A89-37402 Dynamics of a ribbed cylindrical shell under axisymmetric loading of short duration (Dinamika rebristoi tsilindricheskoi obolochki pri deistvii kratkovremennoi osesimmetrichnoi nagruzki). V. F. MEISH and P. Z. LUGOVOI, *Prikladnaia Mekhanika* (ISSN 0032-8243), Vol. 25, March 1989, pp. 21–24. 7 Refs.

The problem of the forced vibrations of a ribbed cylindrical shell is considered with allowance for discrete rib arrangement under conditions of brief loading. The stress-strain state of a smooth shell is determined in the context of linear theory for Timoshenko shells; the ribs are calculated using the theory of curved rods. Particular attention is given to the effect of the reinforcing elements on the behavior of the shell in the presence of an edge shear load. Test calculations are carried out to support the results obtained.

A89-35612 Thermal stress calculation and thermal stability of anisotropic materials. I (Raschet termicheskikh napriazhenii i termostoikost' anizotropnykh materialov. I). A. I. KRIVKO, A. I. ELISHIN, I. L. SVETLOV, and A. I. SAMOILOV, *Problemy Prochnosti* (ISSN 0556-171X), Feb. 1989, pp. 3–9. 19 Refs.

An analytical method is described for calculating the thermal stress state in single-crystal plates and wedges of arbitrary crystallographic orientations. A criterion for assessing the hazard of thermal stresses is then formulated which is based on the physical nature of the plastic deformation of nickel alloy single crystals. The method and criterion proposed here can be used for the approximate thermal stress analysis of cooled single-crystal blades of gas turbine engines. A method for accounting for external centrifugal and torsional loads is also presented.

A89-35491 A refined analysis of the behavior of layered composite structures under thermal and static loading (Utochnennyi analiz povedeniia sloistykh kompozitnykh konstruktsii pri teplovom i staticheskom vozdeistviiakh). V. S. SIPETOV, *Mekhanika Kompozitnykh Materialov* (ISSN 0203-1272), Jan.–Feb. 1989, pp. 142–149. 13 Refs.

The paper is concerned with the development of computational models of composite structures with anisotropic layers subjected to thermal and static loading. First, attention is given to the determination of a temperature field over the layered system. The three-dimensional heat conduction problem is reduced to a two-dimensional problem using the finite element method. Two refined finite-shear models are then developed.

A89-35490 Numerical study of three-dimensional nonlinear waves in composite bodies of revolution (Chislennoe issledovanie trekhmernykh nelineinykh voln v sostavnykh telakh vrashcheniia). SH. U. GALIEV and V. A. ROMASHCHENKO, *Mekhanika Kompozitnykh Materialov* (ISSN 0203-1272), Jan.–Feb. 1989, pp. 136–141. 9 Refs.

The three-dimensional dynamic boundary value problem of the nonaxisymmetric pulsed deformation of a multilayer body of revolution of complex geometry is formulated mathematically, and a numerical-analytical solution procedure is briefly described. The effect of the nonaxisymmetric nature of the pulsed loading on the stress waves generated in a composite shell of revolution is investigated numerically.The influence of nonlinear effects on the attenuation of stress waves of varying intensity is evaluated.

A89-35621 A method for determining initial elastic deformations in riveted joints and a study of their changes under cyclic loading (Metodika opredeleniia nachal'nykh uprugikh deformatsii v zaklepochnykh soedineniiakh i issledovanie ikh izmeneniia pri tsiklicheskom nagruzhenii). N. V. KOSHELEV and V. A. MIZONOV, *Problemy Prochnosti* (ISSN 0556-171X), Feb. 1989, pp. 104–108.

A method is presented for determining initial elastic deformations in riveted joints resulting from the deformation of the joined components prior to assembly. The initial forces in the rivet holes are determined theoretically and experimentally with allowance for the computational schemes of the components being joined. It is shown that controlled generation of initial deformations makes it possible to reduce local stress concentrations near loaded holes, which would increase the strength of the joints under cyclic loading.

A89-34038 Buckling of developable shells (Poteria ustoichivosti razvertyvaiushchikhsia obolochek). A. V. POGORELOV, *Akademiia Nauk SSSR, Doklady* (ISSN 0002-3264), Vol. 304, No. 5, 1989, pp. 1056–1059. 5 Refs.

