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Principle of Superposition of Waves and Energy Conservation Law

by

Kaoru INOUE and Masayuki YAMAZAKI

(Received on September 27, 2005 & accepted on November 16, 2005)

Abstract

Some students in their study of wave motion have asked us "could you explain the contradiction that exists between the principle of superposition of waves and the energy conservation law?" We will answer the question in this paper. This question arises from their focusing only on either the constructive or destructive aspect of superposition of waves. They must pay attention to both aspects of superposition.

Keywords: Principle of superposition, Energy conservation law, Interference, Constructive superposition, Destructive superposition, Mach - Zehnder interferometer.

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Time dependence of internal stress and optical characteristics of SiO_2 optical thin film

by

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(Received on 30 Sep. 2005 & accepted on 14 Jan. 2006)

Abstract

Recently, optical thin films have been increasingly needed in optical components. SiO_2 is most frequently used as a low-refractive-index material of optical thin films. The stress of the film is an important parameter that relates to the adhesion of the film. However, the long-term time dependence of the stress has not been thoroughly discussed for SiO_2 optical thin films. In this report, the time dependence of the stress of SiO_2 optical thin film is discussed in terms of optical characteristics in the infrared region. The optical characteristic and structure of SiO_2 optical thin films prepared by vacuum deposition (using an EB gun) and ion-assisted deposition (IAD) were observed by FT-IR, XRD and SEM. The stress of the SiO_2 optical thin films was measured using an interferometer to determine the change in the substrate shape. The SiO_2 thin films prepared by vacuum deposition and IAD exhibited compression stress. Decreases in the stress of the films for vacuum deposition were observed to continue for more than 1000 hours. This result is different from that of the conventional stress model in which the stress changes stop after about one week. The stresses of the films prepared by IAD were observed to hardly change. Absorption by Si-O bonds was observed at 1100cm^{-1}. The change in bonds from Si-O to Si-OH was observed in the film prepared by vacuum deposition. It is thought that this result of the change in bonds was related to the decrease in the stress of the films.

Keywords: optical thin film, internal stress, SiO_2, ion-assisted deposition

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Strength Evaluation of Concrete Shells with Carbon Fiber Reinforcement

by

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(Received on Aug. 10, 2005, & accepted on Jan. 14, 2006)

Abstract

The main purpose of this study is to evaluate the strength of concrete shells with carbon fiber reinforcement on the basis of linear buckling analysis. The ultimate strength of concrete shells could not be easily evaluated because of the requirement of expensive experiments or complicated numerical analysis. However, on the basis of linear buckling analysis, as proposed by the revised version of the IASS Recommendations, strength evaluation could be easily predicted although with a rough precision. Therefore, in this study, ultimate strength evaluation by stability analysis is carried out with consideration of an effective initial imperfection corresponding to an actual shell thickness fluctuation. For this purpose, hemispherical shells fabricated from concrete reinforced with carbon fiber chips and cylindrical shells fabricated from concrete reinforced with carbon fiber composites were investigated. These shells were supported without any additional stiffening members in order to clearly analyze the boundary conditions. The results of ultimate strength evaluation are discussed on the basis of a fracture strength experiment.

Keywords: Concrete Shell, Strength Evaluation, Carbon Fiber Reinforcement

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Effects of Opening within Concrete Hemispherical Shells Reinforced with Carbon Fiber Chips on Strength.

by

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(Received on Aug.10, 2005 & accepted on Nov.16, 2005)

Abstract

The main purpose of this study is to investigate the effects of openings within a shell on the strength of concrete hemispherical shells reinforced with carbon fiber chips. As the variable parameters of the shell openings, the number of openings and their opening angles of elevation were adopted. Openings on the shell surface could introduce light into the interior space of a building so that the interior space could be brightened and be comfortable to live in. The concrete with carbon fiber chip reinforcement could realize high homogeneity and isotropy independently of the direction of ordinary steel bar reinforcement. A fracture experiment was conducted on small-scaled concrete shell specimens reinforced with carbon fiber chips, which were loaded perpendicularly under point load up to the fracture state. Nonlinear numerical analysis was carried out to compare with the experimental results. The consistency between the experimental strength and the numerical strength was checked by taking into account the actual shell thickness. Furthermore, the fluctuation in the natural frequency corresponding to the fractural state on the shell surface was investigated.

