

Soviet and Japanese Aerospace Literature

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Soviet Aerospace Literature This month: *Dynamic Structural Analysis*

A89-39822 Generalized solutions to contact problems for elastic plates and shells (Obobshchennye resheniia kontaknykh zadach dlia uprugikh plastin i obolochek). I. U. P. ZHIGAL'KO and M. M. TOROPOVA, *Akademiia Nauk SSSR, Izvestiia, Mekhanika Tverdogo Tela* (ISSN 0572-3299), Mar.-Apr. 1989, pp. 109-114. 12 Refs.

A generalized statement of the dynamic contact problem for an elastic shell of arbitrary shape is presented, and a generalized solution is obtained for given kinematics of points belonging to a fixed contact region. In a class of generalized functions, exact solutions are constructed for some dynamic and static problems of the contact interaction of thin elastic plates and momentless cylindrical shells with absolutely rigid bodies. The approach is based on the isolation of the singularities of contact pressure under the punch, derivation of a unified analytical expression for plate or shell deformation conditions, and differentiation in generalized function space.

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.

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.

A89-27394 Characteristics of the deformation and fracture of aluminum targets under conditions of normal impact by a steel impactor (Osobennosti deformirovaniia i razrusheniia aluminievyykh pregrad pri vzaimodeistvii po normali so stal'nym udarnikom). V. V. ASTANIN, SH. U. GALIEV, and K. B. IVASHCHENKO, *Problemy Prochnosti* (ISSN 0556-171X), Dec. 1988, pp. 52-58. 15 Refs.

The indentation and penetration of plates of two aluminum alloys, AMg6 and Al-Zn-Mg, by a cylindrical steel impactor is investigated experimentally. The indentation depth is determined as a function of impact velocity for plates of varying thickness. Some characteristics of the behavior of aluminum alloys under conditions of impact are examined with emphasis on the characteristics associated with the formation and evolution of adiabatic shear bands. The dynamics of these bands and associated thermal effects are investigated numerically.

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.

A89-22252 Solution of problems concerning the stressed state of an anisotropic multilayer cone (Rozv'iazok zadach pro napruzhennii stan anizotropnogo bagatosharovogo konusa). N. D. PANKRATOVA, *Akademiia Nauk Ukrain's'koi RSR, Dopovidi, Seriia A - Fiziko-Matematichni ta Tekhnichni Nauki* (ISSN 0002-3531), Oct. 1988, pp. 44-48. 7 Refs.

An approach is proposed for solving problems concerning the nonaxisymmetric deformation of an anisotropic multilayer hollow cone with a single axis of elastic symmetry. The approach is based on the exact reduction of the three-dimensional elasticity problem to a one-dimensional problem with respect to appropriately selected resolvent functions which is then solved by using a stable numerical method. This approach also makes it possible to calculate hollow cones of orthotropic materials in the case where the principal elasticity directions do not coincide with the coordinate directions.

A89-13817 Control problems under insufficient information. I. U. S. OSIPOV, *System modelling and optimization; Proceedings of the Thirteenth IFIP Conference*, Tokyo, Japan, Aug. 31-Sept. 4, 1987 (A89-13816 03-63). Berlin and New York, Springer-Verlag, 1988, pp. 29-51. 9 Refs.

The mathematical formulation and performance of the control algorithms developed by Osipov and Kriazhinskii (1983, 1985, 1986, and 1987) for inverse structural-dynamics problems are reviewed. The existence of solutions is proved, constructive solution methods are outlined, and numerical results for simple mechanical systems are presented in extensive graphs and briefly characterized. The present approach is applicable to systems with noncontinuous right-hand sides, aftereffects, varying time lags as controls, and time lags in coordinates and controls, and in general to systems governed by a Cauchy problem or standard initial/boundary value problem for parabolic or hyperbolic equations.

A90-23420 Dynamics of structures in the case of an instantaneous stiffness change (Dinamika konstruktsii pri mgnovennom izmenenii zhestkosti). V. I. FIGUROVSKII and G. A. USTINOV, *Aviatsionnaia Tekhnika* (ISSN 0579-2975), No. 4, 1989, pp. 78-80.

The paper is concerned with the dynamic process associated with an instantaneous change in the structure stiffness, such as that resulting from the fracture of one or several elements. A computational model is developed using the finite element method in terms of displacements. The change in the structure stiffness is modeled by an increase in the distance or a reduction in the stiffness of the finite element. Examples illustrating the approach proposed here are presented.

