VOLUME 14, NO. 9
SEPTEMBER 1982

THE SHOCK AND VIBRATION DIGEST

A PUBLICATION OF
THE SHOCK AND VIBRATION
INFORMATION CENTER
NAVAL RESEARCH LABORATORY
WASHINGTON, D.C.

OFFICE OF
THE UNDER
SECRETARY
OF DEFENSE
FOR RESEARCH
AND
ENGINEERING

THE SHOCK AND VIBRATION DIGEST

Volume 14, No. 9
September 1982

A publication of

THE SHOCK AND VIBRATION INFORMATION CENTER

Code 5804, Naval Research Laboratory
Washington, D.C. 20375

The Shock and Vibration Digest is a monthly publication of the Shock and Vibration Information Center. The goal of the Digest is to provide efficient transfer of sound, shock, and vibration technology among researchers and practicing engineers. Subjective and objective analyses of the literature are provided along with news and editorial material. News items and articles to be considered for publication should be submitted to:

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SVIC NOTES

Higher levels of performance are being demanded from many new systems, and more stringent design requirements are being imposed at the same time. Further, some new systems will be expected to survive or function properly in more demanding dynamic environments; other systems will be constrained to limited amounts of motion to satisfy the performance requirements of on-board equipment.

These trends will continue and they may require new materials or possibly new fabrication techniques. Therefore, effective system design in the future will require integrating the dynamics and the materials technologies. Because the overall design process might be tailored to the properties of the materials, and possibly even the fabrication methods, it will be essential for all who are so involved to thoroughly understand materials behavior and how they affect a system's dynamic performance.

Controlling a system's dynamic response is a major consideration in any dynamics design and analysis effort, and damping, or the dissipation of energy, is an important consideration. Many forms of damping exist and all materials exhibit damping to some extent. Most built-up structures combine several forms of damping, e.g., inherent damping in materials, damping in joints and the like. At the present time, this structural damping can only be determined experimentally, and a few have wondered if the measured values represent those encountered in service. This question remains to be answered, but it is virtually impossible to predict the value of structural damping in most systems because many damping mechanisms exist. Another complicating factor is the wide scatter in the value of damping in nominally identically fabricated structures. Nevertheless some applications may arise in the future where it will be necessary to rely on structural damping alone to control a system's dynamic response, therefore, accurate methods for predicting structural damping values are needed. Further research into the phenomena of structural damping will be required before valid prediction methods can be developed.

An early effort to integrate the materials and the dynamics technologies was to use constrained or free layers of polymeric materials to add damping to structures and control their resonant response. This mode of response control will be more important than structural damping in the foreseeable future for several reasons. The added damping technology base is well established, and polymeric materials subjected to cyclic strain dissipate energy more readily than some of the more commonly used structural materials. In the past, these added damping treatments could only be considered as "design fixes," and they were successful because they were properly engineered. The damping technology has advanced. The recent shock and vibration technical literature contains an increasing number of papers on the dynamic behavior of viscoelastically damped structures; thus, it will be possible to design viscoelastic damping treatments into structures at an early stage to prevent noise and vibration problems from occurring. The possibility of more demanding design and performance requirements, coupled with the potentially more adverse dynamic environments, will dictate that added damping treatments should be designed into future systems at an early stage if they are to be effective.

R.H.V.

EDITORS RATTLE SPACE

53rd SHOCK AND VIBRATION SYMPOSIUM

This issue of the DIGEST contains the preliminary program for the 53rd Shock and Vibration Symposium. It will be held at Danvers, Massachusetts (near Boston), from October 26 through 28. As in past years the Symposium program contains papers on a variety of technical subjects. This is the only meeting in the shock and vibration community that contains a mixture of papers on theory and practice in which both mathematical and experimental techniques are used for problem solution. In addition to the unique technical program are other advantages for those attending the Symposium.

The plenary talks provide state-of-the-art reviews and surveys of the technology in specialized topic areas. These talks, given by emminent scientists, are often used as a forum for new ideas and challenges. I am sure that Dr. Ungar, who is this year's Elias Klein Memorial lecturer, will present a stimulating lecture; his topic is microelectronics manufacturing.

The panel sessions and short paper sessions add the informality of open discussion and exchange of ideas necessary for a successful meeting. A panel session on the important MIL STD 810D is scheduled for Tuesday evening.

Only individuals who have consistently attended opening sessions at past Symposia realize its value in providing information on the most recent developments in military and public sectors. Through the years these sessions have been consistently interesting; they contain factual information that is not assembled anywhere else at one meeting.

Finally as in any meeting or symposium the interchange of the attendees, whether they are observers or participants, is of inestimable value. Although attendance at such a meeting is often considered a luxury by management, it is true that the technical leaders in any field reinforce their positions by regular attendance at such meetings as the Symposium.

R.L.E.

SHOCK AND VIBRATION INSTRUMENTATION

R. Plunkett*

Abstract. This article reviews the current state of the art of transducers, signal processing methods, and novel methods.

This is the fourth article in this Journal on shock and vibration instrumentation. The first in April, 1969, was a discussion of general measurement methods with no bibliography. The second in December, 1976, was an annotated listing of 87 references on signal processing, instrumentation, measurement of material properties, and diagnostics. The third in June, 1979, briefly discussed recent development in transducers and digital signal processing.

Because of the extensive series of specialist articles that now appear in the **Shock and Vibration Digest,** the author thinks it appropriate to confine his attention to comments on the current state of the art in transducers, modern signal processing methods, and references containing detailed information. First let us consider a few references to novel methods that have appeared in the past three years.

CURRENT LITERATURE

Optical methods continue to be developed. Fluid mechanicians have developed laser doppler techniques to a useful level. This method has been adapted to a non-contacting torsional probe [1]; Cookson and Bandyopadhyay provide details [2]. Bedore describes an optical system for measuring relative motion [3]. Buschmann describes a scattered light displacement probe for large deflections, 0.1 to 30 mm [4]. Cook, Hamm, and Akay [5] give a nice analysis of the operating principles of a fiber optic displacement gage that has been commercially available from MTI for about ten years; they also discuss differentiating the displacement signal to measure velocity and acceleration.

Fox [6] continues to develop his rotating, vibrating beam system for measuring low frequency angular vibration but it is not yet available commercially. Vomel claims high sensitivity for an electret transducer [7]. Crowson et al [8] describe an ingenious high force pulse generator that has been successfully used during the past eight years.

SPECTRAL ANALYSIS

More generally, there has been an extremely rapid development of digital spectrum instruments for shock and vibration data reductions. The S/V Sound and Vibration Buyer's Guide Issue (March 1981) lists 11 suppliers. Several oscilloscopes with FFT plug-ins are not listed in the Guide. It has become difficult to make a rational choice of equipment. Among the criteria that must be considered are resolution (8 to 14 bit), maximum sample frequency, numbers of channels, computing speed, computing flexibility versus simplicity, portability, and compatibility of output with other computers. The cost ranges from about $2000 for a single-channel FFT oscilloscope plug-in to about $100,000 for a complete multi-channel processor with a dedicated minicomputer. Some care should be taken in deciding whether a two-channel transfer analyzer with 1024 lines (512 per channel) and transfer and coherence capability will do the job (about $10,000) or whether 4096 lines and correlation functions are necessary (about $20,000). There is no unbiased source of information; almost all articles in the trade journals are written by manufacturers' engineers. The best source of mathematical information is still Otnes and Enochson [9, 10]. Newland [11] gives a nice introduction to the subject. All of the manufacturers publish handbooks that describe the uses and abuses of their particular products; the most comprehensive is that of B & K [12].

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TRANSDUCERS AND INSTRUMENTS

The two most widely used measurement devices for shock and vibration work are strain gages and accelerometers. These days, almost all strain gages are foil, usually epoxy backed. Used with modern d.c. signal conditioners they are good to one microstrain and have a very low noise background. Many can be used up to strains of several percent, and this can be exceeded by clip gages. Holman [13] has written a good introduction to strain gages and lists many characteristics. A welcome development is the ready availability of self-temperature compensating gages.

Harris and Crede [14] remains the standard reference for accelerometers and other pickups. The only real change in accelerometers has been the development of units resistant to extreme environments of pressure, temperature, and radiation. Stable charge amplifiers eliminate cable loading, and integral microelectronics provide stability. Almost all high frequency accelerometers use polarized ferroelectric ceramics or sensing elements. As a result, they have roughly the same sensitivity for the same mass and resonant frequency.

There has been little development in inductive velocity pickups; most of the ones on the market are of old, well tried design. Their major use is for vibration monitoring in which their rugged construction overcomes the handicap of high weight, low resonant frequency, and sensitivity to electromagnetic pickup. When velocity is wanted for research purposes, it is usually obtained by integrating an accelerometer signal electronically.

Displacement pickups are available in many forms. The most versatile contacting pickups are linear variable differential transformers that can be made extremely rugged by potting. Non-contacting devices use fiber optics [5], eddy current impedance bridges, and laser doppler and capacitance bridges. Interferometric methods have proven useful for hypervelocity measurements in shock but such measurements are specialized.

It seems unlikely that any new principles will be widely applied to shock and vibration instrumentation within the next few years. What we can look forward to is small but steady improvement in current transducers and continuing reduction in the cost of digital data processing. If current trends persist, the trade off in data analysis systems will continue to be between versatility and simplicity of operation. A series of articles referred to in the last article has appeared in book form [15].

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LITERATURE REVIEW: survey and analysis of the Shock and Vibration literature

The monthly Literature Review, a subjective critique and summary of the literature, consists of two to four review articles each month, 3,000 to 4,000 words in length. The purpose of this section is to present a "digest" of literature over a period of three years. Planned by the Technical Editor, this section provides the DIGEST reader with up-to-date insights into current technology in more than 150 topic areas. Review articles include technical information from articles, reports, and unpublished proceedings. Each article also contains a minor tutorial of the technical area under discussion, a survey and evaluation of the new literature, and recommendations. Review articles are written by experts in the shock and vibration field.

This issue of the DIGEST contains articles about current methods for analyzing dynamic cable response and nonlinear analysis of beams.

Dr. H. Migliore of Portland State University, Portland, Oregon and Dr. R.L. Webster of Brigham City, Utah have written a paper outlining developments since 1979 on the current methods for analyzing dynamic cable response. Emphasis is on ocean engineering applications and closely related activities.

Professor M. Sathyamoorthy of Clarkson College of Technology, Potsdam, New York has written Part II of his article on nonlinear analysis of beams. In Part I, classical methods of analysis for nonlinear beam problems were reviewed. In recent years, finite element methods have often been used for nonlinear static and dynamic analysis of beams and beam-type structures. Part II is a review of such literature.

NONLINEAR ANALYSIS OF BEAMS
PART II: FINITE ELEMENT METHODS

M. Sathyamoorthy*

Abstract. In Part I, classical methods of analysis for nonlinear beam problems were reviewed. In recent years, finite element methods have often been used for nonlinear static and dynamic analysis of beams and beam-type structures. Part II is a review of such literature. The search attempts to cover all the publications from the earliest research in this area.

It is often necessary to obtain approximate numerical solutions to engineering problems as a practical alternative to exact closed-form solutions. With a minimum of simplifying assumptions it is now possible to solve complex problems encountered in many engineering situations by means of the finite element method. A finite element model of a problem provides a piecewise approximation of the governing equations. The method is based on the assumption that a solution region can be analytically approximated by replacing it with an assemblage of discrete elements. These elements can be assembled in many different ways and thus are convenient to use to represent exceedingly complex shapes. The success of the finite element method depends largely on the choice of the shape functions used in the solution process. Since the evolution of digital computers, the finite element method has become widely used to solve many types of problems.