Keywords: Hemispherical Shell, Concrete Shell, Opening

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Strength of Concrete Cylindrical Shells Reinforced with Composite Carbon Fiber under Point Load.

by

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(Received on Aug. 10, 2005 & accepted on Nov. 16, 2005)

Abstract

The main purpose of this study is to investigate, both experimentally and theoretically, the strength of concrete cylindrical shells with composite carbon fiber reinforcement under point load. In this study, composite carbon fiber reinforcement consists of carbon fiber chips and carbon fiber sheets. The chips and sheets could improve the tensile strength of a concrete shell in its internal and external regions, respectively. We investigated how the shell strength is influenced by the differences among the top, bottom and both surfaces reinforced with a carbon fiber sheet attached to a concrete shell mixed with carbon fiber chips. An experimental study was conducted on concrete shells in which static point load was applied perpendicular to the shell surface up to the final fracture state. A theoretical study was conducted by material and geometrical nonlinear finite element analyses including tension cutoff and tension stiffening effects. Nonlinear numerical calculations including fluctuations in the actual shell thickness were carried out. The strength of shells with composite carbon fiber reinforcement was discussed on the basis of the results of the fracture experiments and nonlinear analyses.

Keywords: Concrete Shell, Strength, Composite Carbon Fiber

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Study on Visualization of Soil Turbulence Surrounding Screw Pile Using Thermography

by

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(Received on September 30, 2005 & accepted on January 14, 2006)

Abstract

Using a screw pile in building foundations results in turbulence in the surrounding of the pile. The actual area of soil turbulence cannot be easily evaluated due to difficulty in accessing the area beneath the surface. It has been found that the bearing capacity of the pile was affected by the shear stress of soil under the tip of the pile. The area influenced is determined only on the basis of estimation from the results of load tests. In this article, we propose a method of visualization using thermography suitable for evaluating of possible construction methods for pile and ground improvement.

Keywords: Screw pile, Distortion, Bearing capacity, Visualization

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Study of Dyke Destruction Mechanism by Stormy Waves or Tsunamis and Application of Destruction Criteria to Dykes and Revetments on Hiratsuka and Chigasaki Coasts

by

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(Received on 30 September 2005 & accepted on 14 January 2006)

Abstract

We derived the following results on destruction mechanisms from an experimental investigation of cases of damaged coastal dykes and revetments.

(1) In the case of stormy waves, the complete break of concrete dykes and revetments, which water cannot permeate through the front and crown, is caused by front scour and sucking; moreover, the critical rate of wave overtopping against the complete break is 0.065m^3/m/s.

(2) In the case of tsunamis, the complete break of concrete dykes and revetments is caused by incident wave pressure or back rush pressure, and the tentative critical tsunami heights are about 8m for the incident wave pressure and 5m～6m for the back rush pressure.

Key Words: Stormy Waves, Tsunami, Dyke Destruction Mechanism, Critical Wave Overtopping Rate against Dyke Breaks, Coastal Prevention, Coastal Mitigation

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Sedimentary Environment and Subsidence of Soft Ground of Alluvial Deposits ("Chuseki-so") in Yokohama Lowland

by

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(Received on 30 Sep., 2005, accepted on 31 Jan., 2006)

Abstract

A marked subsidence of soft ground has been occurring as a result of excessive pumping of groundwater due to industrial development and large-scale excavation due to construction works in Yokohama City. The zone in which the subsidence occurs is concentrated around river lowlands and the zone is composed of an extremely weak formation of alluvial deposits. In this paper, we examined the result of investigating the land subsidence, which is one form of ground environmental disaster. On the basis of the result of subsidence measurement, investigation of soil properties and the sedimentation environment of the past, the subsidence rate of the ground was compared with the sedimentation rate of alluvial deposits. As a result, the amount of subsidence inside a stratum is not uniform, and it is shown clearly that there is high correlativity in the sedimentation rate and subsidence rate.