The problem of the buckling behavior of developable (in particular, cylindrical and conical) shells is analyzed using the geometrical method. In accordance with this method, the postcritical elastic deformation of the shell is approximated by infinitely small (geometrical) bending of the middle surface of the shell; the deformation energy and the work produced by the load are calculated from this infinitely small bending. The results obtained are then used to determine the critical load.

A89-30227 Asymptotic behavior of the critical load in stability problems for elastic bodies (Asimptotika kriticheskoi nagruzki v zadachakh ustoichivosti uprugikh tel). A. D. DROZDOV and A. V. LYMZINA, *Akademiia Nauk SSSR, Doklady* (ISSN 0002-3264), Vol. 304, No. 1, 1989, pp. 54–57. 5 Refs.

Stability conditions for isotropic elastic bodies are obtained for finite and small deformations. Determinations are made of the critical conditions in stability problems for a straight rod and a circular ring. The critical loads determined from an analysis of stability equations for elastic bodies are compared with the values calculated on the basis of the engineering stability theory.

A89-30062 Dynamic behavior of engine casing shell elements under kinematic excitation (Dinamicheskoe povedenie obolochechnykh elementov korpusov dvigatelei pri ikh kinematicheskom vozbuzhdenii). V. E. BRESLAVSKII, I. N. GINZBURG, S. M. MORDOVTSEV, and A. I. RUBANENKO, *Problemy Prochnosti* (ISSN 0556-171X), Jan. 1989, pp. 14–17. 10 Refs.

Differential equations describing the motion of a structure consisting of a shell of revolution, a circular band, and an elastic body are obtained for the case of arbitrary kinematic excitation. An algorithm is developed for determining the stress-strain state of the deformed state of reinforced cylindrical and conical shells with a hollow elastic filler in the case of the plane motion of the supporting body. Results of calculations of stresses within the filler and linear forces in the shells are presented.

Japanese Aerospace Literature This month: *Structural Dynamics*

A91-50352 Imperfection behavior of elastic nonlinear systems illustrated by a three-degree-of-freedom model. FUMIO NISHINO and WIBISONO HARTONO, *AIAA Journal* (ISSN 0001-1452), Vol. 29, Sept. 1991, pp. 1507–1514. 9 Refs.

The instability behavior of perfect and imperfect systems is presently studied in light of a simple three-DOF spring model, by means of whose three parameters' variations a range of alterations in system behavior can be investigated. Numerical results are obtained which illustrate the instability behavior of perfect and imperfect elastic nonlinear systems. An equilibrium path may terminate at a point and jump to another point, even when geometric change is continuous; the optimum solution for the mode of imperfection yielding the lowest carrying capacity may also terminate at one point and jump to another, even when norms of imperfections are changed continuously. When hidden critical points are present, the structure is extremely sensitive to imperfections.

A91-31458 Analysis of vibrations of rotating thin circular cylindrical shells. KATSUYOSHI SUZUKI, TADASHI KOSAWADA, and RYOJI TAKAHASHI, *JSME International Journal, Series III* (ISSN 0914-8825), Vol. 34, March 1991, pp. 19–25. 13 Refs.

An exact method using power series expansions is presented for solving free vibrations of rotating thin circular cylindrical shells. Equations of motion, which are differential equations with variable coefficients, are solved exactly by power series expansions. Frequencies and mode shapes of rotating circular cylindrical shells with both ends clamped and with both ends simply supported are presented showing their variations with rotating angular velocity.

A91-31457 Proposition of an incremental transfer matrix method for nonlinear vibration analysis. KIMIHIKO YASUDA, TAKAO TORII, and MASAYUKI KASAHARA, *JSME International Journal, Series III* (ISSN 0914-8825), Vol. 34, March 1991, pp. 12–18.

A transfer matrix method of nonlinear vibration analysis is developed, which makes it possible to analyze nonlinear systems using the same treatments as the ordinary transfer method. For this purpose, the quantities describing the dynamic state of a system are expressed in the form of Fourier series, and the problem is formulated in terms of increments of Fourier coefficients. The validity of the method is demonstrated by applying the method to a three-degree-of-freedom system. The harmonic and subharmonic oscillations of the system are analyzed, and the results are compared with those obtained by direct numerical integration of the equations of motion.