Nonlinear methods of analysis have recently gained attention because of increasing need for efficient design of structural elements. Significant theoretical and computational advances in the nonlinear analysis of structural elements have been made in recent years [1]. Many computer analyses have been carried out, and a number of general purpose computer programs have been developed. Furthermore, extension of the finite element method to the study of nonlinear behavior of both material and geometric-type nonlinear problems has resulted in more realistic models and design methods. Nevertheless, a great deal of work remains to be carried out, particularly in nonlinear analysis.

In Part I various types of nonlinearities were reviewed [1], and the governing nonlinear equations for each case were given. If a static nonlinear problem is considered in which a flexible member undergoes large deformation, the expression for the curvature becomes

$$\frac{1}{R} = \pm \frac{d\theta}{ds} \tag{1}$$

where

$$\frac{dw}{ds} = \sin\theta \tag{2}$$

s is measured along the deformed axis of the member, θ is the slope of the axis of the member, and w is the lateral displacement. Differentiation of equation (2) and substitution in equation (1) gives

$$\frac{1}{R} = \pm \frac{\dfrac{d^2w}{ds^2}}{\left[1-\left(\dfrac{dw}{ds}\right)^2\right]^{1/2}} \tag{3}$$

The strain energy in bending is

$$\begin{aligned} U &= \frac{EI}{2}\int_0^{\ell} \left(\frac{1}{R}\right)^2 ds \\ &= \frac{EI}{2}\int_0^{\ell} \left(\frac{d^2w}{ds^2}\right)^2 \left[1 - \left(\frac{dw}{ds}\right)^2\right]^{-1} ds \end{aligned} \tag{4}$$

The nonlinear stiffness equations can be generated using equation (4) for the total potential after the element and the interpolating functions within the

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element are fixed. The equations for a single element can be expressed as

$$\frac{\partial U^{e*}}{\partial q_i} - \lambda P_i^{\ e} = 0 \qquad (5)$$

U^{e*} stands for non-dimensional strain energy and P_i^e for the generalized forces respectively of an element; λ is a load parameter, and q_i are generalized coordinates.

The nonlinear stiffness equations for an entire structure can be formed by the usual assemblage of elements into the global equilibrium set. This procedure results in a set of nonlinear algebraic equations that can be solved by such techniques as step-by-step method, Newton-Raphson method, or variable interpolation. The nonlinearity considered here is geometric in nature due to the nonlinear curvature-displacement relationship shown in equation (3). A similar procedure could be used to solve problems with other types of nonlinearities [1].

FINITE ELEMENT METHOD

The finite element method has long been used for the analysis of linear problems. Applications concerning structures and structural elements date from the early 1940s. A number of books and papers are available. For a historical note on the finite element method and references concerning linear problems the reader is referred to the book by Desai [2]. Application of the finite element method to linear vibration problems has been reviewed [3]. Finite element modeling techniques described include lumped parameter, transfer matrix, finite element displacement, finite element force, hybrid, and quadratic eigenvalue methods. Linear vibrations of beams, plates, and shells using the finite element method have recently been reviewed [4]. More than 200 references are quoted, of which five deal with nonlinear flexural vibrations of beams.

Martin [5] has summarized work carried out until 1971 in the area of nonlinear analysis using the finite element method. The development of the finite element method to study nonlinear material behavior has been reviewed [6]. Recent developments in dealing with geometrical and physical nonlinearities have also been treated [7-10]. A survey of computer programs for the solution of nonlinear structural and solid mechanics problems is available [11]. These references will provide the reader with information on the application of the finite element method to nonlinear problems. Therefore, the material that follows deals with such specific cases as the nonlinear static and dynamic behaviors of arches, curved and straight beams, cables, and frames.

The use of the finite element technique for the large deflection and post-buckling behaviors of arches [12-14, 37] and for the nonlinear geometric analysis of curved beams [15-18] has been illustrated [12-18, 37]. Geometric and material nonlinearities [25, 47, 50-54] have been considered individually or in combination [19-57]. Post-buckling behaviors have been investigated in various papers [26, 29, 33, 39, 45, 48]. Nonlinear behavior of thin-walled beams [29-31, 44, 49], cable stiffened structures [36], viscoelastic beams [55], spinning cantilevers, and twisted rotor blades [56-57] are special problems. The finite element method has been used [58] to study the geometrically nonlinear behavior of cables. Frames and trusses have been treated [28, 29, 37, 41, 55, 59-66]. Large deflection problems concerning frames have been investigated [28, 37, 41, 55, 59-61]; post-buckling behaviors have been examined [29, 61, 65]. Dynamic problems have been analyzed [64]. Nonlinear finite element analysis of trusses has been carried out [61-63].

Investigations concerning large amplitude flexural vibrations of beams and beam-type structures have been reported [67-91]. Elastic-plastic transient deformations of structures [67]; dynamic response of beam-columns [69]; beams carrying concentrated masses [71, 76, 82]; beams with translational and rotational springs at the ends [71, 90]; beams of variable flexural rigidity [73, 78, 82, 86]; beams accounting for the effects of in-plane inertia, transverse shear deformation and rotatory inertia effects [74, 75, 79, 80]; and curved beams [85, 88] have been considered.

Optimization of a simply supported beam undergoing large amplitude vibration has been studied [91]. Dynamic stability of a nonlinear beam subjected to both longitudinal and transverse excitations [92], nonlinear dynamic analysis of rotors [93], and dynamic nonlinear large displacement analysis of a human leg [94] are special problems. Large displacement transient analysis of space frames and trusses has been treated [95, 96]. It should be noted that most of the investigations concerning nonlinear static and dynamic analysis of beams use the Rayleigh-Ritz finite element approach. Some recent reports [39, 87, 88] indicate that the Galerkin-type finite element method could be used to solve a class of nonlinear problems.

The publications considered thus far are concerned with specific classes of problems. Considerable work has also been reported on general nonlinear studies of structures. The literature belonging to this category includes static cases [97-158] and dynamic problems [123, 125-127, 132, 134, 149, 153, 159-175]. Problems dealing with both geometric and material-type nonlinearities, development and evaluation of solution procedures for geometrically nonlinear problems, effect of higher order terms in certain nonlinear finite element models, geometric nonlinearity combined with plasticity and creep behavior, finite element analysis for problems of large strain and large displacement, time-dependent inelastic deformation in the presence of transient thermal stresses are treated in these references.

CONCLUDING REMARKS

The finite element method has been widely accepted for solving problems of beams and beam-type structures with various different types of nonlinearities. The literature dealing with geometric nonlinearity is extensive; material nonlinearity has received much less attention. A total of 176 papers published mostly after 1972 have been cited in this review. Every effort has been made to include all readily available literature. However, the literature on this subject has been growing steadily; the author believes that a survey paper of this kind is incomplete with respect to papers published in various conference proceedings as well as those published in other languages.

Based on the review presented in the two parts of this paper, it is possible to make the following observations.

- A survey of literature on the large amplitude vibrations of straight beams shows that regardless of the type of boundary conditions of the beam, the nonlinearity is of the hardening type; i.e., frequency increases with increasing amplitude of vibration. Such behavior is observed in all cases in which the nonlinearity is geometric in nature.
- In the case of curved beams, the hardening type of nonlinear behavior is less pronounced because of the curvature of the beam. This is in general agreement with predictions by Pandalai and Sathyamoorthy [176].
- There is little information available in the literature on the effect of modal interaction and its influences on the nonlinear behavior of beams.
- Experimental verification of theoretical results has been neglected for several decades. The author believes that this area deserves attention.

ACKNOWLEDGMENTS

The author is thankful to Mrs. Linda Newton, Senior Secretary of the Mechanical and Industrial Engineering Department, for carefully typing Parts I and II of this paper, particularly the references.

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CURRENT METHODS FOR ANALYZING DYNAMIC CABLE RESPONSE 1979 TO THE PRESENT

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Abstract. Developments since 1979 are outlined. Emphasis is on ocean engineering applications and closely related activities. Two general computer-oriented approaches have become predominant: the finite element method and the method of weighted residuals.

The previous review in 1979 [1] attempted to cover a broad range of techniques addressed to the ocean dynamics of cables and cable structures. The focus was on computations for initial configurations, geometric and material nonlinearities, and various transient phenomena. Specific emphasis was given to the problem of modeling variable length cable lines: the payout/reel-in problem.

This review follows up on some of the efforts reported previously and explores developments since the spring of 1979. Four general topics are treated:

- modeling of variable length effects
- recent activities in modeling general cable behavior
- modeling of surface excitation phenomena
- the advent of general computer codes

As in the previous review, little attention is given to the problem of environmental loads. This is an extremely important aspect of ocean cable structural behavior that deserves special attention. Of particular interest are the loads resulting from vortex shedding.

MODELING VARIABLE LENGTH EFFECTS

Recent activities in the application of the method of weighted residuals (MWR) to the variable length cable problem have been directed to extending one-dimensional models to more general geometric space. The procedures for one-dimensional and two-dimensional space have been given in detail [2, 3]. The target for this effort is to analyze the dynamic behavior of a single cable supporting an object at one end. The other end is subjected to a deterministic motion representative of surface motion of a support vessel. Dynamic effects of payout/reel-in initiation and sudden stops are of special interest.

In the MWR approach, material coordinates are defined in terms of an instantaneous normalized length. The driving functions for length changes are defined with a generalized acceleration function or with an experimentally derived spline function. Governing partial differential equations and assumed polynomial functions are used with weighting models to drive the modeling errors (residual) to zero in a particular average sense. One MWR approach follows the Galerkin technique in that trial functions are also used as weighting functions [4]. Another approach is orthogonal collocation in which the residual is evaluated at specific points (collocation points). Interestingly, the collocation points can be related to the quadrature points associated with the evaluation of the residual integral of the Galerkin method.

Orthogonal collocation is used in the variable length cable procedure, but the residual terms are not treated directly. Instead, approximate expressions for spatial derivatives are developed from the pattern of the collocation points and the polynomial form (half-range Legendre). These expressions for the derivatives are substituted into the governing partial differential equations to yield a set of ordinary differential equations. These equations are numerically integrated using an Adams technique. Because this approach avoids the formation of a large global matrix, cable problems can be solved with relatively little computer time on a medium-sized computer.

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In the reviewed work, the solution regime is a vertical plane with the water surface forming one boundary. Two-dimensional, time-varying surface motion can be input along with time-dependent length changes. Initial configurations are defined by fixing the suspension point and applying the static loads representing the conditions on the suspended body at the other end. The curve of the initial cable state is a catenary-like function that incorporates cable extensibility. If the state of the two end points is known, the actual curve and the initial tensions can be determined by an iterative equilibrium solution.

Although the MWR cable model allows treatment of material nonlinearities, only linear materials have been treated. The collocation technique is globally formulated and is thereby limited to single-span geometrics.

There has been little new activity in modeling variable length phenomena using finite elements since 1979. The authors are aware of only three computer codes with this capability. The SNAPLG Code [5] uses a lumped parameter approach (not formal finite element) and is limited to two-dimensional systems. The SEADYN Code [6] employs a variable length cable/truss finite element and allows intermittent topology redefinition (referred to as mitosis) to control element length related problems. Some effort has been directed at experimental verification of the SEADYN technique [7] with positive results. The ABAQUS AQUA code [8] has a limited capability.