Keywords: land subsidence, alluvial deposits, sedimentary environment, Yokohama city

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Problem of one-dimensional consolidation involving secondary compression by explicit finite difference method

by

Hiroaki SHIRAKO, Daichi IGARASHI, Motohiro SUGIYAMA and Masaru AKAISHI

(Received on 30 Sep., 2005 & accepted on 14 Jan. , 2006)

Abstract

In this paper, we examine the applicability of the explicit finite difference method for one-dimensional consolidation analysis, taking into account secondary compression and time-dependent loading. It is shown that the consolidation time curve of clays is affected by the size of the time increment and that the problem of similitude for the consolidation of clays exhibiting secondary compression depends not only on the constitutive equation of clay but also on the numerical solution.

Keywords: one-dimensional consolidation, secondary compression, time-dependent loading, explicit finite difference method

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Consideration on Cogeneration Systems for Residential Use
Part 1: Characteristics of Electric and Heat Demand

by

Sei Okamoto,Yasuhiro Morimoto and Takane Itoh

(Received on 30, September 2005 & accepted on 3, February 2006)

Abstract

In this paper we describe the features of the electric and heat demand in a domestic cogeneration system. Actual load demands measured in domestic houses in Hiratsuka City are compared with typically used load data in an analysis of a hotel, a hospital, an office building and a domestic house. The following conclusions are obtained. (1) The load change in a residential house is large and quick, especially in heat demand. (2) The load pattern of a residential house is not expressed sufficiently by data with a 1-hour interval and the analysis with these data overestimates the effects of introducing a cogeneration system. (3) Load demand data with a 1-minute interval is necessary for more detailed analysis of a cogeneration system.

Keywords: Home cogeneration system, Electric demand, Heat demand, Load pattern, Heat/electric ratio

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Active Seat Suspension for Small Vehicle (Examination of Factors Affecting Sensory Evaluation Value)

by

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(Received on September 30, 2005 & accepted on February 10, 2006)

Abstract

A small active seat suspension has been designed and manufactured for a one-seat electric vehicle. Our aim was to develop a vibration-isolation system for the driver's seat suspension using active control. However, the evaluation of ride comfort while the electric vehicle was running has depended on subjective judgement by drivers. Thus, it is necessary to evaluate the correlation of subjective judgement with objective judgement based on physical values, i.e., vibrations. In this study, we performed a sensory evaluation of ride comfort. In addition, the factors affecting the sensory evaluation value were examined by multiple regression analysis. As a result, we confirmed that the largeness and smallness of vibration influence the quality of ride comfort more than the hardness and softness of ride comfort.

Keywords: Seat suspension, Ride comfort, Subjective judgement, Electric vehicle, Multiple regression analysis

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Noncontact Guide System for Traveling Elastic Steel Plate (Considerations on Coil Resistance Variation)

by

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(Received on September 30, 2005 & accepted on January 14, 2006)

Abstract

In a factory, a continuous thin steel plate subjected to iron and steel processes supported by rollers tends to experience plate vibrations that lower the quality of the surface finish. In the plating process, rollers negligibly support the steel plates. Therefore, plating nonuniformity due to the generation of vibrations and other factors prevents an increase in productivity. To solve this problem, we developed a noncontact guide system in which electromagnetic forces are applied at the edges of the steel plates. However, it will be necessary to develop a control system that takes into consideration various parameter errors, such as nonuniformity of resistance change for an actual continuous thin-steel-plate process caused by the heat of the electromagnet used. In this study, we confirm the suppressive effect of a sliding-mode control theory that exhibits robustness to resistance variation.

Keywords: Steel plate, Traveling, Edge control, Noncontact guide system, Vibration control, Sliding-mode control

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Electromagnetic Levitation Control for Thin Steel Plate (Fundamental Considerations on Control Performance Using μ-Synthesis)

by

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(Received on September 30, 2005 & accepted on January 14, 2006)

Abstract

Recently, research on a conveyance system based on magnetic levitation of a steel plate has been active. Since the design of its control system is generally carried out for a linearized model, it is difficult to secure satisfactory robustness in the control system. This is because nonlinearity and several disturbances exist in reality. In addition, for an actual steel plate conveyance process it will be necessary to develop a control system that takes into consideration various parameter errors, such as nonuniformity of the plate thickness and the associated weight variation. In this paper, we examine the achievement of robustness to steel plate thickness variation using μ-synthesis.