A90-52419 Practical method of dynamic analysis of symmetrically laminated composite plates. KOHEI SUZUKI and KIN'YA MATSUMOTO, *JSME International Journal, Series III* (ISSN 0914-8825), Vol. 33, Sept. 1990, pp. 310–314. 5 Refs.

A technique using 12-degree-of-freedom rectangular and 9-degree-of-freedom triangular finite elements for the analysis of the bending vibration of composite laminates is proposed which allows for the anisotropy of symmetrical laminates. The approach is shown to be particularly effective in the case of composite plates with a wide range of fiber angles. Based on this method, dynamic analysis programs and eigenvalue, eigenvector, and frequency response analyses with pre- and postprocessors have been implemented on a microcomputer.

A91-51459 Simplified vibration analysis method of shells of revolution using beam model. NOBUYUKI KOBAYASHI, TOSHIO CHIBA, TSUTOMU MIEDA, and KOUJI JITSU, *Ishikawajima-Harima Engineering Review* (ISSN 0578-7904), Vol. 31, May 1991, pp. 190–194. 4 Refs.

A simplified vibration analysis method for the shells of revolution using the beam model is now under consideration. In the beam model, the relations between the shear forces and horizontal deformations are used to calculate the shear area and the relations between the overturning moments and rotation angles to calculate those of the inertia moment. The calculations of the vibration characteristics of the cylindrical shell, spherical shell, and the cylindrical shell with the spherical cap were conducted to verify the accuracy of the beam model. The natural frequencies and the vibration modes of the proposed method are in good agreement with that of the FEM analysis using the axisymmetrical shell model. The proposed method is easily applicable to the vibration analysis of actual shell structures.

A91-35479 Experimental and theoretical study on damped joints in truss structure. HIDEHIKO MITSUMA, AKIO TSUJIHATA, SHINYA SEKIMOTO, and FUMIHIRO KUWAO, *Proceedings of the 8th International Modal Analysis Conference* (Vol. 1), Kissimmee, FL, Jan. 29–Feb. 1, 1990, (A91-35476 14-39). Bethel, CT, Society for Experimental Mechanics, Inc., 1990, pp. 8–14.

Damped joints which enhance the vibration controllability in truss structures have been developed and characterized. The damping and stiffness properties have been evaluated both experimentally and theoretically. Hysteresis loops between the load and displacement time histories obtained by the excitation test in the axial direction of the beam were analyzed to identify loss factors. Frequency response functions were also measured to identify modal characteristics of the damped joint. Parametric surveys were performed to examine the effects of thickness and length of the viscoelastic materials and the constraint layers. Finite element models were evaluated using NASTRAN complex eigenvalue analysis. There was good agreement between experimental and theoretical results. The results shows that well-tuned damped joints can yield good damping effects to truss structures. The damped joints were applied to a large space structure.

A91-34625 Free vibration analysis of shells of revolution considering the fluid-structure interaction. TAKASHI MIKAMI and JIN YOSHIMURA, *Hokkaido University, Faculty of Engineering, Memoirs* (ISSN 0368-9379), Vol. 18, No. 1, 1990, pp. 1–15. 10 Refs.

A simple and effective method is developed in this paper for free vibration analysis of shells of revolution with either internal or external fluids. The fluid region is treated analytically by utilizing the eigenfunction expansions, and the collocation method using the roots of the orthogonal polynominal as collocation points is used to solve the integro-differential equations which govern the motion of the shell. The proposed approach is formulated in some detail. The versatility and accuracy are illustrated through several numerical examples. The method appears to be relatively easy to formulate and gives satisfactory results.

A90-29395 Aeroelastic tailoring analysis for preliminary design of advanced turbo propellers with composite blades. TAKASHI YAMANE and PERETZ P. FRIEDMANN, Technical Papers presented at the 31st AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics and Materials Conference (Part 3), Long Beach, CA, Apr. 2–4, 1990, (A90-29359 11-39). Washington, DC, American Institute of Aeronautics and Astronautics, 1990, pp. 1773–1781. 19 Refs.