A90-21325 Stability and bifurcations of stationary regimes of the nonlinear vibrations of plates and shells (Ustoichivost' i bifurkatsii statsionarnykh rezhimov pri nelineinykh kolebaniakh plastin i obolochek). G. V. ISAKHANOV, E. S. DEKHTIARIUK, V. B. KOVTUNOV, and E. D. LUMEL'SKII, *Problemy Prochnosti* (ISSN 0556-171X), Dec. 1989, pp. 97-102. 9 Refs.

A method is proposed for the numerical analysis of the stability and bifurcations of nonlinear plate and shell vibrations under the effect of periodic loads. A system of equations of motion is written using the finite element method and the method of generalized coordinate with allowance for the geometrical nonlinearity of the plates and shells. The system of differential equations is solved by using the method of continuation in shooting; solutions at the bifurcation points are obtained using the projection method. The approach proposed here makes it possible to determine subharmonic solutions and investigate their stability over a wide range of load parameters.

A90-20437 Low frequency vibrations of a cylindrical shell reinforced by an eccentric frame (Nizkochastotnye kolebaniia tsilindricheskoi obolochki, podkreplennoi eksentricheski raspolzhenym shpangoutom). S. B. FILIPPOV, *Stability and vibrations of mechanical systems* (A90-20426 07-31). Leningrad, Izdatel'stvo Leningradskogo Universiteta, 1988, pp. 141-153. 5 Refs.

The natural vibrations of a thin circular cylindrical shell reinforced by an eccentric frame are investigated analytically. Approximate formulas for determining the low frequency vibrations are obtained by using an asymptotic approach. The applicability limits of a semizero moment theory for calculating such shells are determined.

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.

A90-14560 Dynamic analysis of lifting surfaces of small relative thickness in the case of finite displacements (O dinamicheskoi raschete nesushchikh poverkhnostei maloi otnositel'noi tolshchiny pri konechnykh peremeshcheniakh). 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 thinwalled 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.

A90-14398 Dynamic symmetry condition for an imperfect semi-spherical shell with a perturbation in the free edge shape (Uslovie dinamicheskoi simmetrii neideal'noi polusfericheskoi obolochki pri vozmushchenii formy svobodnogo kraia). M. A. PAVLOVSKII, S. A. SARAPULOV, and S. P. KISILENKO, *Prikladnaia Mekhanika* (ISSN 0032-8243), Vol. 25, Sept. 1989, pp. 102-108. 9 Refs.

The effect of a free boundary shape perturbation on the dynamics of a semi-spherical shell is investigated analytically. The analysis is based on a solution to the problem of the natural frequencies of nearly circular and annular clamped plates. The dynamic symmetry conditions for an imperfect shell with a perturbation in the free boundary shape are determined, and expressions are obtained for calculating the perturbation parameters ensuring this symmetry.

A88-43611 Modal synthesis in the study of the dynamic behavior of complex aircraft gas-turbine engine systems (Modal'nyi sintez v issledovanii dinamicheskogo povedeniia slozhnykh sistem aviatsionnykh GTD). M. K. LEONT'EV, *Aviatsionnaia Tekhnika* (ISSN 0579-2975), No. 1, 1988, pp. 44-48.

The main concepts and the general equations of the methods of modal synthesis for determining the vibration characteristics of complex elastic-inertial systems of aircraft gas-turbine engines are presented. The equations are written in a form convenient for their direct implementation on a computer. Some problems associated with the use of modal synthesis for evaluating the dynamic behavior of complex elastic-inertial systems are identified.

A89-54581 Side branches of oscillations in composite materials with a completely disordered structure (Kraevye vetvi kolebaniia 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.

A89-52883 General theory of simple elastic shells (Obshchaia teoriia uprugikh prostykh obolochek). H. ALTENBACH and P. A. ZHILIN, *Uspekhi Mekhaniki Advances in Mechanics* (ISSN 0137-3722), Vol. 11, No. 4, 1988, pp. 107-148. 36 Refs.

A general theory of simple elastic shells is developed on the basis of the formalized statement of reduced shell models. The discussion covers the kinematics of simple shells, laws of Euler dynamics, energy balance equation and deformation tensors, Cauchy-Green relations, transition to a Love-type theory, and linearization of the principal equations. The main principles of the construction of elasticity tensors are examined, and some applications of the theory are discussed.

