Russian and Japanese Aerospace Literature

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Russian Aerospace Literature
This month: *Structural Dynamics*

A91-50863 Natural vibrations of preloaded anisotropic shells of revolution (Svobodnye kolebaniia predvaritel'no nagruzhennykh anizotropnykh obolochek vrashcheniia). E. I. BESPALOVA, IA. M. GRIGORENKO, A. B. KITAIGORODSKII, and A. I. SHINKAR', *Prikladnaia Mekhanika* (ISSN 0032-8243), Vol. 27, May 1991, pp. 51–57. 15 Refs.

A numerical method for determining the natural frequencies and modes of layered anisotropic shells of revolution under axisymmetric loading are discussed. In accordance with the approach adopted here, the natural vibrations of a shell are treated in the context of the theory of small vibrations as a motion produced by the perturbation of the initial state. The dynamic problem is formulated on the basis of the geometrically nonlinear theory of shells in the quadratic approximation. The lower frequency of an anisotropic elliptical shell of revolution is calculated as an example.

A91-45011 Vibrations of dissipative inhomogeneous viscoelastic shell structures (Kolebaniia dissipativno-neodnorodnykh viazkouprugikh obolochechnykh konstruktsii). E. P. KLIGMAN and V. P. MATVEENKO, *Deformation and fracture of structurally inhomogeneous materials and structures* (A91-45001 19-39). Sverdlovsk, USSR, UrO AN SSSR, 1989, pp. 96–101.

Natural attenuating and steady-state forced vibrations of dissipative inhomogeneous viscoelastic shell structures are examined analytically. The possibility of the substantial reduction of resonance amplitudes and enhancement of the damping properties of layered shells through the introduction of structural elements that change the degree of the dissipative inhomogeneity of the system is demonstrated. Calculations are carried out using the finite element method with allowance for transverse shear in the Timoshenko form. The system energy dissipation under harmonic vibrations is accounted for by using complex dynamic moduli.

A91-13552 Surface instability of two fibers in a matrix (Pripoverkhnostnaia neustoichivost' dvukh volokon v matritse). IU. N. LAPUSTA, *Prikladnaia Mekhanika* (ISSN 0032-8243), Vol. 26, Aug. 1990, pp. 30–36. 13 Refs.

The stability of two fibers located in a semi-infinite elastic matrix normal to its free surface is investigated in the case of axial compression using a rigorous approach based on a three-dimensional linearized stability theory and a piecewise homogeneous medium model. A solution method is proposed for compressible isotropic elastic materials under low subcritical deformations. For various flexural stability loss modes, characteristic equations are obtained in the form of infinite determinants. Good convergence of the method is demonstrated over a wide range of stiffness and geometrical parameters.

A91-33914 Numerical investigation of bifurcations in stability problems for thin-walled structures (Chislennoe issledovanie bifurkatsii v zadachakh ustoichivosti tonkostennykh konstruktsii). G. V. ISAKHANOV, E. S. DEKHTIARIUK, and A. B. KRITSKII, *Problemy Prochnosti* (ISSN 0556-171X), Feb. 1991, pp. 66–72. 10 Refs.

An efficient finite element procedure is proposed for obtaining bifurcating solutions to nonlinear equilibrium equations for thin-walled structures. The initial postcritical behavior of a thin elastic rod is examined as an example using a classical analytical approach and the finite element method. In both cases, the bifurcation solution is obtained by the perturbation method, and the results are compared. The high efficiency and accuracy of the approach proposed here are demonstrated.

A91-26450 Dynamics and stability of layered composite structures with interfacial delaminations (K probleme dinamiki i ustoichivosti sloistykh kompozitsionnykh struktur s mezhfaznymi rassloeniiami). B. L. PELEKH and S. S. MACHUGA, *Prikladnaia Mekhanika* (ISSN 0032-8243), Vol. 26, Dec. 1990, pp. 28–32. 11 Refs.

Composite structures with delaminations are treated as piecewise homogeneous bodies with interfacial defects of various kinds. Phase conjugation conditions are formulated for ideal contact regions, and hypotheses are proposed concerning the interaction between delamination surfaces. For layered composite structures, a method for obtaining dynamic equations and equations of neutral equilibrium is proposed. A numerical method based on the Bubnov procedure is proposed for solving problems of the natural vibrations and critical forces of layered composite shells with interfacial delaminations. The natural vibrations and stability of two-layer cylindrical shells with longitudinal and annular delaminations are examined as an example.