An interesting paper related to this topic is that by Ross [9]. He compared linearized (small angle) and nonlinear solutions and concluded that linearization does not capture the essential nature of the problem.

RECENT ACTIVITIES IN MODELING CABLE BEHAVIOR

Many of the approaches reviewed previously were based on lower order elements. They were generally straight-line elements in a lumped parameter or finite element method format. Higher order elements are now emerging. Early work in this area was reported by Felippa [10]. He tried various strategies to approximate the cable curvature under distributed loads. He found that a three node element in which a quadratic was used to model the transverse motion and a cubic was used to model the extensional motion was the best general purpose cable element. Economic considerations forced him to qualify his conclusions and to retain the straight element (cable/truss) in his library. Felippa's element library also included a full Hermitian cubic element representing a large deflection beam that cost considerably more than the other two elements.

In more recent work, Leonard and Lo [11] utilized quadratic and cubic isoparametric elements to model cables in cable/membrane systems. Their formulation includes large displacements, nonlinear materials, nonconservative pressure loads, and generalized boundary conditions. They obtained initial static configurations with a modification of the viscous relaxation solution [12]. Transient dynamics were treated with Newmark's method.

An alternative to the formal finite element procedure has been developed by Peyrot and his associates [13-15]. The approach is based on the classical catenary equations adjusted for line stretch. The form of the catenary equations preclude explicit solutions for a stiffness matrix or responses to external load changes. This difficulty is overcome by an iterative procedure based on the work of O'Brien [16, 17]. The procedure allows computation of the forces at the end points of a catenary segment. Specification of the unstretched line length, a uniformly distributed load, material stiffness, and positions of the end points are required. Only linear materials were considered; the uniform load can be the line weight plus an approximate drag load. An additional iterative loop was employed to deal with portions of the line lying on the bottom [14].

Static solutions for the discrete catenary approach involve the modified and damped Newton-Raphson procedure. Contributions to the tangent stiffness matrix are approximated by perturbing the initial node positions, iterating to obtain element loads, and using differences to estimate the element stiffness matrix. The element iterative solution is also used to calculate the force residual required for Newton-type iterations. Dynamic solutions are obtained from the linear acceleration method in a predictor-corrector form. Element iterations are required. Special mass lumping procedures are also used. The authors report considerable success in obtaining static solutions for highly complex mooring systems involving such multiple rigid bodies as ships, platforms, and mooring buoys. They claim computational efficiency despite the multiply embedded iterations because of a favorable convergence behavior of the basic catenary solution iterations. However, recent studies [18] with this element and the straight-line finite element suggest significant cost differences. The study used the SEADYN code; it has a limited form of the catenary element and the straight element. A comparison of the static solution behavior of mooring legs modeled by a single catenary (one active node per leg) and legs modeled with eight straight elements (eight active nodes per leg) displayed equivalent stiffnesses, but the catenary solution was more than two times as costly. Not all of this difference is attributable to the equation computations. The modified Newton-Raphson solution required more iterations to reach the same convergence level with catenary elements than with straight elements. Furthermore, the claimed superiority in obtaining initial configurations [14] was not evident because the type of problem addressed was well posed.

Computer program developments and paper publications continue to show little awareness of the activities reviewed here and in previous work. Approaches for the most part tend to be intuitive and based on a discrete component or lumping procedure. The common failing in such work -- lack of understanding of large displacement theory -- usually manifests itself in the neglect of geometric stiffening due to preloads. Indeed, the work reviewed above [13-15] does not include geometric stiffening in the tangent stiffness matrix for motion out of the plane of the catenary. In this case, however, the omission is of little consequence because the modified Newton-Raphson solution for statics is used, and the cable load calculations are correct within the assumptions made regarding uniform loading. Geometric stiffening becomes important if dynamic solutions using small displacement perturbations are employed or if implicit solution methods, such as the Newmark method, are used. A specific use of the small displacement perturbation approach is the calculation of vibration mode shapes and frequencies. Peyrot's use of a predictor-corrector approach for transient dynamic solutions avoids the tangent stiffness matrix, and the problem is not encountered.

A discrete element approach that does not employ the finite element method was overlooked in the last review. This finite segment or rigid link approach [19, 20] is essentially that used in textbook solutions for an articulated pendulum. The structure is assumed to be composed of a set of rigid (inextensible) links with ball joints at their junctures. The equations of motion are obtained via the classical Lagrange equations. The key to the success of the procedure is identification of link-oriented relative coordinates and a transformation procedure for changing coordinates in a linkwise order. The method avoids problems associated with stiff differential equations arising from the cable extension response. It is limited to appropriately ordered systems with tree-like topology (no redundant load paths).

MODELING OF SURFACE EXCITATION PHENOMENA

An important and active area of research is the modeling of cable structures and moorings subjected to ocean wave excitation. Recent emphasis in this area includes mooring of vessels and platforms. There is extensive literature available on vessel and platform responses with and without mooring lines. Much of this work is beyond the scope of this review. A few citations are given of work that is aimed at cable/mooring line responses more than the response of the restrained object.

A review of the state of the art in moored vessel responses with the objective of calculating mooring line loads is found in the proceedings of a seminar sponsored by the Naval Facilities Engineering Command [21]. The seminar covered a diversity of topics; critical problem areas were a description of environmental loads (including wave-induced drift effects) and a format of the solution for the interaction between mooring lines and moored vessel. It was pointed out that a common error in treating restrained vessel responses is neglect of the geometric stiffness due to mooring preloads. Insight into the moored vessel problem is available [22].

An exposition of the approach to modeling of moored platforms has been given by Pauling [21, 23]. The work of Denice and Heaf [24] is also noteworthy. The need for including geometric stiffening terms for mooring leg pretension is again emphasized. Additional papers in this general area are available [25].

Lindman and Knapp [26, 27] have adopted a frequency domain analysis to estimate cable responses to various sea states. They have gone a step further by computing line stresses and cumulative fatigue damage. Their procedure assumes a separation of the loading into quasi-static and frequency-dependent wave loading. The static loads are applied in a nonlinear solution step [28], and the resulting state is used as the reference for the wave loading. The wave-induced dynamics imposed as motion at the top of the mooring line is assumed to be the unrestrained platform response to the wave input. The unique aspect of this work is the post-processing of the line response data to estimate the stress distribution in the internal components of the cable. A strain energy technique is capable of dealing with multilayered cables in tension, torsion, and bending [29]. Stress failure is determined by the maximum distortion energy theory; fatigue calculations use Miner's cumulative damage rule.

THE ADVENT OF GENERAL COMPUTER CODES

The most dramatic development since 1979 has been the emergence of publicly available computer programs having options to deal with submerged cable and pipe structures. Three notable entries are: ANSYS [30], ABAQUS AQUA [8], and LARSTRAN [32].

ANSYS is a well known and widely used general purpose finite element code. It is available through all of the major computer service networks and at numerous private installations. The initial underwater capabilities became available in 1977, but the authors did not become aware of them until 1979. ANSYS allows fluid drag loading and added mass computations for large deflection beam, pipe, and truss structures. A special feature of ANSYS is its static solution procedure for geometrically nonlinear structures. The procedure greatly accelerates convergence for cable-type systems [31]. ANSYS allows special input to deal with strumming-induced drag amplification. Fluid load models include wave effects and spatially varying currents.

ABAQUS is a relatively new general purpose code with solid theoretical and numerical bases. ABAQUS AQUA is a specialized version with options aimed primarily at underwater pipeline construction. Its element library consists of a beam, a limited cable element (weightless with no compression stiffness), and a drag chain element for special purpose bottom interaction. The cable elements can be linear or quadratic in form. General fluid loadings including surface waves are available through user subroutines. Drag coefficients are directly input, and they are not dependent on Reynold's number. There is a limited capability for defining time dependent lengths for the cable elements to allow simulation of payout/reel-in.

The LARSTRAN code is traceable to the activities of J.H. Argyris and ISD in Stuttgart, Germany. Notable applications of the code include the analysis of the cable roof structure for the Munich Olympic Stadium. Det norske Veritas (Norway) has recently acquired the code and is adapting and applying it to ocean mooring applications [33]. It is hoped that LARSTRAN will eventually be available on a commercial network. LARSTRAN is a general purpose code with large displacement and large strain capabilities. It has a library of elements which include trusses, cables, beams, and two-dimensional continuous plates, shells, and membranes.

In a somewhat different category is the SEADYN code [6] under development by the Naval Facilities Engineering Command through the Naval Civil Engineering Laboratory. It is also a finite element code with large displacement and large strain capabilities. It has been developed for the analysis of underwater cable structures and mooring systems. At present the element library consists of a straight-line cable/truss and a bottom-limited catenary. Capabilities are included for treatment of payout/reel-in. Linear and nonlinear material models are available that also include material damping effects. Rigid body options allow analysis of moored vessels and platforms. General environmental load models include options for internally estimating drag coefficient amplifications due to strumming. The code is undergoing continuing development and experimental verification using laboratory and at-sea test data [7, 34]. SEADYN has been released for public use. It is available through NCEL and will be offered on at least one service network.

It should be noted that various other computer codes available to the public have cable analysis capabilities. These are well known large displacement codes with beam and truss elements. They are not considered with those mentioned above because they do not provide user-convenient capabilities for treating the ocean environment or specific cable phenomena. Beyond the public realm dealt with here are numerous special purpose and/or proprietary codes dealing with cable phenomena in the ocean environment. These exist at various commercial and consulting organizations and university research facilities. No attempt has been made to identify and categorize these codes beyond those mentioned.

ACKNOWLEDGEMENTS

Method of Weighted Residual, Variable Cable Length developments were sponsored by Ocean Technology Program of the Office of Naval Research under contract N00014-78-C-0631. The Large Displacement Cable Dynamics Project, sponsored by Naval Facilities Engineering Command through the Naval Civil Engineering Laboratory, is acknowledged.

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BOOK REVIEWS

ELASTIC WAVES IN THE EARTH

W. Pilant
Elsevier-North Holland Publ. Co., New York, NY
1979; 493 pages

The book is an outgrowth of a one-year graduate level course taught by the author at the University of Pittsburgh. Thus the style of presentation is that of a set of classroom lectures and not of a textbook. The presentation of introductory materials in the first eight chapters on the general subject of elastic wave propagation is sketchy and is not a suitable introduction to students. However, the rest of the book contains a wealth of material on elastic waves in the earth. The author must be complimented for providing a comprehensive list of references on the subject. He has also been successful in relating observational seismology to the theory of elastic wave propagation. However, in trying to compress material the author has sacrificed lucidity and comprehensiveness. In short if the book is used as a text for intermediate level graduate students, the instructor will have to provide explanatory material. The book can serve as a valuable reference for students, however, and should prove to be useful to researchers in seismic waves.

The book contains 33 chapters, an excellent list of references, and a bibliography. The major areas covered are: fundamentals of elastodynamics (chapters 1-10), Lamb's problem (chapter 11) and waves in two semi-infinite media in contact (chapters 12-14), rays and modes in multilayered media (chapters 15-21), rays and modes in a radially nonhomogeneous earth (chapters 22-25), elastic wave dissipation (chapters 26 and 27), the seismic source (chapters 28-30), seismic noise (chapters 31 and 32), and seismographs (chapter 33). Clearly the book will be very useful to seismologists. However, because waves in rods, plates, and shells are not treated, the book will be of limited use to mechanicians. In addition, the problem of scattering, which is of considerable interest to acousticians and researchers in seismology and ultrasonic nondestructive evaluation, has not been treated. However, the list of references in Appendix C on this subject is useful.