A89-47988 Nonlinear analysis of arbitrary shell structures using a curvilinear isoparametric element (Nelineinyy analiz proizvol'nykh obolocheknykh konstruktsii s ispol'zovaniem krivolineinogo izoparametricheskogo elementa). I. U. V. SKVORTSOV and K. 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.

A89-46439 Experimental validation of the calculated values of critical loads for reinforced cylindrical shells (Eksperimental'noe obosnovanie raschetnykh znachenii kriticheskikh nagruzok dlia podkreplennykh tsilindricheskikh obolochek). O. M. DUBOVIK and I. D. PAVLENKO, *Problemy Prochnosti* (ISSN 0556-171X), June 1989, pp. 57-59.

Models are proposed for estimating critical loads for cylindrical shells with longitudinal reinforcement loaded by dynamic external pressure. It is shown that the model type depends on the number and inertial characteristics of the reinforcing elements. The approximate method proposed here is validated by using a specially designed experiment. The approximate relations are then extended to the case of loading by a pressure pulse of finite duration.

A89-44753 Nonaxisymmetric vibrations of a ribbed cylindrical shell with allowance for shear deformations (Neosesimmetrichnye kolebaniia rebriatoi tsilindricheskoi obolochki s uchedom sdvigovykh deformatsii). P. Z. LUGOVOI and V. F. MEISH, *Prikladnaia Mekhanika* (ISSN 0032-8243), Vol. 25, May 1989, pp. 50-55. 9 Refs.

The problem of the forced vibrations of a ribbed cylindrical shell is analyzed with allowance for the discrete arrangement of ribs under short-term loads. The stress-strain state of a smooth shell is determined in the context of the linear theory of Timoshenko shells; the ribs are calculated using the theory of curvilinear rods. Numerical results are presented for a clamped cylindrical shell loaded by a nonaxisymmetric surface force. Azimuthal coordinate equations are reduced to spatially one-dimensional equations, which are then solved using the finite difference method.

A89-44730 Nonlinear resonance interactions of longitudinal and flexural waves in a ring (Nelineinyye rezonansnye vzaimodeistviia prodol'nykh i izgibnykh voln v kol'tse). D. A. KOVRIGIN and A. I. POTAPOV, *Akademiia Nauk SSSR, Doklady* (ISSN 0002-3264), Vol. 305, No. 4, 1989, pp. 803-807. 11 Refs.

Experimental studies of the nonlinear vibrations of thin rings and cylindrical shells show that the regimes of their dynamic instability are primarily nonstationary, with several natural modes taking part in the main motion. This gives rise to new nonlinear effects, such as the formation of circularly traveling waves and periodic energy exchange between the modes. Here, these effects are investigated analytically, with particular attention given to resonance triplets (three waves effectively interacting with each other due to nonlinearity).

A89-35620 A singular notched finite element for plates in bending (Singuliarnyy konechnyy element s vrezom dlia izgibaemykh plastin). E. M. DASHEVSKII and M. V. ROTTER, *Problemy Prochnosti* (ISSN 0556-171X), Feb. 1989, pp. 86-90.

A singular finite element with a Y-shaped notch is proposed for the analysis of stress concentration at the tip of sharp angle through defects in plates subjected to bending. To smooth the nonconformity between singular and regular elements, a transition singular finite element is proposed which has the same singularity as the notched element. Results obtained for a plate with a crack and a variable angle notch are presented.

A89-35654 Prospects for the application of holographic interferometry to the study of the resonant vibrations of complex systems (O perspektivakh primeneniia metoda golograficheskoi interferometrii k issledovaniu rezonansnykh kolebaniu slozhnykh sistem). I. F. OBRAZTSOV and V. A. SMIRNOV, *Raschety na Prochnost'*, No. 28, 1988, pp. 134-151.

Results of holographic interferometry studies of the behavior of plates, shells, and complex three-dimensional models of mechanical systems subjected to periodic dynamic loading are reported. Examples are presented to demonstrate the possibility of the vibration of different parts of the same structure at different frequencies. Photographs of holograms are presented.

A89-35652 A method for determining maximum dissipative characteristics in inhomogeneous shell structures (Metodika opredeleniia maksimal'nykh dissipativnykh kharakteristik v neodnorodnykh obolocheknykh konstruktsiakh). V. P. MAIBORODA and V. M. IAGANOV, *Raschety na Prochnost'*, No. 28, 1988, pp. 85-90.

