

# Russian and Japanese Aerospace Literature

During 1994 the *AIAA Journal* will carry selected abstracts on leading research topics from Russian aerospace literature and, as space permits, from similar Japanese literature. The topics will be chosen and the abstracts reviewed for pertinency by *AIAA Journal* editors. This month features Fracture Mechanics from Russia and Japan.

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## Russian Aerospace Literature This month: *Fracture Mechanics*

**A93-55025** Deformation and loss of stability of an atomic chain segment at the crack tip (Deformirovanie i poterya ustojchivosti uchastka tsePOCHKI atomov v verzhine treshchiny). V. M. KORNEV and YU. V. TIKHOMIROV, *PMTF - Prikladnaya Mekhanika i Tekhnicheskaya Fizika* (ISSN 0869-5032), Vol. 34, No. 3, May-June 1993, pp. 160-172. 5 Refs. Documents available from AIAA Technical Library (IAA9324).

Hirth's (1981) atomistic model is considered which describes the extension of a brittle crack in terms of kink propagation. The model represents a linear four-atom chain with interaction between the nearest neighbors; the middle link of the chain is located ahead of the crack tip and breaks as the crack propagates, while the end links model the compliance of the crystal lattice. Here, the problem of the quasi-static extension of the atomic chain at the crack tip is examined analytically using two formulations: (1) a symmetric formulation with allowance for the interaction of nonadjacent atoms and (2) a formulation without the symmetry constraint, with allowance for interaction between the adjacent atoms only. Conclusions about the applicability of the model are presented.

**A93-52974** An experimental study of the elasticity and strength characteristics of a multilayer carbon composite under shear in the reinforcement plane (Eksperimental'noe issledovanie kharakteristik uprugosti i prochnosti mnogosloynnogo ugleplastika pri sdvige v ploskosti armirovaniya). S. O. DZHANKHOTOV, TsAGI, Trudy, No. 11, 1989, pp. 63-72. 10 Refs. Documents available from AIAA Technical Library (IAA9323).

A test method involving the shear of a rigidly clamped specimen in the form of a narrow strip is used to investigate the elastic characteristics and the strength of a commonly used carbon fiber composite, KMU-3L. An analysis of the results obtained indicates that the strip shear method can be effectively used for the experimental determination of the shear modulus of composites with complex reinforcement patterns. However, in the case of cross-ply composites, such as  $\pm 30$  deg or  $\pm 45$  deg, the method underestimates the shear strength. The strength of cross-ply composites can be estimated from tests of specimens with the reinforcement pattern  $0/90$  deg  $\pm \alpha$ .

**A92-21577** Determination of the scale dependence of the strength of fiber fillers and estimation of their adhesion to the matrix from the results of tests on single fibers in a polymer block (Opredelenie masshtabnoi zavisimosti prochnosti voloknistykh napolnitelei i ot-senka ikh adgezii k matritse po rezul'tatam ispytaniy elementarnykh volokon v bloke polimera). V. P. TAMUZS, I. G. KORABEL'NIKOV, I. A. RASHKOVAN, A. A. KARKLINSH, I. A. GORBATKINA, and T. I. ZAKHAROVA, *Mekhanika Kompozitnykh Materialov* (ISSN 0203-1272), July-Aug. 1991, pp. 641-647. 10 Refs.

A method is proposed whereby the ratios of the scale dependence of fiber strength and the fiber-matrix adhesion strength are determined from the same experiment. In the experiment, a single fiber in a polymer block is tested in tension, all fiber ruptures are recorded by the acoustic emission method, and the mean length of the fragments is determined as a function of the fiber stress or strain. The results obtained by this method are in good agreement with the results of direct determinations of the strength of fibers of different lengths.

**A93-51826** Determination of stress intensity factors by the correction coefficient method (Opredelenie koefitsientov intensivnosti napryazheniy s pomoshch'yu metoda popravochnykh koefitsientov). N. M. BORODACHEV and V. A. KOL'TSOV, *Problemy Prochnosti* (ISSN 0556-171X), No. 3, 1992, pp. 12-17. 5 Refs. Documents available from AIAA Technical Library (IAA9322).