A comment about the printing of the book is in order. Because of the high cost of printing more and more books are being published by photo-reproduction of typed manuscripts. The result is that the letters are small and crowded and hard to read. The problem is exacerbated when there are lots of equations, as in the book under review. I do not know of a solution to this problem; I mention it as an exasperated reader.

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THE STABILITY OF DYNAMICAL SYSTEMS

J.P. LaSalle
Society for Industrial and Applied Mathematics
Philadelphia, PA; 1976; 76 pages

With the increasing use of lightweight energy efficient structures, engineers are more frequently meeting situations in which vibration amplitudes are large and linear theory is not sufficient. Small amplitude motions often become unstable, and a nonlinear response must be sought.

In this book an expert on the theory of differential equations describes methods for studying the stability of solutions of sets of nonlinear difference, ordinary differential, and functional differential equations. The book complements to an earlier one [1].

In the first chapter, difference equations of the form

$$x_{n+1} = F(x_n), \qquad (1)$$

where x_n is an n-vector, are studied. Limit and other invariant sets are introduced to describe the asymptotic behavior of solutions. Analogs of Liapunov's direct method for differential equations are described, and the linear problem

$$x_{n+1} = Ax_n \quad (2)$$

(A an nxn matrix) is discussed. Difference equations are becoming increasingly important; many physical problems, especially impact governed systems, can be modeled directly as difference equations [2-4]. Chapter one is a good introduction to the area and might be read in conjunction with other recent books [5, 6].

The second chapter treats autonomous systems of ordinary differential equations of a form more familiar to engineers

$$\frac{dx}{dt} = \dot{x} = f(x) \quad (3)$$

Again x is n-dimensional; limit sets and Liapunov functions are discussed and several examples of nonlinear oscillators of the form

$$\ddot{x} + g(x,\dot{x}) = 0 \quad (4)$$

are given. Computing the asymptotic behavior of solutions and questions of boundedness and stability are stressed.

Chapter three deals with functional equations, such as delay differential equations

$$\dot{x}(t) = f(x(t),x(t-\tau)) \quad (5)$$

and integro-differential equations

$$x(t) = \int_{t-\tau}^{t} f(x(s),s)ds \quad (6)$$

The theory is difficult and incomplete, but Liapunov stability methods can still be used to study asymptotic behavior.

The final chapter deals with nonautonomous difference equations and abstract dynamical systems and is more mathematical in flavor than the preceding material. This chapter is supplemented by an Appendix in which nonautonomous ordinary differential equations are discussed. A typical problem concerns the long time behavior of solutions of a perturbed system

$$\dot{x} = f(x) + h(x,t) \quad (7)$$

where the perturbation strength $|h(x,t)| \to 0$ as $t \to \infty$. Thus the system

$$\dot{x} = f(x) \quad (8)$$

governs the limiting behavior of equation (7). In some cases the limiting equation need not be unique.

The book is aimed primarily at applied mathematicians, particularly dynamical systems theorists, but the authors attempt to demonstrate the relevance of the ideas of limiting behavior and stability to problems in control theory, nonlinear oscillations, and dynamics. The book should thus be of considerable interest to theoretically inclined engineers and mechanicians. References to infinite dimensional nonlinear evolution equations arising from partial differential equations are included. Indeed, much of the theory can be applied almost directly to continuum models of, for example, beams and plates.

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WEAR OF METALS

K.C. Ludema, W.A. Glaeser, and S.K. Rhee, editors
ASME Publ. H00143, New York, NY
1979; 685 pages

Wear is an important aspect of fatigue. The papers in this volume were originally presented at the Second International Conference on Wear. Several societies whose members are actively engaged in wear of materials sponsored the conference. The 84 papers are divided into 8 parts.

Part I comprises a little less than one third of the total papers. Important topics include oxidational theory of wear of metals, impact wear microstructure, SEM observation of the wear process, sliding contact scuffing damage, pitting failures due to rolling contact, wear mechanism of piston rings, low current electrical sliding contact erosive wear, cavitation erosion, surface finish parameters for wear resistance, and surface roughness on wear under friction conditions.

Part II is concerned with abrasion. Topics include microstructural changes due to abrasion, alloy design for abrasive wear, laser surface melting for abrasive wear, dynamically loaded hydrodynamic bearings, wear test of bucket teeth, ball valve wear tests, and abrasive wear of brittle solids.

Part III has to do with various aspects of fretting. This topic has become more important as higher speeds and more efficient machinery and energy systems are sought. Papers have to do with the following topics: fretting fatigue, behavior of metals at elevated temperatures and subjected to various environmental conditions, influence of hardness on fretting wear, sprayed molybdenum coatings, wear of zirconium alloys due to fretting, and the effect of fretting on gear teeth combinations.

Wear resistant coatings are considered in Part IV. Important topics in this section are physical influence of surface treatments on wear, W-Mo carbides for hard facing applications, sprayed chromium - carbide-nuchrome coatings for gas cooled reactors, work hardening on wear resistance of alloys, and wear resistance of alloys and protective layers and coatings on steel in argon.

Part V has to do with wear of cutting tools. Among the topics are mechanism of wear of sentered carbide dental burs, mechanism of notch formation in cutting of ceramic tools used in machining nickel base superalloys, aspects of wear during machining processes, and tool-wear investigations in cemented carbide tools.

Part VI describes wear of ceramics. Topics include surface wear of corundum ceramics at 1500°C, delta aluminum formations during abrasive wear, and influence of gas flow on wear of graphite.

Part VII considers wear of polymers. The quest for high strength light materials has involved a number of different polymers. The development of wear equations in terms of fatigue and topography of sliding surfaces has become important. More work is necessary before wear in polymers is understood.

Part VIII is tutorial in nature. A number of prominent individuals engaged in wear activities review the fundamentals of wear: wear and wear mechanisms, energy dissipation in abrasive wear, simulation of wear of materials, and effect of zeta potential in pitting.

This symposium covers all the the important aspects of wear. Individuals interested in wear theory experimentation and applied aspects of wear will find this volume of interest.

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SHORT COURSES

OCTOBER

UNDERWATER ACOUSTICS
Dates: October 4-8, 1982
Place: University Park, Pennsylvania
Objective: This course provides a broad, comprehensive introduction to underwater acoustics and related topics that are of immediate practical value. It also serves as a foundation for more advanced study of current literature or other specialized courses. The two parts of the course are: Basic Concepts: a two-day heuristic overview of the fundamentals of underwater acoustics, including general acoustics, sonar engineering, transducer principles, and underwater propagation; and Advanced Topics: a three-day in-depth study of three specialized or advanced topics chosen by the student, according to the needs of both the individual and the employer.

Contact: Robert E. Beam, Conference Coordinator, The Pennsylvania State University, Faculty Building, University Park, PA 16802 - (814) 865-5141; TWX 510-670-3532.

VIBRATION CONTROL
Dates: October 11-15, 1982
Place: University Park, Pennsylvania
Objective: The seminar emphasizes principles, general approaches and new developments, with the aim of providing participants with efficient tools for dealing with their own practical vibration problems.

Contact: Mary Ann Solic, Pennsylvania State University, 410 Keller Conference Center, University Park, PA 16802 - (814) 865-4591, TWX No: 510-670-3532.

MAINTAINABILITY AND AVAILABILITY ENGINEERING OF EQUIPMENT AND SYSTEMS
Dates: October 18-22, 1982
Place: Los Angeles, California
Objective: This course should give top management an understanding of the great cost benefits that accrue through the implementation of maintainability and availability engineering methodologies, and participants should be able to determine the following: the distribution of times-to-repair components and times-to-restore equipment; the equipment mean-time-to-restore; the mean man-hours needed to restore; the optimum preventive maintenance schedules for minimum total corrective and preventive maintenance cost; spare parts requirements and their optimization; the reliability, maintainability and availability (both instantaneous and steady state) of maintained equipment and systems. Numerous applications are presented. Course participants' problems will be solicited and solutions given or suggested.

Contact: Mr. Robert Rector, Assistant Director - Short Courses, UCLA, 6266 Boelter Hall, Los Angeles, CA 90024 - (213) 825-3496.

VIBRATION AND SHOCK SURVIVABILITY, TESTING, MEASUREMENT, ANALYSIS, AND CALIBRATION
Dates: October 18-22, 1982
Place: Boston, Massachusetts
Dates: November 15-19, 1982
Place: Santa Barbara, California
Dates: December 8-12, 1982
Place: Huntsville, Alabama
Dates: February 7-11, 1983
Place: Santa Barbara, California
Dates: March 7-11, 1983
Place: Washington, DC
Objective: Topics to be covered are resonance and fragility phenomena, and environmental vibration and shock measurement and analysis; also vibration and shock environmental testing to prove survivability. This course will concentrate upon equipments and techniques, rather than upon mathematics and theory.

Contact: Wayne Tustin, 22 East Los Olivos St., Santa Barbara, CA 93105 - (805) 682-7171.

NOVEMBER

MACHINERY VIBRATION ANALYSIS

Dates: November 9-12, 1982

Place: Oak Brook, Illinois

Objective: In this four-day course on practical machinery vibration analysis, savings in production losses and equipment costs through vibration analysis and correction will be stressed. Techniques will be reviewed along v th examples and case histories to illustrate their use. Demonstrations of measurement and analysis equipment will be conducted during the course. The course will include lectures on test equipment selection and use, vibration measurement and analysis including the latest information on spectral analysis, balancing, alignment, isolation, and damping. Plant predictive maintenance programs, monitoring equipment and programs, and equipment evaluation are topics included. Specific components and equipment covered in the lectures include gears, bearings (fluid film and antifriction), shafts, couplings, motors, turbines, engines, pumps, compressors, fluid drives, gearboxes, and slow-speed paper rolls.

Contact: Dr. Ronald L. Eshleman, Vibration Institute, 101 W. 55th St., Suite 206, Clarendon Hills, IL 60514 - (312) 654-2254.

20TH ANNUAL RELIABILITY ENGINEERING AND MANAGEMENT INSTITUTE

Dates: November 15-19, 1982

Place: Tucson, Arizona

Objective: Emphasis will be on reliability engineering theory and practice; mechanical reliability prediction; reliability testing and demonstration, reliability data sources, maintainability engineering, and life cycle costing; product liability; reliability and maintainability management, life-cycle costing.

Contact: Dr. Dimitri Kececioglu, Reliability Engineering and Management Institute, Aerospace and Mechanical Engineering Department, Building 16, The University of Arizona, Tucson, AZ 87521 - (602) 626-2495.

FEBRUARY

SYSTEMATIC APPROACH TO IMPROVING MACHINERY RELIABILITY IN PROCESS PLANTS

Dates: February 23-25, 1983

Place: San Francisco, California

Objective: This seminar is intended to guide machinery engineers, plant designers, maintenance administrators, and operating management toward results-oriented specifications, selection, design review, installation, commissioning, and post start-up management of major machinery systems for continued reliable operations. Emphasis will be on pumps, compressors, and drivers.

Contact: Sherry Theriot, Professional Seminars International, P.O. Box 156, Orange, TX 77630 - (713) 746-3506.