An algorithm is developed for calculating the natural frequencies, modes, and damping coefficients of shell structures made of viscoelastic materials. It is shown that the presence of structural inhomogeneities in a shell contributes to the damping of vibrations. Recommendations are made concerning the optimization of the dissipative properties of viscoelastic shell structures.

A89-35487 Crack propagation in a plate with circular openings (Rasprostraneniye treshchiny v plastine s kruglymi otverstsiyami). V. P. TAMUZH, N. B. ROMALIS, N. A. DOLOTOVA, and A. L. POLIAKOV, *Mekhanika Kompozitnykh Materialov* (ISSN 0203-1272), Jan.-Feb. 1989, pp. 103-110. 7 Refs.

The effect of a regular system of small pores ahead of a crack on changes in the stress intensity factor is investigated theoretically and experimentally. Experimental determinations of the stress intensity factor are made for PMMA plates by measuring the quasistatic crack propagation rates. The calculated and experimental results are found to be in good qualitative agreement. It is shown that the presence of a damage zone ahead of a macrocrack increases the stress intensity factor.

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.

A89-30062 Dynamic behavior of engine casing shell elements under kinematic excitation (Dinamicheskoe povedenie obolocheknykh elementov korpusov dvigatelei pri ikh kinematicheskoy vzbuzhdenii). V. E. BRESLAVSKI, I. N. GINZBURG, S. M. MORDOVTSOV, and A. I. RUBANENKO, *Problemy Prochnosti* (ISSN 0556-171X), Jan. 1989, pp. 14-17.

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.

A89-21498 Nonlinear dynamics of locally weakened thin-walled structures (Nelineinaya dinamika tonkostennykh konstruktsii s lokal'nymi oslableniyami). V. I. PATSIUK and V. K. RIMSKII, *Akademiia Nauk SSSR, Izvestiia, Mekhanika Tverdogo Tela* (ISSN 0572-3299), Sept.-Oct. 1988, pp. 139-145. 7 Refs.

The kinetics and stressed state of thin-walled shells locally weakened by rectangular and circular openings is briefly examined in terms of Timoshenko's theory. A numerical analysis is then presented for the nonlinear behavior of a composite (three-section) structure in the case of the formation of free openings during its deformation.

A89-27398 Determination of vibration parameters and maximum stresses from limited strain measurements on a rotating blade row (Opredeleniye parametrov vibratsii i maksimal'nykh napriazhenii po rezul'tatam ogranichenno go tenzometrirovaniia vrashchaiushchegosia lopatochnogo ventsa). N. I. NEMTSOV, E. V. UR'EV, I. A. EVSEEV, and B. N. NIKOLAEV, *Problemy Prochnosti* (ISSN 0556-171X), Dec. 1988, pp. 95-98.

A method for processing the phase data of strain measurements on a rotating blade row is presented which makes it possible to determine vibration parameters, such as the number of node diameters, vibration decrement, frequency stratification, and stress in the maximum-stress blade. Some recommendation concerning the application of the method are given. The method has been implemented in computer software written in FORTRAN.

A89-29588 Behavior of pulse loaded plates at large deformations. V. B. IUDAEV, K. Z. KHAIRNASOV, and V. M. FAVORIN, *Mechanical behaviour of materials - V; Proceedings of the Fifth International Conference*, Beijing, People's Republic of China, June 3-6, 1987. Vol. 1 (A89-29551 11-39). Oxford and New York, Pergamon Press, 1988, pp. 785-792.

Theoretical and experimental investigations of the behavior and large deformations of thin plates subjected to dynamic loads are presented. A mathematical model is obtained to study buckling of the shell. Plate dynamic failure and buckling are found to occur much later than at static loading. The problems are solved numerically using the finite difference method.

A89-27397 Modeling of the imperfectly elastic properties of composite materials (Modelirovaniye nesovershennouprugikh svoystv kompozitnykh materialov). V. G. DUBENETS, *Problemy Prochnosti* (ISSN 0556-171X), Dec. 1988, pp. 81-86.

Governing equations for a quasi-homogeneous composite material are obtained which allow for the microstructure and imperfectly elastic properties of the components. The equations are intended for the mathematical modeling of structures exposed to dynamic loading.