A method for determining stress intensity factors is proposed which employs correction coefficients obtained from the solution of simpler similar problems. The correction coefficients allow for the effect of various parameters (e.g., crack shape, body size and shape, loading mode, number of cracks, etc.) on stress intensity factors. The possibility of using this method for solving static and dynamic crack problems is demonstrated by an example.

**A93-47092** Using fracture mechanics for calculating the fatigue life of structures (Primenenie mekhaniki razrusheniya pri raschete ustalostnoj dolgovechnosti konstruksij). A. S. MOSTOVOJ, A. V. KIRILLOV, and A. G. PROKHOROV, *Problems of the strength and fatigue of the elements of aircraft structures* (A93-47076 19-39). Kuibyshev, Russia, Kuibyshevskij Aviatcionnyj Institut, 1990, pp. 113-118. 4 Refs. Documents available from AIAA Technical Library (IAA9319).

A method for calculating the fatigue life of structural elements is proposed which is based on a numerical implementation of a linear-discrete damage accumulation hypothesis. The stressed state of a cross section with a fatigue crack is investigated in terms of linear fracture mechanics. The theoretical results are compared with experimental data for a plate of AMg-6M aluminum alloy with a central hole.

**A93-36794** Load-bearing capacity of an aircraft wing based on the condition of compressed surface fracture (Nesushchaia sposobnost' kryla samoleta po usloviu razrusheniia szhatoi poverkhnosti). V. F. GALKIN, *Stress-strain analysis and optimal design of aircraft structures* (A93-36782 14-39). Moscow, Izdatel'skii Otdel TsAGI, 1992, pp. 105-110. 3 Refs. Documents available from AIAA Technical Library (IAA9314).

A simple physically meaningful method is proposed which makes it possible to determine the fracture-causing bending moment in the cross section of a wing and the safety margin with sufficiently high accuracy without the use of a computer. The method is based on a fracture condition for a surface under compressive loading. The validity of the fracture criterion proposed here is demonstrated experimentally for an H-beam of D16T alloy. Calculations for a compressed wing section of V95pchT2 alloy are found to be in good agreement with static test results.

**A92-23501** Role of inertial and elastic forces in dynamic fracture in the plastic region (Rol' inertsionnykh i uprugikh sil pri dinamicheskom razrushenii v plasticheskoi oblasti). A. G. IVANOV, *Akademiia Nauk SSSR, Doklady* (ISSN 0002-3264), Vol. 321, No. 1, 1991, pp. 28-32. 15 Refs.

The relative contributions of inertial and elastic forces to the dynamic fracture of materials in the plastic region are investigated with reference to recent research related to this problem. Approaches emphasizing the inertial forces and those emphasizing the elastic forces are examined analytically. Arguments are presented in support of the latter approach.

**A93-36785 Methodology for studying the fracture of aircraft structures in static tests (Metodologiya issledovaniia razrusheniia aviatsionnykh konstruktsei pri staticheskikh ispytaniakh).** V. F. KUT'INOV, G. N. ZAMULA, V. F. MOKHOV, K. M. IERUSALIMSKII, and V. P. FOMIN, *Stress-strain analysis and optimal design of aircraft structures* (A93-36782 14-39). Moscow, Izdatel'skii Otdel TsAGI, 1992, pp. 29-39. 4 Refs. Documents available from AIAA Technical Library (IAA9314).

A methodology is presented for the statistical analysis of the existing data base on the fracture of aircraft structures in static tests. Examples of the processing of test results are presented, and the use of application software for the extraction, classification, and organization of fracture data is described. A procedure is also presented for determining the additional safety coefficients for structures that have not passed static tests.

**A93-31092 Fractal decomposition of elastic fields in fracture (Fraktal'nyi raspad uprugikh polei pri razrushenii).** A. B. MOSOLOV, *Zhurnal Tekhnicheskoi Fiziki* (ISSN 0044-4642), Vol. 62, No. 6, June 1992, pp. 23-32. 21 Refs. Documents available from AIAA Technical Library (IAA9311).