NEWS BRIEFS: news on current and Future Shock and Vibration activities and events

Final Call for Papers

8TH WORLD CONFERENCE ON EARTHQUAKE ENGINEERING
July 21-28, 1984
Fairmont Hotel, San Francisco, California

The purpose of the Conference is to foster the advancement of earthquake engineering by providing a forum where participants from all related disciplines can meet to exchange ideas and information on recent developments.

The technical sessions of the Conference will cover all aspects of earthquake engineering, including:

- Seismic risk and hazard
- Ground motion and seismicity
- Soil stability, soil-structure interaction, and foundations
- Experimental methods and tests of structures and components
- Design of structures and structural components
- Special structures and critical facilities
- Response of structures
- Repair, strengthening, and retrofit of structures
- Urban design, socioeconomic issues, and public policy
- Lifelines -- utility and transportation systems
- Non-structural systems and building contents
- Development and enforcement of seismic codes and standards

The Conference will also include a special session on recent earthquakes, invited lectures, a keynote address, and opening and closing ceremonies.

Papers accepted for the Conference can be presented in one of two formats, depending on the wishes of the author: (1) a 15-minute oral presentation, with an additional 5 minutes for discussion, to an audience seated theatre style; or (2) a 2-hour display presentation of graphs, figures, and other materials to a small circulating audience.

Papers accepted for the Conference will be published in the Conference Proceedings, which will serve as a permanent reference. The Proceedings will be distributed at the Conference.

Papers printed in the Proceedings should be no more than 8 pages in length -- typewritten, single-spaced, including figures and tables.

Persons wishing to present papers at the Conference are requested to submit an abstract of their papers to the President of the International Association for Earthquake Engineering (IAEE) on or before October 15, 1982. Abstracts should be typewritten (single spaced) and not more than 400 words in length. The format should be as follows: title of paper; author (or authors) with full mailing address of principal author; and text of abstract. Please also indicate on the upper left corner of the page the topic number most appropriate for your paper.

Prospective authors may submit more than one abstract for consideration, but an author may present only one paper at the Conference.

Four copies of each abstract should be mailed to the following address:

Professor D.E. Hudson, President
International Association for Earthquake Engineering
Department of Civil Engineering
University of Southern California
Los Angeles, California 90007

Authors of selected abstracts will be notified by May 15, 1983. Detailed instructions for the complete manuscripts and additional information about display presentations will be sent to prospective authors at the time of acceptance notification. At that time, authors will be asked to indicate whether they wish to make an oral presentation or a display presentation.

For further information contact: Earthquake Engineering Research Institute, 2620 Telegraph Avenue, Berkeley, California 94704.

Call for Papers

14TH ANNUAL MODELING AND SIMULATION CONFERENCE
April 21-22, 1983
Pittsburgh, Pennsylvania

Special emphasis for the 1983 Conference will be microprocessors and their applications as well as energy, social, economic, and global modeling and simulation and papers on all traditional areas of modeling and simulation.

Only papers which have not been published previously will be considered. These papers should describe significant contributions which add to the knowledge in a particular area or which describe the origin and progress of research that is being currently conducted. All papers submitted and accepted for presentation at the Conference will be considered for publication in the Proceedings. There will be a length limitation on all papers but additional space in the Proceedings may be purchased at a nominal cost.

Two copies of titles, authors, all authors' addresses, abstracts and summaries should be submitted by January 31, 1983. The abstract should be approximately 50 words in length and the summary should be of sufficient length and detail to permit careful evaluation. Identify one author as the correspondent for the paper. All communications will be with this author. Notification of acceptance for presentation will be given by March 7, 1983. Instructions and model paper for the preparation of accepted papers will be mailed to each author. The final typed manuscript will be due by April 22, 1983.

Direct all correspondence to: William G. Vogt or Marlin H. Mickle, Modeling and Simulation Conference, 348 Benedum Engineering Hall, University of Pittsburgh, Pittsburgh, Pennsylvania 15261.

Call for Papers

INTERNATIONAL SYMPOSIUM ON STRUCTURAL CRASHWORTHINESS
September 14-16, 1983
University of Liverpool, England

It is the purpose of this symposium to provide a medium for communicating and discussing recent advances in the structural aspects of crashworthiness and the mechanics of energy absorption by plastic deformations in the context of collision protection systems for a wide range of vehicles. In order to achieve this objective, the scope of the symposium will contain three parts:

- ***Contributions to basic understanding of the plastic behavior of severely deformed thin-walled structures.*** Local plastic failure and energy absorption under compressive loading. Post-buckling behavior and maximum strength of compression members. Localization of plastic flow, formation and growth of folding modes. Propagating buckles. Influence of boundary conditions and imperfections. Effects of inertia and strain rate sensitivity. Modeling concepts for numerical solutions.

- ***Crushing behavior of simple structures.*** Axial and lateral crushing of rectangular and circular tubes, bending of channel and closed section members, denting of tubes, local deformation of stiffeners. Crushing of an assemblage of structures, stiffened panels and cylinders and other crashworthiness protection systems.

- ***Collision protection of land, air and sea vehicles.*** Damage prediction of slow collisions (ships, offshore platforms). Simulation of aircraft, automobile and train crashes. Novel experimental techniques and interpretation of test results. Numerical solutions. Design concepts for optimum energy management.

Original research papers are invited in all above-mentioned topics. The accepted papers will appear in a special symposium issue of the International Journal of Mechanical Sciences and will be available for the symposium. All manuscripts should conform with the requirements set up by this Journal and will be subjected to a regular reviewing procedure. The deadline for the submission of manuscripts is November 1, 1982.

The co-chairmen of the symposium are Professor Norman Jones and Professor Tomasz Wierzbicki. Interested authors are kindly requested to send a provisional title along with a short description of the content of the intended paper as soon as possible to the address below.

For further information contact: Professor Norman Jones, Co-Chairman, Symposium on Structural Crashworthiness, Department of Mechanical Engineering, The University of Liverpool, P.O. Box 147, LIVERPOOL L69 3BX, England.

ADVANCE PROGRAM

53RD SHOCK AND VIBRATION SYMPOSIUM

October 26-28, 1982

Danvers, Massachusetts

U.S. Army Materials and Mechanics Research Center
will be your host for this Symposium

**THE SHOCK AND VIBRATION
INFORMATION CENTER**

GENERAL INFORMATION

CONFERENCE LOCATION: Registration, Information and Unclassified Technical Sessions are at the Radisson Ferncroft Hotel, Danvers, MA. Classified Sessions will be held at the U.S. Army Materials and Mechanics Research Center, Watertown, MA. There is a separate program for the Classified Sessions.

Travel Orders for U.S. Government Employees should indicate the Radisson Ferncroft Hotel as the main conference location. A request is being made for blanket approval for maximum allowable actual expenses of $75.00 at the Radisson Ferncroft in Danvers. Details will be included in the Final Program.

REGISTRATION: Registration fee covers the cost of the proceedings of the 53rd Shock and Vibration Symposium. There is no fee for SVIC Annual Subscribers* and for participants. Since the registration fee covers only the cost of the proceedings, there will be no reduced fee for part time attendance. The schedule of fees is as follows:

Subscriber Registration (for employees
of SVIC Annual Subscribers*) . . . . .No Fee
Participant Registration (Authors,
Speakers, Chairmen, Cochairmen). . . . . . .No Fee
General Registration (All others)
(Payable to Disbursing Officer, NRL) . . . $140.00

On-Site Registration: Pre-registrants may obtain their badges or last minute unclassified registration may be accomplished at the following times:

Radisson Ferncroft Hotel
Monday, October 25 . . . . . 7:00 p.m. - 9:00 p.m.
Tuesday, October 26 . . . . . 7:30 a.m. - 4:00 p.m.
Wednesday, October 27 . . . 8:00 a.m. - 4:00 p.m.
Thursday, October 28 . . . . 8:00 a.m. - 2:00 p.m.

INFORMATION: An Information and message center will be located in the registration area. The phone number in the registration area is 617-777-2500 X2286. Ask for the Shock and Vibration Symposium. Telephone messages and special notices will be posted near the registration desk. All participants should check regularly for messages or timely announcements. Participants will not be paged in the sessions.

OUTSIDE ACTIVITIES: A special planned program of outside activities is available to spouses. (Details are in the enclosed brochure). Since these events can be held only if sufficient interest is shown, it is IMPORTANT THAT ADVANCE REGISTRATION of intent to participate be received. A form for this purpose is included in the brochure.

SPECIAL TOUR: It is likely that a special tour of technical interest will be planned for the morning of Friday, October 29, 1982 for those who wish to stay over. Details will be available in the Final Program.

LODGING: A block of rooms has been reserved at the Radisson Ferncroft Hotel for those attending the Symposium. All reservations may be made by forwarding the enclosed Hotel Reservation Card directly to the Radisson Ferncroft Hotel. It is recommended that hotel reservations be made well in advance of the meeting and, in no case later than 1 October 1982.

COMMITTEE MEETINGS: Space is available to schedule meetings for special committees and working groups at the Symposium. To reserve space contact SVIC. A schedule of special meetings will be printed in the Final Program.

SVIC STAFF:

Mr. Henry C. Pusey, Director
Mr. Rudolph H. Volin
Dr. J. Gordan Showalter
Mrs. Jessica P. Hileman
Mrs. Elizabeth McLaughlin

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PUBLICATIONS

PROCEEDINGS: THE SUMMARIES OF PRESENTED PAPERS will be published in advance. These summaries are longer than the usual abstract and contain

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enough detail to evaluate their usefulness to you as an individual. By reading these in advance of the sessions, you may more effectively choose the papers you wish to hear. The preprints of summaries will be available to all attendees at the time of registration.

SHOCK AND VIBRATION BULLETIN No. 53: Papers presented at the 53rd Symposium will, at the author's request, be reviewed and published in the Bulletin after approval by two reviewers. The discussion following these papers will be edited and published with the respective papers. Registrants who have paid the registration fee or have satisfied the registration requirements will receive a copy of the Bulletin. Additional sets of the 53rd Bulletin will be sent to Annual Subscribers. Others may purchase the Bulletin from the Shock and Vibration Information Center. The price is $140.00 for each set delivered in the United States.

OTHER PUBLICATIONS: Sample copies of current publications of the Shock and Vibration Information Center may be examined at the registration area. Order blanks are available for those wishing to use them.

53RD SYMPOSIUM PROGRAM COMMITTEE

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Mr. Brian Keegan
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NASA Goddard Space Flight Center
Hampton, VA 23665

Opening Session **Tuesday, October 26**
8:30 a.m. **Ferncroft West**

Chairman: Mr. Richard Shea, Director, Mechanics and Engineering Laboratory, U.S. Army Materials and Mechanics Research Center, Watertown, MA

Cochairman: Mr. Henry C. Pusey, Director, Shock and Vibration Information Center, Naval Research Laboratory, Washington, DC

Welcome: Dr. Edward Wright, Director, U.S. Army Materials and Mechanics Research Center, Watertown, MA

Keynote Address: Major General Story C. Stevens, Commanding General, U.S. Army Aviation Research and Development Command, St. Louis, MO

Invited Speakers: Mr. Henry C. Pusey, Director, Shock and Vibration Information Center, Naval Research Laboratory, Washington, DC. Subject: "Technical Information Support for Survivability Programs."