A89-27388 Engineering stability of the motion of a panel in gas flow (O tekhnicheskoi ustoichivosti dvizheniya paneli v gazovom potoke). K. S. MATVICHUK, *PMTF Zhurnal Prikladnoi Mekhaniki i Tekhnicheskoi Fiziki* (ISSN 0044-4626), Nov.-Dec. 1988, pp. 93-99. 26 Refs.

Sufficient conditions are obtained for the finite- and infinite-time engineering stability and asymptotic engineering stability of a two-dimensional panel loaded by a constant force in supersonic gas flow. The regions of the engineering stability of the system are related, via the Mach number, to the positive determinacy conditions of the Liapunov functional, the small positive parameter, and solution regularity conditions for the corresponding Cauchy scalar comparison problem. Conditions leading to instability are identified.

A89-24658 A numerical analytical method for solving certain singular problems in vibration theory (Chislennooanaliticheskii metod resheniia nekotorykh singularnykh zadach teorii kolebaniy). V. A. TEMNENKO, *Dinamicheskie Sistemy* (ISSN 0203-3755), No. 7, 1988, pp. 123-132.

The paper is concerned with the use of the functional expansion method in singular vibration problems where solution constraint conditions play the role of boundary conditions. A method for the numerical implementation of the convergence conditions for functional series is described. The problem of the vibrations of a string freely suspended in a gravitational field, the problem of a vibrating flag in liquid flow, and the problem of constructing periodic solutions to the Mathieu equation are analyzed.

A89-13250 Dynamic boundary layer in shell vibration problems (Dinamicheskii pogransloi v zadachakh kolebaniy obolochek). A. L. GOL'DENVEIZER and I. U. D. KAPLUNOV, *Akademiia Nauk SSSR, Izvestiia, Mekhanika Tverdogo Tela* (ISSN 0572-3299), July-Aug. 1988, Aug. 1988, pp. 152-162. 5 Refs.

The problem of a thin axisymmetric elastic shell of revolution of arbitrary configuration undergoing steady vibrations under the effect of an exponentially varying boundary load is analyzed in the context of three-dimensional theory. Approximate methods are presented for constructing differently varying solutions to elasticity equations. The possibility of using such solutions for the approximate analysis of induced shell vibrations at frequencies beyond the scope of two-dimensional theory is discussed.

A89-14475 Equations for the vibrations of plates with a general anisotropy (Ob uravneniiakh kolebaniy plastin s obshchei anizotropiei). L. A. MOLOTOKOV, *Mathematical problems in wave-propagation theory*. 17. Leningrad, Izdatel'stvo Nauka (Zapiski Nauchnykh Seminarov LOMI. Vol. 165), 1987, pp. 122-135. 11 Refs.

The wave field in an inhomogeneous elastic layer with a general anisotropy is determined. The low-frequency part of this field satisfies the equations of the vibrations of a plate with a general anisotropy. It is shown that these equations are a generalization of well-known plate equations corresponding to special cases of anisotropy.

A88-17873 A unified set of experimental and computational aids for studying the dynamic characteristics of composite materials (Edinyi kompleks eksperimental'nykh i vychislitel'nykh sredstv dlia issledovaniia dinamicheskikh kharakteristik kompozitnykh materialov). I. P. KRASNOSHCHIEKOV and V. P. MUZYCHENKO, V. P. (Daugavpilskie Vysshee Voennoe Aviatcionnoe Inzhenernoe Uchilishche, Daugavpils, Latvian SSR); VOL'MIR, A. S. *Mekhanika Kompozitnykh Materialov* (ISSN 0203-1272), Sept.-Oct. 1987, pp. 921-925. 17 Refs.

A unified set of instruments, test stands, experimental methods, and software has been put together for the a posteriori processing of test results. The methodological base of the system includes the recently developed nonstationary rod method, modified composite Hopkinson rod method, and a relaxation test method. All three methods provide information on the hereditary properties of materials. A block diagram of the system is presented.

A88-37543 Numerical calculations of the natural vibrations of turbomachine blades using the finite element method (Chislennyye raschety sobstvennykh kolebaniy lopatok turbomashin s ispol'zovaniem MKE). O. V. REPETSKII, *Problemy Prochnosti* (ISSN 0556-171X), April 1988, pp. 31-36. 6 Refs.