A fractal model of elastic field decomposition during crack propagation is proposed which is based on the concept of the hierarchical structure of the fractured zone and on the self-similarity of multiple fracture processes. The model is used to investigate the asymptotics of elastic fields at the crack tip in a granular medium. A cascade of cracks and fissures at the fracture site is treated as a fractal cluster; the process of energy radiation from an earthquake epicenter is described. A scaling relation between the seismic energy and the characteristic size of the epicenter is obtained which generalizes the known Sadovskii formula. The dynamic behavior of a crack is described with allowance for the fractal nature of elastic field decomposition at its tip.

**A93-23135 Cyclic fracture toughness and fracture characteristics of VT22 titanium alloy at low temperatures (Tsiklicheskaia treshchinnost' i kharakter razrusheniia titanovogo splava VT22 pri nizkikh temperaturakh).** L. F. IAKOVENKO, I. A. POKHIL, N. M. GRINBERG, and F. F. LAVRENT'EV, *Fiziko-Khimicheskaiia Mekhanika Materialov* (ISSN 0430-6252), Vol. 28, No. 2, Mar.-Apr. 1992, pp. 81-85. 14 Refs. Documents available from AIAA Technical Library (IAA9307).

The cyclic fracture toughness of VT22 titanium alloy was investigated at atmospheric pressure and in vacuum at room and low temperatures. Partial kinetic diagrams of fatigue fracture are presented. It is found that, in vacuum, the crack growth rate curve shifts toward higher values of the maximum cycle stress intensity factor as compared with tests in air. A decrease in test temperature leads to a change in the curve slope, producing intersecting curves. The general characteristics of the fatigue fracture of the alloy are discussed.

**A93-23130 A model of plasticity bands in elastic-plastic fracture mechanics problems (Model' smug plastichnosti v pruzhnoplastinikh zadachakh mekhaniki ruinovannia).** V. V. PANASIUK and M. P. SAVRUK, *Fiziko-Khimicheskaiia Mekhanika Materialov* (ISSN 0430-6252), Vol. 28, No. 1, Jan.-Feb. 1992, pp. 49-68. 203 Refs. Documents available from AIAA Technical Library (IAA9307).

Theoretical solutions to elastic-plastic fracture mechanics problems in which plastic regions are modeled by slip bands are reviewed. Experimental studies of the phenomenon of plastic deformation localization in thin layers near cracks are also examined. Attention is given to two-dimensional problems concerning the evolution of plasticity bands in bodies with cracks under conditions of plane stress state, plane deformation, and longitudinal shear as well as the corresponding axisymmetric and three-dimensional problems. The discussion also covers the use of plasticity band models in bending problems for plates and shells with cracks.

**A93-12934 Dual estimates in flexible structure design problems (Dvoistvennye otsenki v zadachakh proektirovaniia uprugikh konstruktsei).** L. V. PETUKHOV, *Prikladnaia Matematika i Mekhanika* (ISSN 0032-8235), Vol. 56, No. 3, May-June 1992, pp. 434-441. 5 Refs. Documents available from AIAA Technical Library (IAA9302).

The paper is concerned with minimum-volume problems for two- and three-dimensional structures with stress constraints that are defined as strength theory conditions and used for a variety of materials. For such optimum design problems, dual problems are formulated which can be used for estimating optimal or nearly optimal designs. Examples of dual estimates for three optimal design problems are presented.

**A92-15030 Limiting state of a surface under thermal loading (Predel'noe sostoianie poverkhnosti pri termicheskoi vozddeistvii).** V. M. POLIAEV, A. N. GENBACH, and A. A. GENBACH, *Teplofizika Vysokikh Temperatur* (ISSN 0040-3644), Vol. 29, Sept.-Oct. 1991, pp. 923-934. 8 Refs.

An analysis is carried out to determine heat fluxes and thermal stresses produced in rocks and also in the metal walls of combustion chambers and nozzles by a high-temperature supersonic gas jet. It is shown that the fracture mechanism of metals is essentially different from that of rocks; some of their thermomechanical properties are also different. Nevertheless, based on a solution for the heat conductivity equation with boundary conditions of the second kind, an analogy is established between the behaviors of these materials, and expressions are obtained which make it possible to predict and prevent the limiting states of vapor-generating surfaces and to select optimal thermal loads for fracturing rocks.

