membrane is not well understood. In this paper, we examine the effects of an axial crease on the eigen-frequency. First, we investigate the changes of bending stiffness by a bending experiment. Next, we construct an analytical model based on the bending stiffness. Finally, we compare the results of the eigenvalue analysis and vibration experiment of the inflatable tube. It is shown that the simple modeling method using bending stiffness is adequate for the eigenvalue analysis of an inflatable tube.

Keywords: space structure, deployable structure, inflatable structure, membrane, eigen-frequency

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Research on the High Precision Attitude Determination of a Small Satellite

by

Makoto IMAMURA[*1] and Takao TAKAHASHI[*2]

(Received on Mar. 24, 2012 and accepted on May 17, 2012)

Abstract

In Japan, various agencies are developing small satellites. These projects are characterized by compact devices and low cost, so the satellites use commercial parts, including for example, MEMS gyro sensors for the satellite attitude determination system. However the calibration system for a MEMS gyro sensor is very expensive and there are very few of them. In this study, we designed and developed a calibration system for the MEMS gyro sensor that offers stable performance and low cost. We also used our measuring device to acquire various characteristics of the MEMS gyro sensor. Finally, we developed a new signal processing circuit that further improves the performance.

Keywords: small satellite, MEMS gyro sensor, calibration, signal processing circuit

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