Finite elements for calculating the vibrations of compressor and turbine rotor blades on the basis of shell theory are described. Calculations are carried out for wide-chord and cooled blades, shrouded blades, and blades with antivibration flanges. The numerical calculations are in good agreement with experimental data and other solutions.

A88-30118 Dynamic snap-through of an elastic shell under the effect of an impulsive load (Dinamicheskoe proshchekivanie uprugoi obolochki pod deistviem impul'snoi nagruzki). L. S. SRUBSHCHIK, *Prikladnaia Matematika i Mekhanika* (ISSN 0032-8235), Vol. 52, Jan.-Feb. 1988, pp. 97-109. 19 Refs.

An analysis of the dynamic instability 'in the large' is carried out for an elastic shallow shell under impulsive loading and for a more general nonlinear elastic continuous conservative system with Rayleigh friction and specified initial velocity. The analysis is based on an energy approach developed for the analysis of the dynamic snap-through of a nonlinear elastic system under the effect of a stationary stepped load. The dynamic stability of the system and the critical impulsive load are determined.

A88-29958 A method for the numerical solution of dynamic problems in shell theory (Metod chislennogo resheniia dinamicheskikh zadach teorii obolochek). O. S. NARAIKIN, *Prikladnaia Mekhanika* (ISSN 0032-8243), Vol. 24, Feb. 1988, pp. 30-38. 6 Refs.

An algorithm for the numerical solution of boundary value problems in the dynamics of elastic shells of revolution is presented which is based on the construction of a matrix of fundamental solutions to the resolvent system of equations. The convergence of the algorithm is demonstrated, and estimates of its accuracy are obtained. The problem of the vibrations of a shallow spherical shell is analyzed as an example, and the results obtained are compared with the known Klein-Silvester solution.

A87-35876 The use of an asymptotic method for solving problems in shell dynamics (Ob ispol'zovanii asimptoticheskogo metoda dlia resheniia zadach dinamiki obolochek). P. Z. LUGOVOI and V. F. MEISH, *Prikladnaia Mekhanika* (ISSN 0032-8243), Vol. 23, Feb. 1987, pp. 38-44. 9 Refs.

The two-dimensional problem of the behavior of a cylindrical shell under short-term nonaxisymmetric loading is described by a mathematical model based on a hyperbolic system of Timoshenko equations. The

unknowns are expanded into Fourier series in terms of the circular coordinate; a small parameter is introduced which characterizes the ratio of the shell thickness to the shell radius. The system is solved using the Laplace transform for the time coordinate and the Bubnov-Galerkin procedure for the axial coordinate. A numerical example involving a hinged cylindrical shell under nonaxisymmetric loading is presented.

A87-46119 Optimal excitation of the resonance vibrations of elastic systems (Optimal'noe возбуждение резонансных колебаний упругих систем). A. I. KOSTOGLOTOV and L. A. SHEVTSOVA, *Prikladnaia Mekhanika* (ISSN 0032-8243), Vol. 23, May 1987, pp. 23-30. 8 Refs.

The Pontriagin maximum principle is applied to the analysis of the resonance vibrations of thin cylindrical shells. Expressions are obtained for the repetition rates, widths, and switching phases of the pulses exciting linear and nonlinear resonance vibrations. It is shown that optimal excitation of vibrations is accompanied by changes in the shell frequency and pulse repetition rate. The allowance for nonlinear elasticity leads to a monotonic change in the pulse repetition rate and vibration frequency. Calculation results are presented for various loading conditions.

A87-34339 The mechanics of composite materials with local warpage in the structure (K mekhanike kompozitnykh materialov s lokal'nymi iskrivleniiami v strukture). S. D. AKBAROV, *Prikladnaia Mekhanika* (ISSN 0032-8243), Vol. 23, Jan. 1987, pp. 119-122. 6 Refs.

An approach to the solution of problems in the mechanics of composite materials with local warpage in the structure is developed on the basis of a piecewise homogeneous body model. The approach is demonstrated for the case of an infinite elastic matrix reinforced by a single locally bent layer of a filler material; the matrix and filler materials are assumed to be isotropic and homogeneous. A specific numerical example is presented.

A88-48318 Reconstruction of the stress strain state of a structural element from measurement results using R-functions (Vosstanovlenie napriazhenno-deformirovannogo sostoiianiia elementa konstruksii po rezul'tatam izmerenii s ispol'zovaniem R-funktsii). V. P. LYSENKO and S. B. SKOPINTSEV, *Samoletostroenie - Tekhnika Vozdushnogo Flota* (ISSN 0581-4634), No. 54, 1987, pp. 75-79.