A90-12400 A method for calculating the fatigue life of specimens with a stress raiser. II (Metodika rascheta dolgovechnosti obraztsov s kontsentratorom napriazhenii. II). P. A. FOMICHEV and J. POLAK, *Problemy Prochnosti* (ISSN 0556-171X), Sept. 1989, pp. 100–103. 8 Refs.

The theoretical fatigue lives of specimens with stress raisers are analyzed in relation to the method used to determine the theoretical stress intensity factor. A method for calculating the fatigue life of specimens with a stress raiser is proposed which allows for the effective stress gradient in the stress concentration zone prior to the formation of a macroscopic fatigue crack. The effective stresses under cyclic elastoplastic loading are obtained by the equivalent energy method. The results obtained by the approach proposed here are in good agreement with experimental data for specimens of 15313 steel.

A91-32390 **Oscillations of the reflector shells of mirror antennas under vibrational excitation (Kolebaniia obolochek reflektorov zerkal'nykh antenn pri vibratsionnom vozbuzhdenii).** V. S. GU-DRAMOVICH, N. G. BARANOV, N. A. KONOVALOV, and I. M. MAITALA, *Prikladnaia Mekhanika* (ISSN 0032-8243), Vol. 27, Jan. 1991, pp. 64–71.

Experimental data are presented on the three-dimensional oscillations of nearly parabolic reflector shells of large mirror antennas under vibrational excitation. In the experiments, reflector shells were tested in the horizontal and vertical positions using electrodynamic vibration stands. The amplitude-frequency characteristics of the reflectors are determined. The effect of the location and parameters of the shell supports on these characteristics is discussed.

A91-25149 **Application of the asymptotic method to the analysis of the finite-amplitude vibrations of shallow shells (Primenenie asimptoticheskogo metoda k issledovaniiu kolebanii pologikh obolochek pri konechnykh amplitudakh).** N. I. ZHINZHER and V. E. KHROMATOV, *Prikladnaia Mekhanika* (ISSN 0032-8243), Vol. 26, Nov. 1990, pp. 93–99. 8 Refs.

The asymptotic approach proposed by Bolotin (1962, 1979) is used to calculate the nonlinear vibrations of shallow shells and plates. Frequency relations are obtained in finite form for the nonlinear vibrations of shallow shells; the behavior of frequencies is investigated as a function of the vibration amplitude. Asymptotic expressions are obtained for the vibration frequency densities of shells and plates. The limits distributions of the vibration frequencies are determined, and the presence of points where the frequency density is particularly high is demonstrated.

A91-13551 **Dynamics of shell structures under impulsive loading (Review) (Dinamika obolochechnykh konstruktsii pri impul'snykh nagruzkakh /Obzor/).** P. Z. LUGOVOI, *Prikladnaia Mekhanika* (ISSN 0032-8243), Vol. 26, Aug. 1990, pp. 3–20. 202 Refs.

Research related to the effect of impulsive loading on shell structures is reviewed with reference to work published over the past ten years. Studies concerned with a variety of problems in shell dynamics are classified with allowance for the structural characteristics of the shells. The discussion covers smooth shells, shells with holes, ribbed shells, coupled shells, and shell structures of detonation chambers.

A91-12012 **Nonlinear plane elasticity theory and its application to physically and geometrically nonlinear crack mechanics (Nelineinaia ploskaia teoriia uprugosti i ee primenenie k fizicheski i geometricheski nelineinoi mekhanike treshchin).** K. F. CHERNYKH, *Uspekhi Mekhaniki—Advances in Mechanics* (ISSN 0137-3722), Vol. 12, No. 4, 1989, pp. 51–75. 11 Refs.

For an elastic potential of a special kind, corresponding to a prestressed material (infinitely linearly elastic), an exact nonlinear elasticity solution is obtained for base boundary value problems, such as a plane with a rectilinear crack and a plane with a linear solid inclusion. The asymptotic behavior of the stresses is determined, as is the configuration of the deformed contour of the crack. The asymptotic form of stresses is also examined for an elastic potential of a more general kind. The exact solutions obtained here are compared with linear elasticity solutions.

A91-12010 **Normal vibrations of nonlinear finite-dimensional systems (Normal'nye kolebaniia nelineinykh konechnomernykh sistem).** L. I. MANEVICH, and IU. V. MIKHLIN, *Uspekhi Mekhaniki—Advances in Mechanics* (ISSN 0137-3722), Vol. 12, No. 3, 1989, pp. 3–38. 56 Refs.