An analytical study of aeroelastic tailoring has been conducted to determine the flutter characteristics of advanced turbo propellers for preliminary design purposes. The structural dynamic model for composite pretwisted propeller blades developed by Kosmatka and Friedmann (1989) is combined with Smith's (1972) unsteady cascade theory with the sweep corrections and finite span corrections to produce an aeroelastic analysis tool. The free vibration analysis of the SR-3 propeller model built of unidirectional graphite/epoxy, reveals that the natural frequencies of the blade can be changed from baseline values to 53 percent of baseline only by changing fiber orientation. Using p-k modal flutter analysis it was also found that the fiber orientation with a little larger sweep angle than that of the elastic axis can eliminate flutter without any weight penalty and that the corresponding first natural mode has the least bending-torsion coupling. However, the flutter velocity is sensitive to fiber orientation and interblade phase angle. These indicate the effectiveness of the aeroelastic tailoring technique and the convenience of the present analysis technique for the advanced turbo propellers.

A91-26692 Free nonlinear vibrations of stiffened rectangular plates with an initial curvature. III—Experiment. SEINOSUKE SUMI, MASAO ARITOMI, and KEN KIRIOKA, *Japan Society for Aeronautical and Space Sciences Journal* (ISSN 0021-4663), Vol. 38, No. 443, 1990, pp. 660–668. 14 Refs.

This paper presents an experimental investigation of the linear (small amplitude) and nonlinear (large amplitude) fundamental vibrations of orthotropic stiffened square plates with a small initial curvature. The stiffened plates are made of tough-pitch copperplates by photo-etching. The plates are excited by a speaker and the modes of linear vibration are measured by laser holography. The effects of the initial curvatures on the vibration modes and the vibrations of eigen-frequencies with the amplitude are clarified. The experimental results are found to verify previous theoretical investigations.

A91-36236 Vibration and buckling of tapered rectangular plates with two opposite edges simply supported and the other two edges elastically restrained against rotation. H. KOBAYASHI and K. SONODA, *Journal of Sound and Vibration* (ISSN 0022-460X), Vol. 146, April 22, 1991, pp. 323–337. 23 Refs.

The paper describes an application of a method of power series expansions to the free vibration and buckling problems of isotropic rectangular plates with linear thickness variation. The plates are simply supported on the two opposite edges parallel to the direction of thickness variation and the other two edges are elastically restrained against rotation. By the present method, one can solve exactly the governing equation with variable coefficients. The choice of the origin for the power series expansion plays an important role in obtaining rapid convergence and accurate results. The effects of thickness variation and rotational stiffness of the elastic spring on the eigenvalues and mode shapes are shown numerically and graphically on the basis of new results obtained by the present exact analysis.

A91-26691 The vibration properties of a vertical cylindrical shell partially filled with liquid induced by longitudinal excitation. I—A method of nonlinear analysis by FEM. SHIGEO KOBAYASHI and TOSHIO NAGASHIMA, *Japan Society for Aeronautical and Space Sciences Journal* (ISSN 0021-4663), Vol. 38, No. 443, 1990, pp. 655–659. 8 Refs.

As a fundamental research relating to the amplitude of Pogo oscillation of liquid propellant launch vehicles, an experimental study was conducted in which a cylindrical shell vertically hung and partially filled with liquid was longitudinally excited at the bottom. The vibration of the shell wall was induced at the several specific ranges of exciting frequency by the mechanism of parametric excitation. To analyze this problem, a set of nonlinear equations of vibration is derived with the aid of the finite element method. Axial mode shapes of the axisymmetrical and circumferentially n-wave modes are calculated from the linear part of the set of nonlinear equations. Using these two modes, the set of nonlinear equations is reduced to the coupled equations of two degrees of freedom. The equations to calculate a stationary vibration, and its stability are derived. The range of the parametric excitation is obtained in the plane of exciting force amplitude and frequency.

A91-23689 Experimental modal analysis by means of multi-variable discrete model fitting. Y. OKADA, K.-I. MATSUDA, T. TAKAHI, and K. YAMANAKA, Vibration analysis—Techniques and applications; Proceedings of the Twelfth Biennial ASME Conference on Mechanical Vibration and Noise, Montreal, Canada, Sept. 17–21, 1989 (A91-23676 08-39). New York, American Society of Mechanical Engineers, 1989, pp. 267–271. 9 Refs.