Mr. Dale B. Atkinson, Chairman, Joint Technical Coordinating Group on Aircraft Survivability, Naval Air Systems Command, Washington, DC. Subject: "Aircraft Survivability."

Captain F.S. Hering, Director, Survivability and Readiness Subgroup, Naval Sea Systems Command, Washington, DC. Subject: "Fleet Survivability."

Mr. Otto Renius, Chief, Survivability Research Division, U.S. Army Tank-Automotive Command, Warren, MI. Subject: "Survivability of Mobile Ground Systems."

Lt. Colonel Donald Gage, Ballistic Missile Office, U.S. Air Force, Norton AFB, CA. Subject: "Survivability of Fixed Ground Systems."

Plenary A **Tuesday, October 26**
2:00 p.m. **Ferncroft West**

ELIAS KLEIN MEMORIAL LECTURE

Chairman: Mr. Henry C. Pusey, Shock and Vibration Information Center, Naval Research Laboratory, Washington, DC

Speaker: Dr. Eric Ungar, Bolt, Beranek and Newman, Inc., Cambridge, MA

Subject: Vibration Challenges in Microelectronics Manufacturing – Dr. Eric Ungar and Mr. Colin G. Gordon, Bolt, Beranek and Newman, Inc., Cambridge, MA

Session 1A **Tuesday, October 26**
3:00 p.m. **Ferncroft East**

MACHINERY DYNAMICS

Chairman: Dr. Ronald L. Eshleman, The Vibration Institute, Clarendon Hills, IL

Cochairman: Mr. Samuel Feldman, NKF Engineering Associates, Inc., Vienna, VA

1. Analytical and Experimental Investigation of Rotating Blade Response due to NPF Excitation – J.S. RAO and H.M. JADVANI, Indian Institute of Technology, New Delhi, India

2. Prediction of Critical Speeds, Unbalance, and Non-synchronous Forced Response of Rotors – M. LALANNE, P. BERTHIER and G. FERRARIS, Institut National Des Sciences Appliquees de Lyon, France

3. Unbalance Response of a Single Mass Rotor Mounted on Dissimilar Hydro-Dynamic Bearings – R. SUBBIAH, R.B. BHAT and T.S. SANKAR, Concordia University, Montreal, Quebec, Canada

4. Nonlinear Coupling Responses to Variable Frequency Excitations – F.H. WOLFE and A.J. MOLNAR, Engineering-Analytical Dynamics Corp., Trafford, PA

5. Source Signature Recovery in Reverberant Structures – R.H. LYON, Massachusetts Institute of Technology, Cambridge, MA

6. Comparison of Statistical Energy Analysis and Finite Element Analysis Predictions with Experimental Results at High and Low Frequency Ranges – L.K.H. LU, W.J. HAWKINS, and D.F. DOWNARD, Westinghouse Electric Corp., Marine Division, Sunnyvale, CA and R.G. DEJONG, Cambridge Collaborative, Cambridge, MA

Session 1B **Tuesday, October 26**
3:00 p.m. **Ferncroft West**

PYROTECHNIC SHOCK-MEASUREMENT/SIMULATION

Chairman: Mr. C. Douglas Hinckley, TRW Systems, Ogden, UT

Cochairman: Mr. Peter Bouclin, Naval Weapons Center, China Lake, CA

1. Flight-to-Flight Variability in Shock and Vibration Levels Based on Trident I Flight Data – L.R. PENDLETON and R.L. HENRIKSON, Lockheed Missiles and Space Company, Sunnyvale, CA

2. Cruise Missile Pyrotechnic Shock Definition and Component Test Program – E.S. ROSENBAUM, Convair Division of General Dynamics, San Diego, CA

3. Pershing II Pyrotechnic Shock Test and Test Simulation – M.E. HUGHES, Martin Marietta Corporation, Orlando, FL

4. Pyrotechnic Shock Simulation – R.S. NICHOLS, U.S. Army White Sands Missile Range, White Sands, NM

5. Strain Histories Associated with Stage Separation Systems Using Linear Shaped Charge – D.R. POWERS, McDonnel Douglas Astronautics Company, Huntington Beach, CA

6. On the Attenuation of Pyro Shock – S. BARRETT, Martin Marietta Corporation, Denver, CO

Panel Session — **Tuesday, October 26**
7:30 p.m. — **Ferncroft West**

MIL-STD-810D

MIL-STD-810D was revised recently, and significant changes appear in the dynamics portions of MIL-STD-810D. These changes, and changes in the method(s) for using the revised standard, will be discussed in this panel session. The composition of this panel will appear in the Final Program.

Plenary B — **Wednesday, October 27**
8:30 a.m. — **Ferncroft West**

MAURICE BIOT 50TH ANNIVERSARY LECTURE

Chairman: Mr. Henry C. Pusey, Shock and Vibration Information Center, Naval Research Laboratory, Washington, DC

Speaker: Mr. Gene M. Remmers, David Taylor Naval Ship Research and Development Center, Bethesda, MD

Subject: The Evolution of Spectral Techniques in Navy Shock Design

Abstract: In his Doctoral Thesis at CALTECH in 1932, Maurice Biot applied the concepts of spectral analysis to structural response during earthquakes. In this and succeeding publications, Biot and others developed spectral techniques to calculate stresses in structures induced by dynamic loads from transient excitations. This talk reviews the early work of the 1930's which forms the basis for current analytical tools used by the U.S. Navy for the design of shock resistant shipboard equipment. The further evolution of insight on the interpretation of measured response spectra and the required description of structural systems gained from the Navy shock design R&D efforts from the 1940's to the present will also be described.

Session 2A — **Wednesday, October 27**
9:40 a.m. — **Ferncroft East**

VIBRATION: TEST AND CRITERIA

Chairman: Mr. John Wafford, Aeronautical Systems Division, Wright Patterson Air Force Base, OH

Cochairman: Mr. Howard D. Camp, Jr., U.S. Army Electronic Research & Development Command, Ft. Monmouth, NJ

1. Criteria for Accelerated Random Vibration Tests with Nonlinear Damping – R.G. LAMBERT, General Electric Company, Utica, NY

2. Vibration Test Environments for Electronics Mounted in a Remotely Piloted Vehicle – V.R. BEATTY, Harris Government Information Systems Division, Melbourne, FL

3. Vibration Test Software for Electronics Mounted in a Remotely Piloted Vehicle – S.M. LANDRE, Harris Corporation, Melbourne, FL

4. Automated Vibration Schedule Development for Wheeled and Tracked Vehicles at Aberdeen Proving Ground – W.H. CONNON, III, Materiel Testing Directorate, Aberdeen Proving Ground, MD

5. Testing for Severe Aerodynamically Induced Vibration Environments – H. N. ROOS and G. R. WAYMON, McDonnell-Douglas Aircraft Corp., St. Louis, MO

6. Evaluation of Modal Testing Techniques for Spacecraft Structures – K. SHIRAKI and H. MITSUMA, National Space Development Agency of Japan, Tokyo, Japan

7. A Free-Free Modal Survey Suspension System for Large Test Articles – R. WEBB, Martin Marietta Corporation, Denver, CO

Session 2B — **Wednesday, October 27**
9:40 a.m. — **Ferncroft West**

SHOCK TESTING AND ANALYSIS

Chairman: Mr. Edwin Rzepka, Naval Surface Weapons Center, Silver Spring, MD

Cochairman: Mr. Ami Frydman, Harry Diamond Laboratories, Adelphi, MD

1. An Explosive Driven Shock Tube for Verifying Survival of Radioisotope Heat Sources During Space Shuttle Launch Accident – F.H. MATHEWS, Sandia National Laboratories, Albuquerque, NM

2. Equivalent Nuclear Yield and Pressure by the Response Spectrum Fit Method – J.R. BRUCE and H.E. LINDBERG, SRI International, Menlo Park, CA

3. Calculation of the Shock Wave from a Pentolite Tapered Charge – J.T. GORDON and D.K. DAVISON, Physics International Company, San Leandro, CA

4. Effect of Measurement System Phase Response on Shock Spectrum Computation – P.L. WALTER, Sandia National Laboratories, Albuquerque, NM

5. Efficient Algorithms for Calculating Shock Spectra (On General Purpose Computers) – F.W. COX, Computer Sciences Corp., Houston, TX

6. Evaluation and Control of Conservatism in Drop Table Shock Tests – T.J. BACA, Sandia National Laboratories, Albuquerque, NM

7. Ice Impact Testing of Space Shuttle Thermal Protection System Materials – P.H. DEWOLFE, Rockwell International Corp., Downey, CA

Session 3A | **Wednesday, October 27**
2:00 p.m. | **Ferncroft East**

DAMPING

Chairman: Dr. Frederick C. Nelson, Tufts University, Medford, MA

Cochairman: Dr. Jack Henderson, Air Force Wright Aeronautical Laboratories, Wright Patterson AFB, OH

1. Experimental Investigation of Controlling Vibrations Using Multi-Unit Impact Dampers – C.N. BAPAT and S. SANKAR, Concordia University, Montreal, Quebec, Canada and N. POPPLEWELL, University of Manitoba, Winnipeg, Manitoba, Canada

2. Harmonic Response of a Structure Including a Dry Friction Damper – M. LALANNE, A. BASSIOUNI, and J. DER HAGOPIAN, Institut National des Sciences Appliquees, Villeurbanne, France

3. An Experimental Hybrid Model for a Bilinear Hysteretic System – C.S. CHANG, N. POPPLEWELL, K.R. McLACHLAN, and W. McALLISTER, University of Manitoba, Winnipeg, Manitoba, Canada

4. System Dynamics Synthesis of Space Structures from Substructure Tests and Analysis – M.L. SONI, University of Dayton Research Institute, Dayton, OH

5. The Measurement and Analysis of Platform Damping on Advanced Turbine Blade Response – T.J. LAGNESE and D.I.G. JONES, Air Force Wright Aeronautical Laboratories, Wright Patterson AFB, OH

6. A Vibration Damping Treatment for High-Temperature Gas Turbine Applications – A.D. NASHIF, Anatrol Corp., Cincinnati, OH, D.I.G. JONES, Air Force Wright Aeronautical Laboratories, Wright Patterson AFB, OH, W.D. BRENTNALL, A.G. METCALFE and A.R. STETSON, Solar Turbines, Inc., San Diego, CA

7. Experimental Measurement of Material Damping Using Digital Test Equipment – P.W. WHALEY and P.S. CHEN, University of Nebraska, Lincoln, NB

8. Electronic Damping of a Large Optical Bench – R.L. FORWARD, Hughes Research Laboratory, Malibu, CA, C.J. SWIGERT, Hughes Aircraft Company, Culver City, CA and M. OBAL, Air Force Weapons Laboratory, Kirtland AFB, NM

Session 3B | **Wednesday, October 27**
2:00 p.m. | **Ferncroft West**

FLUID/STRUCTURE DYNAMICS

Chairman: Dr. Anthony J. Kalinowski, Naval Underwater Systems Center, New London, CT

Cochairman: Dr. Martin W. Wambsganss, Argonne National Laboratory, Argonne, IL

1. Experimental Validation of the Component Synthesis Method for Predicting Vibration of Liquid-Filled Piping – F.J. HATFIELD and D.C. WIGGERT, Michigan State University, East Lansing, MI and L.C. DAVIDSON, David Taylor Naval Ship Research and Development Center, Annapolis, MD