Keywords : Steel plate, Noncontact vibration control, Electromagnetic levitation, Disturbance, μ-synthesis, Optimal control

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Vibration Characteristics of Thin Steel Plate under Magnetic Field Using Permanent Magnets (Considerations on Distance between Permanent Magnets)

by

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(Received on September 30, 2005 & accepted on January 14, 2006)

Abstract

In the thin steel plates which are used in many industrial products, including automobiles, flaws on the plate surface and peeling during the surface treatment process are induced due to the use of many rollers in the conveyance process. These flaws lead to the deterioration of the quality of the plate surface. To solve this problem, the authors proposed a device for controlled levitation of a rectangular sheet steel by means of a hybrid actuator using five electromagnets and thirty permanent magnets. However, it is necessary to consider the elastic vibration and deflection of a thin steel plate under a magnetic field generated by permanent magnets. In this study, for fundamental consideration of the permanent magnet system, experiments were performed using an elastic steel beam. The attractive force of the permanent magnets, the elastic vibration, and the deflection of the steel plate were calculated by the finite element method.

Keywords : Permanent magnet, Electromagnetic levitation control, Elastic vibration, Steel beam, FEM

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Analysis of Fluid Column Separation of Antilock Braking System of Vehicles

by

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(Received on September 30, 2005 & accepted on January 14, 2006)

Abstract

The fluid column separation occurring in the pressure control line of the antilock braking system (ABS) of vehicles was analyzed by numerical simulations, and the results were compared with those obtained experimentally. As the experimental setup, the ABS for passenger cars installed on a test stand was used. The pressure fluctuation was measured with a pressure sensor installed on the pressure control line. Four cases of numerical simulation were studied. The calculation method was the characteristic curve method, and the viscosity-elasticity model was used for the braking hose. The first case of simulation was one in which a model with no fluid column separation was used. The other cases used models that differed with respect to the handling of the gas column structure. The simplest model was the one that took no account of the generation mechanism and the structure of the gas column. Other models considered the generation mechanism and the structures of the gas column, which were a single large bubble of air and a group of minute bubbles. In this paper, the limitation of calculation with no model and the validity of the models were described.

Keywords: Antilock braking system, Fluid column separation, Cavitations, Numerical analysis, Structure of gas column.

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Lateral Displacement Control by Rudder Steering with Roll Angle Hold System

by

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(Received on Sep. 30, 2005 & accepted on Jan. 14, 2006)

Abstract

In general, lateral displacement deviation of an airplane from a reference flight path is compensated using an aileron with a changing roll angle and by turning. However, in aileron control, a pilot is required to operate the aileron with multiple phase-lead compensation. In this study, we propose a method of handling the lateral displacement control by rudder steering, holding its roll angle automatically using an aileron. Using rudder control in the roll angle hold state, the flight path is directly changed by a side force due to sideslipping. Therefore, the phase-lead compensation operation of a pilot is mitigated in contrast to aileron control. Then, experiments on the task of holding the flight path using a flight simulator are carried out. The experiments show that, in rudder control in the roll angle hold state, the pilot's control input is slower than in aileron control. This means that the pilot's work load is less than in aileron control. However, in some part of the pilot evaluation results, rudder control was slightly worse than aileron control. We inferred that the result is related to the pilot being unfamiliar with flight path correction in the roll angle hold state.

Keywords: Lateral displacement control, Rudder steering, Roll angle hold system, Airplane

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Synthesis and Evaluation of Hyperbranched Aromatic Polyamide with Ferrocene Moiety Exhibiting High Refractive Index

by

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(Received on March 31, 2006 & accepted on June 21, 2006)

Abstract

To develop a woodpile-type photonic crystal consisting of an organic polymer material, we have attempted to prepare a novel polymer with a high refractive index of over 2.0. For this purpose, the synthesis of hyperbranched aromatic polyamide containing a ferrocene moiety at the chain ends (HB-PA-Fc) was carried out, and the refractive index was evaluated using a confocal microscope and compared with that of aromatic polyamide containing ferrocene in the main chain (L-PA-Fc). HB-PA-Fc was prepared by the polymer reaction of ferrocenylmethanol with the starting hyperbranched aromatic polyamide (HB-PA), which was easily prepared by the polymerization of AB_2-type monomer. It was found that HB-PA-Fc exhibited a high refractive index of 2.03, which is higher than those of L-PA-Fc and HB-PA. Therefore, the hyperbranched structure and the introduction of the ferrocene moiety were effective for improving the refractive index. In addition, the degree of branching of HB-PA was calculated as 0.367 using a Frechet-type equation based on the model compound.