A method of identifying natural frequencies, damping ratios and associated vibrating modes from the free decaying response of a structure is presented. This method is based on the least square fitting of a multivariable discrete model to a structure. The mathematical model is analyzed by an eigenvalue routine to get the z-domain poles and the associated eigenvectors. The poles are converted into the s-domain to get the resonant frequencies and damping ratios. The proposed technique is applied to a free plate and its accuracy is tested.

A91-15047 Free nonlinear vibrations of stiffened rectangular plates with an initial curvature. II—Theoretical analyses of clamped plate. SEINOSUKE SUMI, MASAO ARITOMI, and KENSUKE TAKEUCHI, *Japan Society for Aeronautical and Space Sciences Journal* (ISSN 0021-4663), Vol. 38, No. 439, 1990, pp. 405–413. 15 Refs.

Theoretical analyses are presented for free nonlinear vibrations of stiffened rectangular plates with an initial curvature. Clamped boundary conditions with movable or immovable in-plane edges and the initial deflections with single or double curvatures are assumed. The dynamic analog of the Marguerre equations extended to orthotropic stiffened rectangular plates is used and the solutions for fundamental vibration are obtained by applying the Galerkin procedure and the method of successive approximation. Numerical results illustrate the influence of stiffening parameters, initial deflections, amplitude and in-plane edge conditions on the fundamental frequencies.

A90-32337 Practical method of dynamic analysis of symmetrically laminated composite plates. K. SUZUKI and K. MATSUMOTO, Dynamics of plates and shells—1989; Proceedings of the ASME/JSME Pressure Vessels and Piping Conference, Honolulu, HI, July 23-27, 1989 (A90-32326 13-39). New York, American Society of Mechanical Engineers, 1989, pp. 85–89.

This paper presents FEM-based eigenvalue, eigenvector, and frequency-response analysis techniques for symmetrically laminated composite plates using a stand-alone desktop microcomputer. A 12-DOF finite element has been formulated considering the anisotropic behavior of symmetrically laminated composite plates. A subspace iteration algorithm is used for the eigenvalue and eigenvector analyses. A modal analysis effective for this particular problem has been developed to calculate frequency-response functions using the results of the eigenvalue analysis. Furthermore, pre- and postprocessor eigenvalue analyses have been conducted. A vibration test taking CFRP plates as test pieces is performed to prove the effectiveness of the method. Study shows that this dynamic and eigenvalue analysis technique could be effective for plates, whereby not only a wide range of fiber angles but also dynamic coupling effects between bending and torsion forces are taken into consideration.

A90-53032 Dynamics of the antenna pointing control system with flexible structures. MASAZUMI UEBA, AIAA/AAS Astrodynamics Conference, Portland, OR, Aug. 20-22, 1990, Technical Papers. Part 2 (A90-52957 24-13). Washington, DC, American Institute of Aeronautics and Astronautics, 1990, pp. 704–711. (AIAA Paper 90-2951).

This paper describes the dynamics of the antenna pointing control system with flexible structures of onboard large antennas for multibeam communication satellites. A method is clarified for deriving the dynamics of a 3.5-m-diameter flexible large antenna reflector and a flexible support boom with a driven mechanism on its tip. Two important coupling coefficients, between a rigid-satellite main body and a flexible main reflector and between a driven subreflector and a support boom, are shown. The effect of the critical structural parameters on the antenna pointing control system is also evaluated.

A90-52416 Free vibration analysis of cantilevered composite plates of arbitrary planform. YOSHIHIRO NARITA, *JSME International Journal, Series III* (ISSN 0914-8825), Vol. 33, Sept.1990, pp. 291–296. 11 Refs.

The free vibration problem of cantilevered composite plates of arbitrary planform is solved by an extension of the Ritz method. The lamination of fibrous composite material is included in the analysis by obtaining the equivalent bending rigidities. The cantilever plate is assumed to have a straight clamped edge and free edges along an arbitrary boundary, and the boundary conditions are accommodated by use of double power series for assumed defections. In the numerical study, four typical plate planforms are considered, and the natural frequencies are calculated for plates made of boron-epoxy material. The dependence of the free vibration characteristics on the lamination parameters, e.g., fiber orientation and number of layers, is discussed.