2. Acoustic Responses of Coupled Fluid-Structure System by Acoustic-Structural Analogy – Y.S. SHIN, Naval Postgraduate School, Monterey, CA

3. Fluid-Structure Interaction by the Method of Characteristics – F.D. HAINS, Naval Surface Weapons Center, Silver Spring, MD

4. Underwater Explosion Shock Analysis of a Compliant Tube Sonar Baffle – V. GODINO, R. HABERMAN, and D. HAMEL, Bolt, Beranek and Newman, Inc., New London, CT

5. A Solution to the Axisymmetric Bulk Cavitation Problem – F.A. COSTANZO and J.D. GORDON, David Taylor Naval Ship Research and Development Center, UERD, Portsmouth, VA

6. Random Response of Linear Continuous Systems to Condensation Oscillation Loads – T.Y. SHIH and P.C. SUN, NUTECH Engineers, Inc., San Jose, CA

7. Determination of Flow Induced Vibration Forces Using Laser-Doppler Measurements — W.W. DURGIN, Worcester Polytechnic Institute, Alden Research Laboratory, Holden, MA

8. Nonlinear Liquid Sloshing under Random Vertical Excitation — R.A. IBRAHIM and A. SOUNDARARAJAN, Texas Tech University, Lubbock, TX

Plenary C — **Thursday, October 28**
8:30 a.m. — **Ferncroft West**

Chairman: Mr. Richard Shea, U.S. Army Materials and Mechanics Research Center, Watertown, MA

Speakers: Mr. Robert Fitzpatrick and Mr. John F. Mescall, U.S. Army Materials and Mechanics Research Center, Watertown, MA

Subject: Materials Implications of Advanced Thermal and Kinetic Energy Threats

Session 4A — **Thursday, October 28**
9:40 a.m. — **Ferncroft East**

DYNAMIC ANALYSIS I

Chairman: Lt. Col. John J. Allen, Air Force Office of Scientific Research, Bolling AFB, Washington, DC

Cochairman: Mr. Herbert Saunders, General Electric Company, Schenectady, NY

1. Dynamic Simulation of Structural Systems with Isolated Nonlinear Components — L. MINNETYAN and J.A. LYONS, Clarkson College of Technology, Potsdam, NY and T.G. GERARDI, Air Force Wright Aeronautical Laboratories, Wright Patterson AFB, OH

2. Experimental and Analytical Investigation of Active-Loads Control for Aircraft Landing Gear — D.L. MORRIS, Air Force Wright Aeronautical Laboratories, Wright Patterson AFB, OH and J.R. McGEHEE, NASA Langley Research Center, Hampton, VA

3. On Modal Identification of Multiple Degree of Freedom Systems — D.I.G. JONES, Air Force Wright Aeronautical Laboratories, Wright Patterson AFB, OH and A. MUSZYNSKA, Bently Nevada Corporation, Minden, NV

4. An Application of the Kinetic Energy Calculation as an Aid in Mode Identification — J.J. BROWN and G.R. PARKER, Hughes Helicopters, Inc., Culver City, CA

5. Dynamics of a Simple System Subjected to Random Impact — T.T. SOONG, State University of New York, Buffalo, NY

6. Approximate Numerical Predictions of Impact Induced Structural Responses — R.W. WU, Lockheed Missiles and Space Company, Sunnyvale, CA

7. Commonalities of Nuclear Power Plant Seismic Assessments and SENTRY V&H Assessments — J.F. JENKINS and C.K. WOOD, Patel Engineers, Huntsville, AL

Session 4B — **Thursday, October 28**
9:40 a.m. — **Ferncroft West**

VEHICLE DYNAMICS

Chairman: Dr. Richard A. Lee, U.S. Army Tank Automotive Command, Warren, MI

Cochairman: Dr. Grant R. Gerhart, U.S. Army Tank Automotive Command, Warren, MI

1. A Stochastic Model for Man-Machine-Soil-Environmental System and the Influence of Vibrations — A.S. MASSINAS, Greek Army and P.A. DRAKATOS, M.I.T., Cambridge, MA

2. An Optimum Seat-Suspension for Off-Road Vehicles — S. RAKHEJA and S. SANKAR, Concordia University, Montreal, Quebec, Canada

3. Frequency and Time Domain Analysis of Off-Road Motorcycle Suspension — M. van VLIET, S. SANKAR, and C.N. BAPAT, Concordia University, Montreal, Quebec, Canada

4. Braking-Turning-Maneuvering Stability of Heavy Transporters — P. WOODS, Martin Marietta Corporation, Denver, CO

5. Acoustic Environments for JPL Shuttle Payloads Based on Early Flight Data — M. O'CONNELL and D. KERN, Jet Propulsion Laboratory, Pasadena, CA

6. Computer Aided Synthesis of a Satellite Antenna Structure with Probabilistic Constraints — V.K. JHA, SPAR Aerospace Corp. and T.S. SANKAR and R.B. BHAT, Concordia University, Montreal, Quebec, Canada

7. Dynamic Behaviour of a Satellite Antenna Structure in Random Vibration Environment — V.K. JHA, SPAR Aerospace Corp., T.S. SANKAR and R.B. BHAT, Concordia University, Montreal, Quebec, Canada

Session 5A — **Thursday, October 28**
2:00 p.m. — **Ferncroft East**

DYNAMIC ANALYSIS II

Chairman: Dr. James J. Richardson, U.S. Army Missile Command, Redstone Arsenal, AL

Cochairman: Mr. Brantley R. Hanks, NASA Langley Research Center, Hampton, VA

1. Modified Guyan Reduction Method – M. PAZ, University of Louisville, Louisville, KY

2. Model Reduction Techniques and Their Application to Vibrating Systems – A.S.R. MURTY, Indian Institute of Technology, Kharagpur, India

3. A New Class of Probability Distributions Associated with Structural Vibration – H.B. CHENOWETH, Westinghouse Electric Corporation, Baltimore, MD

4. On the Face-Shear Vibrations of Contoured Crystal Plates – S.DE, National Research Institute, W. Bengal, India

5. The Large Deformation Bend-Buckling Behavior of a Cylindrical Shell Undergoing Whipping Motions – K.A. BANNISTER, Naval Surface Weapons Center, White Oak, Silver Spring, MD

6. Viscoplastic Analysis of Mild Steel Shell Structures – R.S. ATKATSH, Weidlinger Associates, New York, NY

7. Dynamical Behaviour of Composite Layered Beams by the Finite Element Method – P. TROMPETTE and R. GAERTNER, Institut National des Sciences Appliquees, Villeurbanne Cedex, France

8. Simple Approximate Models for a Class of Structures – A.J. MOLNAR and F.H. WOLFF, Engineering Analytical Dynamics Corp., Trafford, PA

Session 5B **Thursday, October 28**
2:00 p.m. **Ferncroft West**

SHORT DISCUSSION TOPICS

Chairman: Mr. R.E. Seely, Naval Weapons Handling Center Earle, Colts Neck, NJ

Cochairman: Mr. E. Kenneth Stewart, U.S. Army Armaments Research and Development Command, Dover, NJ

Details of this session will appear in the Final Program.

ABSTRACT CATEGORIES

MECHANICAL SYSTEMS

- Rotating Machines
- Reciprocating Machines
- Power Transmission Systems
- Metal Working and Forming
- Isolation and Absorption
- Electromechanical Systems
- Optical Systems
- Materials Handling Equipment

STRUCTURAL SYSTEMS

- Bridges
- Buildings
- Towers
- Foundations
- Underground Structures
- Harbors and Dams
- Roads and Tracks
- Construction Equipment
- Pressure Vessels
- Power Plants
- Off-shore Structures

VEHICLE SYSTEMS

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- Ships
- Aircraft
- Missiles and Spacecraft

BIOLOGICAL SYSTEMS

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- Animal

MECHANICAL COMPONENTS

- Absorbers and Isolators
- Springs
- Tires and Wheels
- Blades
- Bearings
- Belts
- Gears
- Clutches
- Couplings
- Fasteners
- Linkages
- Valves
- Seals
- Cams

STRUCTURAL COMPONENTS

- Strings and Ropes
- Cables
- Bars and Rods
- Beams
- Cylinders
- Columns
- Frames and Arches
- Membranes, Films, and Webs
- Panels
- Plates
- Shells
- Rings
- Pipes and Tubes
- Ducts
- Building Components

ELECTRIC COMPONENTS

- Controls (Switches, Circuit Breakers)
- Motors
- Generators
- Transformers
- Relays
- Electronic Components

DYNAMIC ENVIRONMENT

- Acoustic Excitation
- Shock Excitation
- Vibration Excitation
- Thermal Excitation

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EXPERIMENTATION

- Measurement and Analysis
- Dynamic Tests
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ANALYSIS AND DESIGN

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- Analytical Methods
- Modeling Techniques
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GENERAL TOPICS

- Conference Proceedings
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ABSTRACTS FROM THE CURRENT LITERATURE

Copies of articles abstracted in the DIGEST are not available from the SVIC or the Vibration Institute (except those generated by either organization). Inquiries should be directed to library resources. Government reports can be obtained from the National Technical Information Service, Springfield, VA 22151, by citing the AD-, PB-, or N- number. Doctoral dissertations are available from University Microfilms (DA), 313 N. Fir St., Ann Arbor, MI; U.S. Patents from the Commissioner of Patents, Washington, DC 20231. Addresses following the authors' names in the citation refer only to the first author. The list of periodicals scanned by this journal is printed in issues 1, 6, and 12.

ABSTRACT CONTENTS

MECHANICAL SYSTEMS

ROTATING MACHINES

(Also see Nos. 2029, 2043)

82-1845

Current Problems in Turbomachinery Fluid Dynamics

E.M. Greitzer, W.T. Thompkins, Jr., J.E. McCune, A.H. Epstein, and C.S. Tan

Gas Turbine and Plasma Dynamics Lab., Massachusetts Inst. of Tech., Cambridge, MA, Rept. No. AFOSR-TR-82-0027, 136 pp (Nov 30, 1981)

AD-A110 432

Key Words: Turbomachinery, Fluid-induced excitation

A multi-investigator effort on problems of current interest in turbomachinery fluid dynamics was carried out. Four different tasks having to do with a wide range of design and off-design flow fields were identified. These are: investigation of fan and compressor design point fluid dynamics (including formulation of design procedures using current three-dimensional transonic codes and development of techniques for instantaneous temperature measurements in transonic fans); studies of compressor stability enhancement (including basic investigations of fluid dynamics of compressor casing/hub treatment); fluid mechanics of gas turbine engine operation in inlet flow distortion (including inlet vortex distortion and combined circumferential/radial distortions); and investigations of three-dimensional flows in highly loaded turbomachines (including actuator duct theory and blade-to-blade flow analysis) and linearized analysis of swirling three-dimensional flows in turbomachines. This report summarizes the work carried out to date as well as indicates the direction of future efforts on these tasks.