The normal vibrations of nonlinear finite-dimensional systems are investigated analytically using small parameter, iteration, and Pade approximation methods. The discussion covers normal vibration paths in configuration space, normal vibrations in conservative systems allowing rectilinear modes, and splicing of local expansions in the problem of the normal vibrations of nonlinear systems. Attention is also given to normal vibrations in near-conservative nonatonomous and self-oscillatory systems and application aspects of the theory of normal vibrations.

A90-50772 **A finite element analysis of the natural vibrations of statically stressed turbine blades (Konechnoelementnyi analiz sobstvennykh kolebanii staticheski napriazhennykh lopatok turbomashin).** IU. S. VOROB'EV, A. I. SHEPEL', L. G. ROMANENKO, V. N. VODCHENKO, and Z. V. SAPELKINA, *Problemy Prochnosti* (ISSN 0556-171X), July 1990, pp. 88–94.

A finite element procedure for analyzing the natural vibrations of turbine blades is presented which allows for the effect of static loads. The principal stages of the three-dimensional calculation procedure are described, and calculation results are presented for test problems. A study is made of the effect of centrifugal forces and structural characteristics on the vibration characteristics of real blades.

A90-29206 **Integration of a dynamic boundary-layer equation (Integrirovanie uravnenii dinamicheskogo pogransloia).** IU. D. KAPLUNOV, *Akademiia Nauk SSSR, Izvestiia, Mekhanika Tverdogo Tela* (ISSN 0572-3299), Jan.–Feb. 1990, pp. 148–160. 8 Refs.

The plane and antiplane boundary-layer equations describing meridional band oscillations, used in the analysis of the high-frequency oscillations of shells of revolution, are simplified by dividing the stress-strain state into the symmetric and antisymmetric components. Particular solutions to the simplified equations are obtained which satisfy the uniform boundary conditions on the shell face surfaces.

A90-43009 **Method for the numerical solution of the dynamics equations of thin-walled shells based on the isolation of strongly oscillating components (Metod dlia chislennogo resheniia uravnenii dinamiki tonkostennykh obolochek, osnovannyi na vydelenii sil'noostsilliruiushchikh komponent).** E. G. EVSEEV and A. IU. SE-MENOV, *Akademiia Nauk SSSR, Doklady* (ISSN 0002-3264), Vol. 310, No. 4, 1990, pp. 785–788. 15 Refs.

A splitting methodology is described which makes it possible to isolate the strongly oscillating components in a special manner, assuring the stability of explicit schemes, including the case where tau/k is much greater than 1, where tau is the time integration step and k is the ratio of the shell thickness to the curvature radius of its middle surface. The hyperbolic operator is approximated by difference schemes that take into account the distinctive properties of the system. The proposed method makes it possible to evaluate the applicability of different numerical methods and the reasons for their numerical instability.

A90-37830 **Vibration equations for a helicopter rotor blade (Uravneniia kolebanii lopasti nesushchego vinta vertoleta).** R. A. MIKHEEV and T. D. SMOL'IANINOVA, *Raschety na Prochnost'*, No. 29, 1989, 15 Refs.

The problem of rotor blade vibration is analyzed using a mathematical problem based on differential equations describing blade motions. The differential equations of blade motion are derived using equilibrium equations for a blade element. A linearized system of differential equations of blade motion can be solved using an efficient method based on the Vlasov-Kantorovich approach. The same method can also be used in a more complex (nonlinear) approach.

A90-32555 **Stability of nearly cylindrical shells (Ustoichivost' obolochek, blizkikh k tsilindricheskim).** P. E. TOVSTIK, *Leningradskii Universitet, Vestnik, Matematika, Mekhanika, Astronomiia* (ISSN 0024-0850), Jan. 1990, pp. 76–80.

An analysis is made of the stability of the momentless stressed state of a thin nearly cylindrical elastic shell of medium length. The shell is loaded by normal external pressure or in torsion. By using the methods of asymptotic integration, forms of stability loss are obtained which involve the entire middle surface or are localized in the vicinity of the weakest generatrix.

A90-29001 **Approximation of frequency characteristics using identification with a complex mass matrix (Approksimatsiia chastotnykh kharakteristik na osnove identifikatsii s kompleksnoi matritsei mass).** M. S. GALKIN and B. V. GRIGOR'EV, *TsAGI, Uchenye Zapiski* (ISSN 0321-3439), Vol. 20, No. 2, 1989, pp. 45–52.