A90-34087 On the strength of a composite beam. S. SUZUKI, *Journal of Sound and Vibration* (ISSN 0022-460X), Vol. 136, Jan. 22, 1990, pp. 315–321. 7 Refs.

A static and dynamic stress analysis is carried out for the case of a three-layer composite beam subjected to uniformly distributed impulsive loads, with account being taken of the warping of the section. The relationships between the dimensions and the mechanical properties of the composite beam and the shearing stress at the boundary are studied. The fundamental equations of motion of the beam are solved by the Laplace transformation method. From the results of the theoretical analysis, it is evident that the shearing stress in the softer part of the composite beam becomes large and rupture is liable to occur in this part.

A90-33595 Dynamics of multi-spool gas turbines using the matrix transfer method—Theory. Y. KAZAO and E. J. GUNTER, *International Journal of Turbo and Jet-Engines* (ISSN 0334-0082), Vol. 6, No. 2, 1989, pp. 153–161. 14 Refs.

A theoretical procedure for the dynamic analysis of multi-spool turborotors with flexible supports and flexible branches using a modified transfer method in which multi-span rotors with multiple branches may be computed accurately and rapidly on a small engineering workstation is presented. A scaling procedure is introduced into the transfer matrices by appropriate transformations of slope, moment, and shear coefficients. The numerical difficulties caused by branches are described using a simple model and methodology to eliminate this problem is developed. A computer algorithm used to calculate undamped critical speeds of multi-span rotors with multiple branches is studied.

A90-32500 Steady-state response of a damped cantilever annular sector plate with curved radial edges. KATSUAKI TANAKA, GEN YAMADA, and YUKINORI KOBAYASHI, *Hokkaido University, Faculty of Engineering, Bulletin* (ISSN 0385-602X), Feb. 1990, pp. 83–89. 5 Refs.

The steady-state response is presented for a damped cantilever annular sector plate with curved radial edges by the Ritz method. The plate is transformed into a regular sector plate with unit outer radius by a transformation of variables. The transverse displacement of the transformed plate is approximately expressed in series by the power function. Substituting the expression for the kinetic and strain energies of the plate into Lagrange equation, the dynamic response of the plate is derived analytically. The numerical examples are calculated for annular sector plates with symmetrically curved radial edges. The effects of the damping factor and observation point on the steady state responses of the plate are studied.

A90-32370 The dynamic J integral (J-prime) and its use in finite element simulation of dynamic crack propagation. T. NISHIOKA, Y. TAKEMOTO, and R. MURAKAMI, Dynamic fracture mechanics for the 1990's; Proceedings of the ASME/JSME Pressure Vessels and Piping Conference, Honolulu, HI, July 23-27, 1989 (A90-32362 13-39). New York, American Society of Mechanical Engineers, 1989, pp. 117–125. 23 Refs.

Recent theoretical and computational studies of the dynamic J integral and moving finite element procedures are summarized. The invariance of the elastodynamic J integral with respect to the shape of an infinitesimal process zone is discussed. An asymptotic expression method for determining the mixed-mode stress intensity factors using path-independent integrals is examined, as is a moving finite element method aided by computerized symbolic manipulation. A concept of an element-controlling plane based on Lagrangean-element mapping for the simulation of dynamic crack curving is discussed.

A90-33594 Dynamics of multi-spool gas turbines using the matrix transfer method—Applications. Y. KAZAO and E. J. GUNTER, *International Journal of Turbo and Jet-Engines* (ISSN 0334-0082), Vol. 6, No. 2, 1989, pp. 143–152.

Application of the modified matrix transfer method in which multispan rotors with multiple branches can be computed accurately and rapidly on a microcomputer is presented. The procedure is used for the dynamic analysis of turborotors with flexible supports and flexible offset impellers and fans, turbine-generators on flexible foundations, and multispool gas turbines with flexible casings. Several rotor dynamic case studies, using simple models of a rotor coupled with a casing or foundation, are also presented. A dynamic analysis of a gas turbine with dual-span rectors (a low pressure rotor and a high pressure rotor) with flexible disks and a flexible casing is discussed. It is shown that the gas turbine system critical speeds cannot be computed using single span theory and that the interaction of flexible casing or foundation with the rotor may cause multiple or bifurcated critical speeds to occur within the operating speed range.