**A93-12752 Prediction of the inelastic deformation and fracture of composite laminates (Prognozirovanie neuprugogo deformirovaniia i razrusheniia sloistykh kompozitov).** V. E. VIL'DEMAN, I. V. SOKOLKIN, and A. A. TASHKINOV, *Mekhanika Kompozitnykh Materialov* (ISSN 0203-1272), No. 3, May-June 1992, pp. 315-323. 12 Refs. Documents available from AIAA Technical Library (IAA9302).

A structural/phenomenological model of the deformation of multilayer transversally isotropic materials is proposed which employs micro- and macrodamage tensors and concepts of plasticity theory for anisotropic media. Results of a computer simulation of the inelastic deformation of composite laminates in the case of a complex stressed state are presented for metal/polymer (copper/polycarbonate) and metal/metal (aluminum/magnesium) composites. Expressions are obtained which relate the residual stresses generated during unloading to the prestress level.

**A93-10107 Crack growth and fracture in creep (Rost treshchin i razrushenie v usloviakh polzuchesti).** V. V. BOLOTIN and B. V. MINAKOV, *Rossiiskaia Akademiia Nauk, Izvestiia, Mekhanika Tverdogo Tela* (ISSN 0572-3299), No. 3, May-June 1992, pp. 147-156. 15 Refs. Documents available from AIAA Technical Library (IAA9301).

A theory of crack growth in creep is developed which is based on the synthesis of fracture micro- and macromechanics. Crack growth is treated as a process involving alternating states of stability and instability, with allowance made for the microdamage accumulated near the crack fronts. Particular attention is given to the calculation of generalized fracture mechanics forces for materials subject to creep and to the effect of various factors on these forces, crack growth rate, and time to final fracture.

**A92-44111 Fracture of composite materials at high temperatures and under finite strains (Razrushenie kompozitnykh materialov pri vysokikh temperaturakh i konechnykh deformatsiiakh).** I. U. DIM-ITRIENKO, *Mekhanika Kompozitnykh Materialov* (ISSN 0203-1272), No. 1, Jan.-Feb. 1992, pp. 43-54. 8 Refs. Documents available from AIAA Technical Library.

A model is developed to study elastomer porous composite materials under large strains and at high temperatures. The model makes it possible to describe finite deformations, damage and thermomechanical destruction, coking shrinkage, heat and mass transfer, and gas filtration in pores of composites. The model is described by a system of integral-differential equations. A cylindrical heat-resistant shell made of an elastomer composite in internal high-temperature gas flow is analyzed using the proposed model. Results indicate that finite strains substantially affect heat-mass transfer, filtration, and thermomechanical surface destruction of the composite material.

**A92-44110 The brittle fracture characteristics of dispersely filled composites under different adhesive conditions (Zakonno-mnosti khрупkogo razrusheniia dispersno-napolnennykh kompozitov v razlichnykh usloviakh adgezionnoi svyazannosti).** V. G. OSHMAN, *Mekhanika Kompozitnykh Materialov* (ISSN 0203-1272), No. 1, Jan.-Feb. 1992, pp. 34-42. 5 Refs.

Mechanisms of interface debonding and fracture in composite materials are analyzed using the energy criterion of crack propagation in the elastic media. It is found that, for ideal bonds, the composite strength increases with the filling due to the increasing rigidity and surface deformation. For low adhesive strengths, the composite strength decreases due to reduction of elastic moduli and fracture surfaces. When the adhesive fracture accompanies the crack propagation and occurs in the front points or in their vicinity, the composite strength increases with the filling. For certain ratios of adhesive/cohesive fracture parameters, composite strength values can exceed the values associated with ideal bonds.

**A92-28375 Determination of the edge effect region in the case of filler rupture in weakly reinforced composites (Viznachennia oblasti kraiovikh effektiv pri rozrivu napovniuvacha v slabarmovaniikh kompozitakh).** O. M. GUZ', I. V. KOKHANENKO, and O. S. IAKOVLEVA, *Akademiia Nauk Ukrain'skoi RSR, Dopovidi, Matematika, Prirodoznastvo, Tekhnichni Nauki* (ISSN 0868-8052), July 1991, pp. 42-44. 7 Refs.