A mathematical model with complex mass and stiffness matrices is proposed. It is shown that the introduction of an additional parameter, the imaginary part of the generalized mass, makes it possible to describe the resonance characteristics near the resonance frequency with a higher accuracy than that obtainable by other known methods. Two methods of frequency characteristic approximation are compared with reference to full-scale test results for aircraft structures.

A90-24217 **Limiting state of radial turbomachine wheels (Predel'noe sostoianie radial'nykh koles turbomashin).** V. E. GOKHBERG and O. S. SADAKOV, *Problemy Prochnosti* (ISSN 0556-171X), Jan. 1990, pp. 118–120.

The problem of the limiting rotation frequency of a radial turbine wheel is solved by the kinematic method assuming the formation of a circular plastic hinge in the limiting state. For a given hinge radius, the problem is shown to be reduced to that of solving two equilibrium equations. Calculations for a large number of radial wheels have revealed, in some cases, a large margin of the load-carrying capacity, which is absent in the case of standard calculations without considering bending effects.

A90-20407 **Statics and dynamics of three-dimensional Timoshenko rods (K statike i dinamike prostranstvennykh sterzhnei tipa Timoshenko).** V. I. TKACHISHIN and N. P. FLEISHMAN, *Prikladnaia Mekhanika* (ISSN 0032-8243), Vol. 25, Nov. 1989, pp. 74–81. 11 Refs.

Resolvent equations for arbitrarily twisted curved three-dimensional Timoshenko rods are obtained in curvilinear coordinates. Isoparametric finite element schemes are constructed for solving problems in the statics and dynamics of rods of complex geometry. The efficiency of the approach proposed here is demonstrated using results of numerical calculations.

A90-15563 **Technological methods of increasing the load-bearing capacity of large components of filament-wound composites (Tekhnologicheskie metody povysheniia nesushchei sposobnosti krupnogabaritnykh izdelii iz namotochnykh kompozitov).** E. I. STEPANYCHEV and V. S. PICHUGIN, *Mekhanika Kompozitnykh Materialov* (ISSN 0203-1272), Sept.-Oct. 1989, pp. 917–921.

The existing methods of increasing the density of filament wound composites at the stage of the semifinished product are analyzed. New methods for forming large components, making it possible to control the process variables throughout the fabrication process are proposed. It is shown that the dependences of the fracture pressure and stresses on the formation force are extremal, whereas the deformability dependence is monotonically decreasing. Results of a microstructural analysis of the material of shells produced by the existing methods and the method proposed here are presented.

A90-14560 **Dynamic analysis of lifting surfaces of small relative thickness in the case of finite displacements (O dinamicheskom raschete nesushchikh poverkhnostei maloi otnositel'noi tolshchiny pri konechnykh peremeshcheniiakh).** V. G. GAINUTDINOV, *Aviatsionnaia Tekhnika* (ISSN 0579-2975), No. 3, 1989, pp. 19–23. 5 Refs.

An algorithm is presented for the dynamic analysis of flexible lifting surfaces modeled by thin and thin-walled rods as well as lifting surfaces described by more complex models. Attention is given to lifting surfaces of large and moderate aspect ratios and lifting surfaces whose cross sections move like rigid disks under deformation. Equations of motion are obtained for the case of finite displacements, and an example of calculations is presented.

A90-12313 **Calculation of shells of complex geometry in cylindrical coordinates using a spline version of the finite element method (K raschetu obolochek slozhnoi geometrii v tsilindricheskikh koordinatakh na osnove splainovogo varianta MKE).** M. S. KORNISHIN and N. M. IAKUPOV, *Prikladnaia Mekhanika* (ISSN 0032-8243), Vol. 25, Aug. 1989, pp. 53–60. 8 Refs.

A spline version of the finite element method is proposed for calculating shells of complex geometry, whose middle surface can be conveniently represented in cylindrical coordinates. An extension of the method to the analysis of closed shells is presented. Numerical results for model problems are given, as are examples of calculations for shells of complex geometry.

A90-12283 **An algorithm for the analysis of the nonlinear deformation and stability of circular cylindrical shells with initial shape imperfections (Algoritm issledovaniia nelineinogo deformirovaniia i ustoichivosti krugovykh tsilindricheskikh obolochek s nachal'nymi nesovershenstvami formy).** L. P. ZHELEZNOV and V. V. KABANOV, *PMTF—Zhurnal Prikladnoi Mekhaniki i Tekhnicheskoi Fiziki* (ISSN 0044-4626), July–Aug. 1989, pp. 143–148. 5 Refs.