A90-32336 Dynamic instability of circular cylindrical shells under periodic external pressure—Influence of axisymmetric bending vibrations. K. NAGAI and N. YAMAKI, Dynamics of plates and shells—1989; Proceedings of the ASME/JSME Pressure Vessels and Piping Conference, Honolulu, HI, July 23–27, 1989 (A90-32326 13-39). New York, American Society of Mechanical Engineers, 1989, pp. 77–83. 12 Refs.

This paper presents theoretical solutions for dynamic instability of cylindrical shells subjected to periodic hydraulic pressure or lateral pressure, considering the effect of axisymmetric bending vibration prior to instability. The Donnell equations with the transverse inertia force are used, and the problem is solved under four typical sets of boundary conditions. First, applying the Galerkin procedure, the problem is reduced to that of a finite-degree-of-freedom system. Next, the stability boundaries of the principal, combination, and secondary parametric resonances are examined using Hsu's method. Calculations are carried out for typical shell geometry and boundary conditions. The results demonstrate that the unperturbed bending vibration gives quite a significant effect on the instability boundary for shells with moderate length.

A90-32333 Free vibration analysis of cantilevered composite plates of arbitrary planform. Y. NARITA, Dynamics of plates and shells—1989; Proceedings of the ASME/JSME Pressure Vessels and Piping Conference, Honolulu, HI, July 23-27, 1989 (A90-32326 13-39). New York, American Society of Mechanical Engineers, 1989, pp. 59–64. 7 Refs.

The free vibration problem of cantilevered composite plates of arbitrary planform is solved by an extension of the Ritz method. The lamination of fibrous composite materials is included in the analysis by obtaining the equivalent bending rigidities. The cantilever plate is assumed to have a straight clamped edge and free edges along arbitrary boundary, and the boundary conditions are accommodated by use of double power series for assumed deflections. In numerical study, four typical plate planforms are considered, and the natural frequencies are calculated for plates made of boron-epoxy material. The dependence of the free vibration characteristics on the lamination parameters, e.g. fiber orientation and number of layers, is discussed.

A90-32328 Free vibration of a spinning polar orthotropic shallow spherical shell. Y. KOBAYASHI and G. YAMADA, Dynamics of plates and shells—1989; Proceedings of the ASME/JSME Pressure Vessels and Piping Conference, Honolulu, HI, July 23-27, 1989 (A90-32326 13-39). New York, American Society of Mechanical Engineers, 1989, pp. 17–22. 9 Refs.

An analysis is presented for the free vibration of a spinning polar orthotropic shallow spherical shell. For this purpose, the governing equations and the boundary conditions of the shell are derived by applying Hamilton's principle to the strain and kinetic energies of the shell. The variables in the equations can be written as summation of the quasi-static components which are independent of time and the dynamic ones. The linear equations on the vibration about the deformed state are solved by using the transfer matrix method. The method is applied to a spinning clamped-free shallow spherical shell. The eigenvalues of vibration are calculated numerically, and the effects of the spinning velocity and the orthotropy of the shell on the free vibration are studied.

A90-29417 Effect of a structural damping on dynamic stability of a free flexible plate subjected to a follower force. KEN HIGUCHI, EARL H. DOWELL, Technical Papers presented at the 31st AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics and Materials Conference (Part 4), Long Beach, CA, Apr. 2–4, 1990, (A90-29409 11-39). Washington, DC, American Institute of Aeronautics and Astronautics, 1990, pp. 1965–1971. 6 Refs. (AIAA Paper 90-0940).

A plate-like large space structure may undergo dynamic instabilities when it is thrusted by a nonconservative compressive force. A flexible rectangular plate with four free edges, one of which is subjected to a tangential follower force, is considered. The effects of structural damping are studied here, because small damping may destabilize the nonconservative system. The calculation shows that the thrusted free-edged plate with structural damping also has both divergence and flutter types of instability, and the flutter thrust load with small structural damping is drastically lower than that without damping. The destabilizing effect depends on the slenderness ratio of the rectangular plate.