The extension of edge effect regions in weakly reinforced composite laminates is investigated numerically in the case of the presence of two parallel interacting cracks in the filler layer. The approach used here is based on the use of three-dimensional linearized elasticity equations and modeling of the composite by a piecewise homogeneous medium consisting of homogeneous rigidly connected bodies. Edge effect regions are shown for various values of the ratio of the elasticity moduli of the filler and the matrix.

**A92-27548 Generalization of the method of equivalent stressed states for determining the crack opening displacement for a crack of arbitrary type (Uzagal'nennia metodu ekvivalentnykh napruzhenikh staniv dlia viznachennia rozkrittia trishchini dovil'nogo tipu).** I. M. PAN'KO and N. I. TIM'IAK, *Fiziko-Khimicheskaiia Mekhanika Materialov* (ISSN 0430-6252), Vol. 27, July-Aug. 1991, pp. 44-47. 6 Refs.

Based on the deformation approach in nonlinear fracture mechanics, the method of equivalent stressed states is used to determine the crack opening displacement for arbitrary mechanisms of crack propagation. Results are presented for a transverse shear crack in a plate and an antiplane shear crack formed under torsion in a cylindrical specimen with an external circular crack. The simplicity of the method of equivalent stresses makes it suitable for a variety of engineering applications.

**A92-36424 Prediction of the consolidation of dispersed defects (Prognozirovanie ob'edineniia rasseiannykh defektov).** S. R. IGNATOVICH, *Problemy Prochnosti* (ISSN 0556-171X), No. 2, 1992, pp. 71-78. 10 Refs. Documents available from AIAA Technical Library.

Three different models describing the consolidation of dispersed cracks in the bulk and on the surface of materials are examined. One model uses crack length distributions, while another model uses only numerical characteristics of such distributions. The third model determines the probability of the coalescence of a maximum length crack with any neighboring crack. The relations presented here can be used to predict defect consolidation based on the number and size of the accumulated defects and time.

**A92-27481 Effect of a local stress field near cracks and inclusions on flow of gradient-type physical substances (Vpliv lokal'nogo polia napruzhenn' bilia trishchin i vkluchchen' na potik fizichnoi substantzii gradientnogo tipu).** V. V. PANASIUK and M. G. STASHCHUK, *Akademiia Nauk Ukrain's'koi RSR, Dopovidi, Matematika, Prirodoznavstvo, Tekhnichni Nauki* (ISSN 0868-8052), March 1991, pp. 50-52. 6 Refs.

The effect of stress-strain field on flows of physical substances near the tip of a crack or an inclusion is investigated on the basis of the known laws of thermodynamics and linear fracture mechanics. A differential equation is obtained and solved by the method of separation of variables. An analytical expression is obtained which relates the physical substance concentration at the tip of a crack or a rigid inclusion to the corresponding stress intensity factors.

**A92-25311 Effect of mechanical layer characteristics on the internal instability of a composite (Vliianie mekhanicheskikh kharakteristik sloev na vnutrenniuiu neustoiichivost' kompozita).** I. A. GUZ', *Prikladnaia Mekhanika* (ISSN 0032-8243), Vol. 27, Dec. 1991, pp. 110-114. 10 Refs.

The effect of the mechanical characteristics of the filler and the matrix on the critical deformation of a layered composite is investigated in the context of three-dimensional nonaxisymmetric and plane problems. The analysis is carried out on the basis of the second version of the theory of small subcritical deformations in the three-dimensional linearized stability theory for deformable bodies. Expressions are presented which relate the critical deformation to each of the mechanical properties of the layers.

**A92-25279 Engineering composite mechanics in the USSR (Inzhenernaia mekhanika kompozitov v SSSR).** I. U. M. TARNOPOL'SKII, *Mekhanika Kompozitnykh Materialov* (ISSN 0203-1272), Sept.-Oct. 1991, pp. 787-795. 73 Refs.