Keywords: *Ferrocene, Hyperbranched Polyamide, Photonic Crystal, Refractive Index.*

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Synthesis of PDMS/PEO-Grafted Aromatic Polyamide and Gas Permeability

by

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(Received on March 31, 2006 & accepted on July 5, 2006)

Abstract

Poly(ethylene oxide) (PEO) is one of the highly functional polymers, which have the ability to form complexes with metal ions. On the other hand, polydimethylsiloxane (PDMS) membrane has high permeability for both gases and liquids. However, PEO and PDMS cannot form ultrathin membranes because the glass transition temperatures of these polymers are very low. In this study, the synthesis of novel graft copolyamides with high mechanical strength that contain both PEO and PDMS segments in the side chains was carried out by a macromonomer method, to develop a new functional membrane material that was expected to possess the high permeability of PDMS and the functionality of a PEO-metal complex. The copolymer membranes were prepared by solvent casting, and the gas permeability of these membranes was evaluated. In addition, the effect of the addition of Ag ions to the copolymer membrane on the permselectivity of olefin gas was investigated. As a result, it was found that the introduction of the PDMS segment was effective for improving the gas permeability, and the copolymer membranes with Ag ions exhibited a higher selectivity of olefin gas than that of the copolymer membrane without Ag ions.

Keywords: *polydimethylsiloxane / polyamide / graft copolymer / gas permeability / olefin separation / silver ion*

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Study of Possible Acceptance Capacity of Requested Wheeled Power Using Genetic Algorithm

by

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(Received on Mar. 31, 2006 & accepted on Jun. 21, 2006)

Abstract

In this study we examine how much PPS can enter an existing transmission network within permissible limits of restriction of system operation. The possible consignment acceptance capacity and the number of operations by a genetic algorithm (GA) are examined. A flexible AC transmission system (FACTS) device controls line flow flexibly. Therefore, to maximize the total wheeled power simultaneously requested by several PPSs, we propose an algorithm for determining the optimal impedance of a TCSC (a FACTS device). The effectiveness of the proposed method is demonstrated using practical 15-bus and IEEE30-bus systems.

Keywords: Power producer and supplier (PPS), Power wheeling, Simultaneous transfer capability (STC), Optimal power flow (OPF), n-1 criterion, Flexible AC transmission system (FACTS), Thyristor-controlled series capacitor (TCSC), Genetic algorithm (GA)

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Strength of Concrete Shells Reinforced with Carbon Fiber Sheets

by

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(Received on Mar. 28, 2006 & Accepted on Jun.3, 2006)

Abstract

The main purpose of this study is to investigate, both experimentally and theoretically, the strength of concrete shells reinforced with carbon fiber sheets. The effects of shell thickness on shell strength were described in our previous study, therefore, both inner and outer molds were adopted in the casting of concrete shells to minimize the difference between the actual shell thickness and the designed thickness. A static point load was applied perpendicularly to the cylindrical shell specimens until the fracture state was obtained. Four kinds of regions reinforced with carbon fiber sheets, None, Top, Bottom, and Both shell surfaces, were investigated and compared with each other. A theoretical study by nonlinear finite element analysis, which included fluctuations in shell thickness, was also conducted. The strength of the concrete shell, with consideration of the influence of shell thickness, is discussed on the basis of the results of the nonlinear finite element analysis of the results of the fractural experiments.

Keywords: Concrete Shell, Carbon Fiber Sheet, Thickness Fluctuation

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Strength of Concrete Shells Reinforced with Composite Carbon Fiber

by

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(Received on March 28, 2006 & accepted on June 3, 2006)

Abstract

This study concerns the strength of concrete shell structures reinforced with composite carbon fiber, which consists of carbon fiber chips and carbon fiber sheets. The glue work between the concrete shell surface and the carbon fiber sheets had imperfections in our previous study, so the strength of concrete reinforced with carbon fiber sheets could not be confirmed in the previous experiments. Accordingly, in this study, more precise careful glue work was attempted so that reasonable experimental results were achieved in comparison with numerical results. In the experimental study, small-scale cylindrical shell specimens with four kinds of regions reinforced with carbon fiber sheets were applied with a single static point load until fractural states were attained. In the theoretical study, material and geometrical nonlinear finite element analyses including tension cutoff and tension stiffening effects were adopted to compare the results of the fractural experiments. The strength of concrete shells reinforced with composite carbon fiber is discussed on the basis of the results of the fractural experiments and numerical analysis while taking the effects of shell thickness into consideration.