A solution to the stability problem for circular cylindrical shells with initial imperfections is obtained in sufficiently general form, without any restriction on the load and the form of the initial and bifurcation deflections. The approach used here is based on the method of finite elements in displacements. The finite element is selected in the form of a rectangle of natural curvature whose shape functions account for its displacement as a rigid body.

A89-54581 **Side branches of oscillations in composite materials with a completely disordered structure (Kraevye vetvi kolebanii v kompozitnykh materialakh s polnost'iu razuporiadochennoi strukturoi).** A. V. CHIGAREV and N. I. CHEPELEV, *Mekhanika Kompozitnykh Materialov* (ISSN 0203-1272), July–Aug. 1989, pp. 600–607. 15 Refs.

A study is made of the dynamic edge effect in composites of stochastic structure. Oscillation branches, including acoustic and side branches, are determined by the reference equation method. For long wavelengths, the amplitude of the acoustic mode is shown to be significantly greater than that of the edge mode; for short wavelengths, their amplitudes are of the same order. As the oscillation frequency increases, the penetration depth of the acoustic mode oscillations decreases and that of the edge oscillations increases.

A89-54533 **Solution of elasticity problems by complete-system methods (Reshenie zadach teorii uprugosti metodami polnykh sistem).** E. I. BESPALOVA, *Zhurnal Vychislitel'noi Matematiki i Matematicheskoi Fiziki* (ISSN 0044-4669), Vol. 29, Sept. 1989, pp. 1346–1353. 14 Refs.

The main principles of complete-system methods are examined with particular reference to the solution of problems in the statics and free vibrations of inhomogeneous anisotropic bodies in a variational formulation. A characteristic feature of the methods is the reduction of the initial N-dimensional problem to N interrelated one-dimensional problems. Some computational aspects of the approach are illustrated by a specific example.

A89-49333 **Computational model for determining the fatigue life of a body weakened by a thin cavity (Raschetnaia model' dlia opredeleniia ustalostnoi dolgovechnosti tela, oslablennogo tonkoi polost'iu).** M. M. STADNIK and R. V. RIZNICHUK, *Fiziko-Khimicheskaia Mekhanika Materiallov* (ISSN 0430-6252), Vol. 25, May–June 1989, pp. 83–88. 24 Refs.

A model for calculating the fatigue life of a body containing a thin cavity is developed which is based on the estimation of deformation at the tips of a stress raiser and a short crack originating at it. The problem of deformation estimation is solved approximately using the interpolation method. Results of an experimental verification of the model using specimens of 65G and JIS SM41B steel are presented.

A89-35641 **Characteristics of the calculation of the thermal stress state of a deformable body under pulsed heating (Osobennosti rascheta termonapriazhennogo sostoianiia deformiruemogo tela pri impul'snom nagreve).** V. S. ZARUBIN and G. N. KUVYRKIN, *Akademiia Nauk SSSR, Izvestiia, Mekhanika Tverdogo Tela* (ISSN 0572-3299), Jan.–Feb. 1989, pp. 127–132. 11 Refs.

The paper proposes a theoretical approach to describe the behavior of a deformable medium, where the governing thermodynamic functions of vector and tensor internal structure parameters are used as the arguments. The derived system of governing equations is used to calculate the dynamic loading of a radiation-absorbing material by a pulsed heat flux.

A90-28984 **A method for increasing the convergence rate of Ritz and Bubnov-Galerkin methods when using coordinate functions that do not satisfy the boundary conditions of the problem (Sposob uskoreniia skhodimosti metodov Rittsa i Bubnova-Galerkina pri ispol'zovanii koordinatnykh funktsii, ne udovletvoriaiushchikh granichnym usloviiam zadachi).** R. A. SHIBANOV, *TsAGI, Uchenye Zapiski* (ISSN 0321-3439), Vol. 20, No. 1, 1989, pp. 62–71. 9 Refs.

With equations of rod vibrations used as an example, a method is presented for increasing the convergence rate of Ritz and Bubnov-Galerkin solutions to boundary value problems when using coordinate functions that do not satisfy the boundary conditions of the problem. It is proposed that the imposed boundary conditions be supplemented by an additional compliance due to the degrees of freedom of the structure that are not taken into account in the dynamic scheme. Results of calculations are presented which provide an estimate of the effect of boundary condition correction on the solution accuracy.