Recent theoretical and experimental research in the field of engineering composite mechanics conducted in the USSR is briefly reviewed. In particular, attention is given to the micromechanics and macromechanical approaches to the study of composites; composite strength theories; the principle of energy smoothing; and development of generalized methods for the strength analysis of composite structures. The discussion also covers the development of specialized theories accounting for the specific structural properties of composites and studies of the fracture modes of composites.

**A92-25277 Effect of biochemical treatment on the strength and adhesion properties of fibers of poly-n-aminobenzimidazole (Vlianie biokhimicheskoi obrabotki na prochnostnye i adgezionnye svoistva volokon iz poli-n-aminobenzimidazola).** A. I. SVIRIDENOK, T. K. SIROTINA, E. V. PISANOVA, and S. F. ZHANDAROV, *Mekhanika Kompozitnykh Materialov* (ISSN 0203-1272), Sept.-Oct. 1991, pp. 771-776. 6 Refs.

The properties of poly-n-aminobenzimidazole fibers exposed to microorganisms were investigated experimentally. It is shown that the biochemical modification of the fiber surface improves the wetting properties of the fibers with respect to thermoplastic melts and contributes to a better fiber-substrate adhesion. Fiber modification is also shown to produce changes in the fracture mode of the fibers and to increase the average fiber strength.

**A92-23588 Relationship between the fatigue fracture diagram and the fatigue curve (Sviaz' mezhdu diagrammoi ustalostnogo razrusheniia i krivoi ustalosti).** A. V. PROKOPENKO, A. M. KHUTYZ, A. G. KRYGIN, and V. M. STEPKOV, *Problemy Prochnosti* (ISSN 0556-171X), Nov. 1991, pp. 38-44. 13 Refs.

A method is developed for converting the fatigue curve to the fatigue fracture diagram. The method involves solving a system of three equations of the number of cycles to fracture for different levels of variable stress, determined by integrating the dependence of the crack growth rate on the stress intensity factor. The validity of the method has been demonstrated using fatigue and fracture toughness data in the literature.

**A92-18349 Diagnosing piecewise constant stiffness in the presence of nonlinear resonances (K diagnostike kusochno-postoiannoi zhestkosti pri nelineinykh rezonansakh).** N. P. PLAKHTIENKO, *Prikladnaia Mekhanika* (ISSN 0032-8243), Vol. 27, Oct. 1991, pp. 112-120. 8 Refs.

The effect of a transverse crack in a cantilever specimen on the stiffness coefficient is estimated for different bending directions. The problem of n-th order resonances is solved for a single-degree-of-freedom system with a piecewise linear recovery force characteristic. Approximate analytical expressions are obtained for calculating the amplitude-phase-frequency curves for n-th order resonances.

**A92-23587 Two-criterion estimation of the limiting state of a body with a crack under asymmetric loading (Dvukhkriterial'naia otsenka predel'nogo sostoiianiia tela s treshchinoi pri nesimmetrichnom nagruzhении).** I. V. ORYNIAK and V. M. TOROP, *Problemy Prochnosti* (ISSN 0556-171X), Nov. 1991, pp. 32-38. 35 Refs.

Ways of obtaining correct fracture toughness characteristics in the case of longitudinal and transverse shear are examined. The use of effective stress intensity factors, calculated in the context of the theory of maximum tensile stresses, is proposed for determining the limiting state and the critical brittleness temperatures under combined loading. An approximate method is proposed for deriving a weight function for cracks under conditions of asymmetric loading.

**A92-23568 Structure of a plane fracture wave in brittle bodies (Struktura ploskoi volny razrusheniia v khрупkikh telakh).** A. V. TALONOV and B. M. TULINOV, *Akademiia Nauk SSSR, Izvestiia, Mekhanika Tverdogo Tela* (ISSN 0572-3299), Nov.-Dec. 1991, pp. 102-107. 13 Refs.

The propagation of a plane fracture wave in a brittle material is examined using a model of a medium weakened by a large number of microcracks. The evolution of the fracture process in time is considered with allowance for changes in the deformation properties of the medium. The effect of cracking kinetics on the structure of the fracture wave is demonstrated.