Keywords: Concrete Shell, Composite Carbon Fiber, Strength

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Effect of Prop-Type Damper on Vibration of Three-Span Continuous Bridge

by

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(Received on Mar. 23, 2006 & accepted on Jun. 3, 2006)

Abstract

We present a prop-type damper that can control the undesired vibration of a bridge girder. The damper consists of a prop and a damping material, and was placed between the pier and the girder of the bridge at a suitable angle. During the vertical vibration of the bridge girder, the damping material at the tip of the prop converts the vertical vibration into horizontal vibration. Owing to the horizontal motion of the damping material, the vibration of the bridge girder can be decreased effectively. We apply the prop-type damper to a three-span continuous bridge to attenuate the vibration caused by a live load. TDAPⅢLT (3D software for framework analyses) is used to elucidate the effects of the prop-type damper.

***Keywords*:** Damping Device, Passive Control, Time History Response

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One-dimensional Consolidation Prediction of Peaty Soft Grounds Using the Oedometer Test Results

by

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(Received on March 31, 2006 & accepted on July 18, 2006)

Abstract

We present comparisons of test results using oedometers of various sizes and case records of long-term settlement observation in the field for investigating hypothesis of scale and time effects during one-dimensional consolidation. Observational results correspond to hypothesis *A* that the volumetric strain versus log(*time*) relationship for a given load increment is simply displaced in proportion to H^2, as commonly assumed in practice. An example is presented for the prediction of one-dimensional consolidation settlement including a secondary consolidation stage. In this method the rate of secondary consolidation during primary consolidation is expressed by the function for the magnitude of secondary consolidation occurring in the one-dimensional consolidation stage. The necessary soil constants are gained from the consolidation-time curve observed in a conventional standard oedometer test. The calculated results coincide with the observed consolidation-time curves including the primary and secondary consolidations. Also, the proposed secondary compression model is promising for the prediction using hypothesis *B* based on Suklje's Isotaches concept.

Keywords: Peat, Standard consolidation test, One-dimensional consolidation, Secondary compression, Isotaches method

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Effects of Consolidation Pressure Increment Ratio on Secondary Compression

by

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(Received on March 31, 2006 & accepted on June 3, 2006)

Abstract

An experimental study of secondary consolidation characteristics is described. It is observed that secondary compression is dependent on the amount of pressure increment and pressure increment ratio. The relative magnitudes of primary and secondary compressions vary with the amount of pressure increment, and the shape of the consolidation-time curve is markedly influenced by the secondary compression behavior. A new theoretical analysis for evaluating the shape of consolidation-time curves is illustrated using the relationship between the degree of consolidation and time factor. The oedometer test results were compared with theoretical predictions.

Keywords: primary consolidation, secondary compression, clay, pressure increment

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Improvement of Dry Cutting Performance with Metal-Doped DLC-Coated Tool

by

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(Received on March 31, 2006 & accepted on June 3, 2006)

Abstract

The purpose of this research is to improve the dry-cutting performance for ferrous metal with throw-away tips coated by metal-doped DLC (diamond-like carbon) films. The films were deposited on Si substrates and the throw-away tips by DC magnetron sputtering. The frictional properties and adhesive strength of the films were evaluated by ball-on-disk friction tests and scratch tests, respectively. X-ray photoelectron spectroscopy measurements were carried out to investigate the chemical bonding state of the films. Ti-DLC film showed a low friction coefficient of 0.1 at room temperature and 0.03 at 100°C. These values were almost the same as the friction coefficients of the DLC film. The Ti-DLC film had higher critical load in the scratch tests than the DLC film, and the throw-away tips coated with Ti-DLC film showed high dry cutting performance for S45C material. It is thought that the improvements of the mechanical properties of the DLC films after doping with Ti led to the high cutting performance.