A90-15566 **Axisymmetrical contact problems in shell theory (Osesimmetrichnye kontaktnye zadachi teorii obolochek).** V. V. ZOZULIA and B. IA. KANTOR, *Prikladnaia Mekhanika* (ISSN 0032-8243), Vol. 25, Oct. 1989, pp. 64–69. 11 Refs.

The existence of solutions to contact problems in different functional spaces and the well-posedness of the problems is investigated with reference to Kirchhoff-Love and Timoshenko shells and also a model considering the compression of shell layers in the thickness direction. It is found that the contact problems considered may be well-posed in some functional spaces and ill-posed in other spaces. Generalized solutions are obtained in the cases where classical solutions do not exist. For the approximation of generalized solutions to integral Fredholm equations of the first kind by classical solutions use is made of various regularization methods.

A89-47988 **Nonlinear analysis of arbitrary shell structures using a curvilinear isoparametric element (Nelineinyi analiz proizvol'nykh obolochechnykh konstruktsii s ispol'zovaniem krivolineinogo izoparametricheskogo elementa).** IU. V. SKVORTSOV and KH. S. KHAZANOV, *Aviatsionnaia Tekhnika* (ISSN 0579-2975), No. 2, 1989, pp. 15–19.

A finite element procedure is proposed for the analysis of arbitrary shells in the case of large displacements. The procedure uses Timoshenko's kinematic hypothesis, which allows for transverse shear and normal compression. The separation of the contributions of different types of deformation makes it possible to construct simplified shell models.

A89-39824 **The method of discontinuous solutions in Timoshenko plate theory (Metod razryvnykh reshenii v teorii plastin Timoshenko).** G. A. MORAR', *Akademiia Nauk SSSR, Izvestiia, Mekhanika Tverdogo Tela* (ISSN 0572-3299), Mar.–Apr. 1989, pp. 171–178. 15 Refs.

Discontinuous solutions for plate deflections, normal angle rotation, and forces are obtained which make it possible to formulate, in the form of integral equations, various problems concerning defects of arbitrary nature. The analysis is based on plate equations allowing for shear deformation. The approach used here is similar to the method of distortions used in shell theory.

A89-39821 **Contact problem in coupled thermal stress theory and a numerical method for solving it (O kontaktnoi zadache sviazannoi teorii temperaturnykh napriazhenii i metode ee chislennogo resheniia).** V. I. ZAITSEV, *Akademiia Nauk SSSR, Izvestiia, Mekhanika Tverdogo Tela* (ISSN 0572-3299), Mar.–Apr. 1989, pp. 102–108. 9 Refs.

A numerical method for solving quasi-static contact problems in coupled theory of thermal stresses with friction is presented which uses an incremental formulation based on the sequential loading approach. Details of the solution procedure are presented. The method proposed here can be used for estimating the performance of real structures of complex configurations and in the realization of contact interaction in general form with allowance for the presence of gap, slip, and cohesion zones.

A89-38436 **Stability of shells of revolution with random axisymmetric shape irregularities (Ob ustoichivosti obolochek vrashcheniia so sluchainymi osesimmetrichnymi nepravil'nostiami formy).** S. M. BAUER, *Leningradskii Universitet, Vestnik, Matematika, Mekhanika, Astronomiia* (ISSN 0024-0850), Jan. 1989, pp. 102–104.

For a class of axisymmetric initial imperfections depending on two random parameters, a combined distribution of these parameters is obtained assuming the equal probability of the occurrence of any specific imperfection. The probability characteristics of the critical load are then determined using asymptotic formulas for the critical load.

A89-37421 **Dynamical calculations of engine components based on elasticity equations (O postroenii dinamicheskikh raschetov detalei dvigatelei na osnove uravnenii teorii uprugosti).** N. D. KUZNETSOV, L. I. FRIDMAN, A. I. ERMAKOV, and V. N. UKHOV, *Problemy Prochnosti* (ISSN 0556-171X), March 1989, pp. 3–8. 109 Refs.

An elasticity approach to the vibration analysis of gas turbine engine components of complex configurations is proposed which makes it possible to determine the natural frequencies and modes of structures with a higher accuracy than that obtainable with methods based on kinematic hypotheses. The method consists of the approximation of geometrically complex components by canonic bodies, conjugation of these bodies, and derivation of a frequency equation for the whole system.

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. MORDOVT-SEV, 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 matrix 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.