**A92-23508 The 'quantum' nature of the dynamic fracture of brittle media (O 'kvantovoi' prirode dinamicheskogo razrusheniia khрупkikh sred).** I. U. V. PETROV, *Akademiia Nauk SSSR, Doklady* (ISSN 0002-3264), Vol. 321, No. 1, 1991, pp. 66-68. 11 Refs.

The dynamic behavior of brittle bodies is characterized by certain effects that cannot be explained on the basis of classical criteria. It is shown here that by considering the physical discreteness of dynamic rupture, it is possible to resolve some of the contradictions of the classical theory. The concept of the 'quantum' nature of dynamic fracture and the corresponding criteria make it possible to avoid the use of a priori dynamic strength curves.

**A92-21679 Long-term fracture of a plate of an orthotropic viscoelastic composite with a central crack under constant loading (Dlitel'noe razrushenie plastiny iz ortotropnogo vliakouprugogo kompozita s tsentral'noi treshchinoi pri postoiannoi nagruzhke).** A. A. KAMINSKII and S. A. KEKUKH, *Prikladnaia Mekhanika* (ISSN 0032-8243), Vol. 27, Nov. 1991, pp. 77-84. 14 Refs. Documents available from AIAA Technical Library (IAA9207).

The long-term fracture behavior of an orthotropic viscoelastic composite plate due to the subcritical propagation of a central normal tearing crack under constant loading is investigated analytically using a modified version of the delta-c model. The problem is stated in the context of the Volterra theory for integral operators. The final expressions are obtained for resolvent finite operators with kernels in the form of the Rabotnov fractional exponential function.

**A92-21539 Fractal J-integral in fracture (Fraktal'nyi J-integral v razrushenii).** A. B. MOSOLOV, *Pis'ma v Zhurnal Tekhnicheskoi Fiziki* (ISSN 0320-0116), Vol. 17, Oct. 12, 1991, pp. 45-50. 10 Refs.

The behavior of the J-integral in a fractal model of a crack is examined. It is shown, in particular, that in the case of fractal cracks, the J-integral is no longer invariant. By redefining the conditions of fracture, an invariant fractal Jf-integral is proposed which is similar to a J-integral for a V-notch with an opening angle of 2 beta. The problem of a plane punch with fractal surface roughness is considered as an example.

**A92-15068 Durability of structurally stable nickel alloys (Dolgovechnost' strukturno-stabil'nykh nikelovykh splavov).** I. I. TRUNIN, S. A. IUGANOVA, and I. U. V. KASHIRSKII, *Metallovedenie i Termicheskaiia Obrabotka Metallov* (ISSN 0026-0819), No. 11, 1991, pp. 13-15. 6 Refs. Documents available from AIAA Technical Library (IAA9203).

Fracture processes occurring in nickel alloys during creep are analyzed mathematically. A formula is proposed which can be used for estimating the life of high-temperature nickel alloys. The validity of the formula is supported by experimental data on Ni-Cr-Al-Ti alloys.

**A92-12786 Cracks with a fractal surface (Treshchiny s fraktal'noi poverkhnost'iu).** R. V. GOL'DSHTEIN and A. B. MOSOLOV, *Akademiia Nauk SSSR, Doklady* (ISSN 0002-3264), Vol. 319, No. 4, 1991, pp. 840-844. 5 Refs.

Theoretical considerations concerning cracks with a fractal surface are presented. In the framework of this theory, fracture is considered as a multilevel (multifractal) process.

**A92-12781 Asymptotic relations, acceleration of fracture, and subcritical crack growth under creep (Asimptoticheskie sootnosheniia, akseleratsiia razrusheniia i dokriticheskii rost treshchiny pri polzuchestii).** A. M. LIN'KOV, *Akademiia Nauk SSSR, Doklady* (ISSN 0002-3264), Vol. 319, No. 3, 1991, pp. 585-589. 15 Refs.

The crack-tip-zone problem taking creep into account is investigated on the basis of asymptotic relations linking the displacement rupture with forces. These relations are used to establish the acceleration of fracture in a specific range of parameters. Numerical results are presented, and stationary motions and subcritical crack growth under creep are indicated.