Keywords: Dry machining, Metal-doped diamond-like carbon, Throw-away tip

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Reduction in Friction of TiN Thin Film by Molybdenum Disulfide Addition

by

Takashi SAKAKI and Masao KOHZAKI

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Abstract

Molybdenum disulfide (MoS_2) was added to TiN films to reduce the friction coefficient of the films. TiN and TiN-MoS_2 thin films were formed by magnetron sputtering. We investigated the crystallinity and chemical bonding states of the TiN-MoS_2 composite thin films by X-ray diffraction (XRD) analysis and X-ray photoelectron spectroscopy (XPS). The adhesive strength and friction coefficients of the TiN and TiN-MoS_2 thin films were evaluated by scratch tests and ball-on -disk friction tests, respectively. The scratch tests revealed that the adhesive strength of the TiN-MoS_2 composite thin film was as high as that of the TiN thin film. Moreover, a decrease in the friction coefficients was observed owing to MoS_2 addition in an ambient atmosphere. Therefore, the TiN-MoS_2 composite thin film is thought to be a new candidate for lubricious hard coating.

Key words: Magnetron sputtering, TiN-MoS_2 composite film, Molybdenum disulfide

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Comparison of Various Calculation Techniques for Finite-Element Method at Large Eddy Simulation of Turbulent Channel Flow

by

Hiroo OKANAGA and Katsumi AOKI

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Abstract

In this paper, the effects of the discretization methods of the convection term and the calculation methods of the mass matrix of the unsteady term for the finite-element method (FEM) are discussed with regard to turbulent channel flow and using Large Eddy Simulation (LES). A FEM scheme is based on the Fractional-Step (FS) method with same-order interpolation for velocity and pressure. The Smagorinsky model is applied to the turbulence model to approximate the Reynolds stress term. The pressure Poisson equation is solved by the element by element scaled Conjugate Gradient (CG) method. The obtained results are compared with each other. The effects of the various techniques for FEM are estimated.

Keywords: Turbulent Channel Flow, Finite-Element Method, Computational Fluid Dynamics, LES

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Examination on Horizontal Stabilization in Noncontact Positioning Control of Magnetically Levitated Thin Steel Plate

by

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Abstract

As a noncontact transfering system of thin steel plates which are used in various industrial products such as automobile, we have proposed a magnetic levitation control system and have confirmed the feasibility by using the digital control experiment. However, we also found the risk that side slipping and dropping of the plate may occur due to inertial force, since the levitation control does not provide restraining force for the direction of travel. Therefore we have proposed to equip some electromagnetic actuators in order to control the horizontal motion of the levitated steel plate. In addition, we have reported that it is possible to suppress elastic vibration of a steel plate in the vertical direction by aligning several permanent magnets parallel to the electromagnets for the horizontal positioning. The attractive force applied to the steel plate by the permanent magnets changes according to the distance between the permanent magnet and the edge of the steel plate. Such uncertainties for the modeling deteriorate the performance of steel plate positioning using the electromagnet. In this paper, we propose to design a horizontal positioning control system for magnetic levitation of a steel plate using μ -synthesis that is robust for the model uncertainty.

Keywords: Steel plate, Electromagnetic levitation, Permanent magnet, Positioning control, μ-synthesis, Optimal control.

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Electromagnetic Levitation Control for Thin Steel Plate (Experimental Considerations on Effect of Characteristics of Electromagnetic Variation Induced by Heat Generation)

by

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Abstract

In recent years, research on the noncontact conveyance system with the application of electromagnetic levitation technology has been active. However, because of the high nonlinearity of the attractive force of an electromagnet and various uncertainties in circuit current such as changes in resistance attributable to heat generation by the electromagnet, the stability of levitation is not sufficiently ensured. In addition, for an actual steel plate conveyance process, it will be necessary to develop a control system that takes into consideration various parameter errors, such as the nonuniformity of plate thickness and the associated weight variation. In this study, we examine the possible achievement of the robustness of the effect of the characteristics of electromagnetic variation induced by heat generation using μ-synthesis.