Methods for reconstructing the stress-strain state of structural elements from experimental data are examined which are based on a solution obtained by using the formalism of R-functions. The efficiency of approximating within a region is compared with that of approximating at a region boundary. An optimal approximation function is derived.

Japanese Aerospace Literature This month: *Dynamic Structural Analysis*

A90-23338 Analysis of the dynamic stress concentration factor by the two-dimensional boundary element method. HIROYUKI MATSUMOTO, TADAHARU ADACHI, YOSHITAKA KAKUHAMA, and KEIICHI FUKUZAWA, *JSME International Journal, Series I* (ISSN 0914-8809), Vol. 33, Jan. 1990, pp. 37-43. 19 Refs.

Two-dimensional impulsive stresses are analyzed by the boundary element method with the Laplace transformation and the numerical inversion using the fast Fourier transformation. The condition of the stability between the length of the element and the time step is given by the analysis. The validity of the condition is confirmed by the numerical results. Under the consideration of this condition, the dynamic stress concentration factors of the circular hole, the elliptic hole and the elliptic notch in a strip are obtained from surface forces and tangential derivatives of surface displacement. It is shown that the dynamic stress concentrations are approximately ten percent larger than the static ones.

A90-20768 Nonstationary vibration of a rotating shaft with nonlinear spring characteristics during acceleration through a critical speed. YUKIO ISHIDA, TAKASHI IKEDA, SHIN MURAKAMI, and TOSHIO YAMAMOTO, *JSME International Journal, Series III* (ISSN 0914-8825), Vol. 32, Dec. 1989, pp. 575-584. 9 Refs.

The phenomena of nonstationary oscillations of a flexible rotating shaft with nonlinear spring characteristics is investigated for the case of constant acceleration and deceleration through a critical speed of a one-half order subharmonic oscillation of forward precession. Through numerical simulations, the influence of angular acceleration, λ , and the initial angular position, Ψ_0 , of a rotor unbalance on the maximum amplitude of the subharmonic oscillation is examined. The results show that: (1) the maximum amplitude depends markedly on λ and Ψ_0 , (2) in order to always pass through this critical speed with finite amplitude during acceleration, an angular acceleration greater than a certain value λ_{crit} is necessary, and (3) when λ is less than λ_{crit} , but greater than zero, the shaft's ability to pass through this critical speed depends on Ψ_0 . Experiments are performed validating these theoretical results.

A90-20767 A method of vibration analysis by use of analytical solutions together with the finite element method applications to two-dimensional acoustic problems. YOSHIHIKO URATA and TOSHI-AKI NAKAGAWA, *JSME International Journal, Series III* (ISSN 0914-8825), Vol. 32, Dec. 1989, pp. 547-553.

A method is presented for the vibration analysis of continuous bodies. The analyzed domain is divided into several subdomains, and analytical solutions are used for the regularly shaped ones. However, the finite element method is used for the irregularly shaped subdomains. The analytical solutions are transformed into relations between generalized forces and generalized displacements at nodal points located on the boundaries of the regular subdomains. The resulting relations have the same forms as those of the finite element method. Therefore, the solutions for the regular subdomains can be joined directly to the finite element method solutions for the irregular subdomains. As examples, some two-dimensional acoustic problems are analyzed by this method. It is shown that the method has more accurate results and shorter computational time when compared to using the finite element method only.

A89-43798 Experimental study of free vibration of clamped rectangular plates with straight narrow slits. KOICHI MARUYAMA and OSAMU ICHINOMIYA, *JSME International Journal, Series III* (ISSN 0914-8825), Vol. 32, June 1989, pp. 187-193.

The real-time technique of timeaveraged holographic interferometry is applied to determine the natural frequencies and corresponding mode shapes of clamped rectangular plates with straight narrow slits, and the effect of the lengths, positions, and inclination angles of slits on the natural frequencies and corresponding mode shapes is investigated. Four types of slit locations for a slit parallel with respect to the sides of a plate and a slit having various inclination angles with respect to the longer sides are considered. The natural frequencies obtained experimentally are expressed in terms of a dimensionless frequency parameter, and the results are shown graphically as a function of dimensionless slit length and inclination angle.