Keywords: Steel plate, Electromagnetic levitation, Disturbance, Resistance variation, μ -synthesis, Optimal control

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Horizontal Uniaxial Noncontact Positioning Control for Magnetically Levitated Steel Plate (Fundamental Considerations for Ultrathin Steel Plate)

by

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Abstract

In this paper, we report the suppression of the elastic vibration of levitated ultrathin steel plate under horizontal noncontact positioning control. For thin steel plates that are used in many industrial products including those of the automobile industry, we have proposed a magnetic levitation control system and confirmed its feasibility through a digital control experiment. However, there is a risk that side slipping or the dropping of the plate may occur owing to inertial force because the levitation control system does not provide a restraining force for the direction of travel. Therefore, we have proposed the addition of electromagnetic actuators to control the horizontal motion of a levitated steel plate. In addition, we have reported that it is possible to suppress the elastic vibration of a steel plate in the vertical direction using the electromagnetic actuators for horizontal positioning. An ultrathin steel plate generates elastic vibration easily and is not secured in terms of the levitation direction.

Keywords: Electromagnetic Levitation Control, Steel Plate, Vibration Control, Elastic Vibration

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Active Seat Suspension for Small Vehicle (Effects of Changes in Motor Characteristics on Control Performance)

by

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Abstract

The purpose of this study is to examine the effectiveness of active seat suspension in small cars and the problems associated with the practical use of active seat suspension. A small active seat suspension can be installed in a one-seater electric automobile. In an actual driving test, a test road, for which the concavity and convexity of an actual road surface were simulated using hard rubber, was prepared. In this study, we have aimed to develop a vibration isolation system with a high robustness for the driver's seat using sliding mode control, which is resistant to factors such as changes in motor characteristics. Experiments were carried out under several conditions, and the obtained results were compared with optimal control results. It was verified that the suppression of vibration by the sliding mode control of the vibration isolation system occurred.

Keywords: Active seat suspension, Riding comfort, Electric vehicle, Optimal control, Sliding mode control

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Robust Noncontact Guide Control for Traveling Elastic Steel Plate Using Permanent Magnets and Electromagnets

by

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Abstract

In a typical factory, a continuous thin steel plate subjected to iron and steel processes and supported by rolls tends to undergo plate vibrations that lower the quality of surface finish. In the plating process, the steel plate is conveyed 20-50 m in the vertical direction for drying, during which the steel plate is negligibly supported by rollers and other mechanisms. Therefore, plating nonuniformity due to the generation of vibration and other factors prevents an increase in productivity. To solve this problem, we have developed a noncontact guide system in which electromagnetic forces are applied to the edges of the steel plate. The control performance of replacing the electromagnet with a permanent magnet that has no running cost has been examined. However, the deleterious effect of the negative spring force of a permanent magnet has not been examined to date. In this study, we examine the possibilities for the robustness of the negative spring force of a permanent magnet using the sliding-mode-control theory.

Keywords: Steel plate, Noncontact guide, Sliding mode control, Permanent magnet, Vibration control

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Influence of Relative Relationship between Short-Period and Phugoid Modes on Pitch Attitude Control

by

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Abstract

The longitudinal motion of an aircraft is influenced by two oscillatory motion modes which are called the short-period mode and the phugoid mode. The pitch attitude handling qualities of a STOL (short takeoff and landing) airplane degrades as its flight speed slows. The main cause of this degradation is considered to be that the natural frequencies of the two modes approach each other. However, we have studied the effects of modal parameters using a flight simulator, including the initial amplitude ratio and difference in the initial phase angles, of the short-period and phugoid components in the pitch attitude response to elevator step input. The results show that the difference in the initial phase angles plays the most important role in a human pilot's pitch control and the effect of the proximity of the two natural frequencies is small.

Keywords: Airplane, Flying Qualities, Short-Period Mode, Phugoid Mode, Pitch Control

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Flow Separation into Tube in Density Oscillator

by

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Abstract

In a density oscillator that uses salt and fresh water, the downflow of salt water and the upflow of fresh water through the tube take place alternately. This oscillation repeats automatically. It is important to analyze the mechanism of this flow switching. It is considered that flow separation at the inside wall of the tube near the exit of flow triggers the flow switching. We experimentally clarified the conditions under which the flow separation is caused.

Keywords: density oscillator, separation, nonequilibrium, Hagen-Poiseuille flow, jet, switching

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