82-1846

Research on Turbine Rotor-Stator Aerodynamic Interaction and Rotor Negative Incidence Stall

R.P. Dring, H.D. Joslyn, L.W. Hardin, and J.H. Wagner

United Technologies Res. Ctr., East Hartford, CT, Rept. No. UTRC/R81-915048, AFWAL-TR-81-2114, 107 pp (Nov 1981)

AD-A110 341

Key Words: Interaction: rotor-stator, Aerodynamic loads, Turbines, Experimental test data

The aerodynamic interaction between the rotors and stators of a large scale axial turbine stage have been studied experimentally. The data included measurements of the time averaged and instantaneous surface pressures and surface thin film gage output on both the rotor and stator at midspan. The data also included measurement of the stator suction and pressure surface time averaged heat transfer at midspan. The data was acquired with rotor-stator axial gaps of 15% and 65% of axial chord. The upstream potential flow influence of the rotor on the stator was seen as well as the downstream potential flow and wake influences of the stator on the rotor. The second phase of the program was an investigation of the nature of the full-span steady flow over the rotor with incidence varying up to negative incidence stall. Full-span pressure distributions and surface flow visualization were acquired over the entire range of incidence. The data indicated separation-free flow and large radial flows on the pressure surface in the vicinity of design incidence.

82-1847

Review of Noise Reduction Methods for Centrifugal Fans

W. Neise

Deutsche Forschungs- und Versuchsanstalt f. Luft- und Raumfahrt e.V., Inst. f. Experimentelle Strömungsmechanik, Abteilung Turbulenzforschung, 1000 Berlin 12, West Germany, J. Engrg. Indus., Trans. ASME, 104 (2), pp 151-161 (May 1982) 21 figs, 30 refs

Key Words: Fans, Noise reduction

Several methods of reducing the noise of centrifugal fans are discussed, most of which were aimed at a lower blade passage frequency level because tonal noise components are of particular annoyance. The various methods are: increasing the cutoff clearance, increasing the radius of curvature of the cutoff edge, angle of inclination between impeller blades and cutoff edge, staggering the blades of double inlet or double row impellers, wire meshes mounted along the inner and outer circumference of the radial blade row, irregular blade spacing, mismatch between the acoustic impedances of fan and duct system, triangular guide belt around the impeller, rectangular fan casing, circular fan casing, acoustically optimized fan casing, optimum annular clearance between impeller eye and intake nozzle, acoustical lining of the interior of the fan casing, using minima of the fan acoustic radiation efficiency, and resonators at the cutoff.

82-1848

Acoustic Similarity Laws for Fans

W. Neise and B. Barsikow

Deutsche Forschungs- und Versuchsanstalt f. Luft- und Raumfahrt e.V., Inst. f. Experimentelle Stromungsmechanik, Abteilung Turbulenzforschung, 1000 Berlin 12, West Germany, J. Engrg. Indus., Trans. ASME, 104 (2), pp 162-168 (May 1982) 11 figs, 10 refs

Key Words: Fans, Noise prediction

In order to verify experimentally acoustic similarity laws for fans, experiments were made with three dimensionally similar centrifugal fans of 140, 280, and 560 mm impeller diameter. The fans were connected to anechoically terminated discharge ducts. From the experimental results it is concluded that fan noise data that are taken on model fans can be extrapolated to other dimensionally similar fans of different size for arbitrary fan speeds and working fluids, provided that the operating condition and the measurement position are the same.

82-1849

The Transient Characteristics of a Pump during Start Up

S. Saito

Res. and Dev. Ctr. for Hydraulic Machinery, Haneda Plant, Ebara Corp., 11-1 Haneda, Asahi-cho, Ota-ku, Tokyo, Japan, Bull. JSME, 25 (201) pp 372-379 (Mar 1982) 9 figs, 2 tables, 6 refs

Key Words: Pumps, Transient response, Start up response

For the purpose of clarifying the transient characteristics of a diffuser pump during start up, a series of tests were carried out in which three factors affecting the characteristics were varied. These factors were mass of water in the pipeline, valve opening and starting time. The results of the tests indicate that the locus of operating points on the head-capacity plane during pump start up deviates from the system resistance curve to a great degree as the mass of water in the pipeline becomes large and the starting time becomes short, and the trail of the operating points approaches the shut-off point. Analysis of the total pump system was made on the basis of one dimensional equations of motion using an analog computer. The results of the analysis compared well with those obtained from the experiments. Axial thrust during start up was measured and is also discussed.

82-1850

Testing and Dynamic Simulation of Offshore Compression Systems Can Pay Off in the Field

R. Williams

Rojan Engrg. Ltd., Bexley, Kent, UK, Oil Gas J., 80 (18), pp 202-212 (May 3, 1982) 5 figs, 1 table

Key Words: Off-shore structures, Compressors, Testing techniques, Simulation

A comprehensive testing program for all compression equipment of offshore oil and gas platforms is presented. A dynamic simulation study which should be made of the complete process separation/compression system is described. The article also gives typical details of these programs and highlights the benefits to be gained by the contractor, field operator and others.

82-1851

An Aerothermodynamic Analysis of Transonic Compressor Rotors Containing Three-Dimensional Shocks

Xu Jian-zhong, Jiang Zuo-ren, Yang Jin-sheng, Zhang Ying, and Du Zhuan-sfie

Inst. of Engrg. Thermophysics, Academia Sinica, Peking, China, J. Engrg. Power, Trans. ASME, 104 (2), pp 386-393 (Apr 1982) 11 figs, 1 table, 23 refs

Key Words: Rotors, Compressors, Shock waves

Based on the basic aerothermodynamic equations in the differential and integral forms on an arbitrary stream surface in an arbitrary nonorthogonal curvilinear coordinate system derived in this paper, the relations between gas parameters ahead of and behind a shock on such a stream surface are established. These relations are greatly different from the relations for a plane shock because they contain the normal direction of the spatial shock, and the correlations between the stream surfaces are closer. Assuming the location and shape of the shock and using the above relations, calculations on the generalized surfaces of revolution are made, and the iterations between these calculations and the calculation on the central S_2 stream surface are completed. These computational results and comparison with those of the conventional throughflow calculation demonstrate some important features of the three-dimensional shock and the transonic flow in an axial compressor rotor.

82-1852

Dynamic Response of a Clamped/Free Hollow Circular Cylinder under Travelling Torsional Impact Loads

J.B. Jonker

Ultra-Centrifuge Lab., Planthofsweg 85, Almelo, The Netherlands, Nucl. Engrg. Des., 67 (2), pp 191-201 (1981) 16 figs, 4 refs

Key Words: Rotors, Casings, Cylinders, Moving loads, Shock excitation, Vibration response, Torsional response

Impact-induced vibrations in the casing of a gas centrifuge due to a sudden failure of the spinning rotor (crash) can cause structural disintegrity of the casing. In order to study the influence of the rotor failure behavior and the impact load histories on the dynamic response of the casing, a simple crash model is proposed to analyze the transient torsional response due to tangential components of the impact loads. The casing is modeled as a linear-elastic hollow circular cylinder, clamped at the lower end and free at the upper end. A perturbation method is used to show that the general two-dimensional theory of axi-symmetric torsional wave propagation in circular cylinders may be approximated by the elementary one-dimensional theory. Solutions are obtained according to the usual modal expansion approach. Measurements of transient torsional responses are shown to be in good agreement with the calculated responses by choosing a suitable shape of the pulses. The effects of traveling velocity and pulse shape are investigated. The transfer of kinetic energy in the rotor to vibrational energy of torsion in the casing is studied.

82-1853

A Method to Observe and Record Vibration Modes of Rotating Circular Objects

E. Möller and U. Ringh

Dept. of Physics and Measurement Tech., Linköping Univ., Linköping, Sweden, Exptl. Mech., 22 (6), pp 226-230 (June 1982) 3 figs, 3 refs

Key Words: Saws, Circular saws, Disks (shapes), Vibration measurement

A method has been developed to record the vibration modes of a rotating circular disk; in this case a circular saw, at various rotating speeds. A picture is produced on a cathode-ray-tube display and photographed. The vibrations are measured by means of a sensor at a variable position along a radius of the saw. The signal is fed to the intensity input of the display, the oscilloscope beam being swept circularly in synchronism with the saw to derotate the pattern. Exposures are made at successively increasing sensor radius and corresponding sweep radius. The picture obtained is less detailed than a holographic picture, but the method is easy to apply, even for rotating objects with a certain skewness.

82-1854

An Analysis of the Movement of the Crankshaft Journals during Engine Firing

M. Ishihama, Y. Hayaski, and T. Kubozuka

Central Engrg. Labs., Nissan Motor Co., Ltd., Yokosuka, Japan, SAE Paper No. 810772

Key Words: Crankshafts, Combustion noise

In order to clarify the generation mechanism of engine noise, which is a significant problem in the first-burn engine, the behavior of the crankshaft, the force transferred to the main bearing caps supporting the crankshaft, and the deformation of the cylinder block, were analyzed during engine firing. As a result, it was determined that the crankshaft which deflects due to inertial force pushes the bearings violently under combustion pressure and causes intense fore-and-aft vibration of the bearings, which in turn causes vibration of the cylinder-block skirt. This is a main cause of combustion noise.

RECIPROCATING MACHINES

(Also see Nos. 1973, 1986)

82-1855

Diesel Noise Reduction: A Study

R.G. DeJong and N.E. Parsons

Cambridge Collaborative, Inc., Auto. Engr. (SAE), 90 (6), pp 70-74 (June 1982) 7 figs, 1 table (Based on SAE Paper 820240, "Piston Slap Noise Reduction in a Vee-Block Diesel Engine," by R.G. DeJong and N.E. Parsons)

Key Words: Diesel engines, Engine noise, Noise reduction, Acoustic linings

A design modification in the cylinder liner and block bore in a diesel engine has reduced piston slap noise by four dB(A).

POWER TRANSMISSION SYSTEMS

82-1856

Studies on a Hydraulic Oscillator (3rd Report, Theoretical Analysis of the Oscillator with a Servovalve Mechanism)

S. Konami and T. Maeda

Dept. of Aeronautical Engrg., The Natl. Defense Academy, Hashirimizu Yokosuka, Japan, Bull. JSME, 25 (201), pp 380-386 (Mar 1982) 10 figs, 1 table, 5 refs

Key Words: Oscillators, Hydraulic equipment, Self-excited vibrations

A combined use of a vibratory element and a servovalve is available for the application of the hydraulic oscillator utilizing the self-excited vibration phenomenon. The vibratory characteristics of the hydraulic oscillator with the servovalve mechanism depend on the dynamic characteristics of the actuator connected with it. The nondimensionalized simultaneous equations of motions regarding an oscillator with servovalve mechanism and an actuator connected with it were derived and by using an analog computer, the solutions to the equations of which coefficients were systematically varied were obtained. By this analog simulation analysis, the effects of the nondimensionalized factors representing actuator characteristics on the hydraulic oscillator characteristics were clarified, and a guide to designing a hydraulic oscillator with the servovalve mechanism is presented.

MATERIALS HANDLING EQUIPMENT

(See No. 1925)

STRUCTURAL SYSTEMS

BRIDGES

82-1857
Dynamic Analysis of Cable-Stayed Bridges
R. Mirghaderi
Ph.D. Thesis, Purdue Univ., 209 pp (1981)
DA8210230

Key Words: Bridges, Cable stayed bridges, Moving loads, Computer programs, Impedance technique

The structural impedance approach is extended to study the transient response of bridges due to general traffic conditions. A computer code STRIM is developed to study the dynamic behavior of bridges subjected to several types of traffic loads. It is demonstrated that the present approach has the capability of modeling the complete dynamic interactions between the vehicles and the bridge structure. More importantly, a bridge can more readily be modeled as a two or three dimension structure. More realistic traffic loads such as a sequence of moving vehicles with variable speeds and accelerations can be included.

82-1858
Highway Bridge Vibration Studies
J.T. Gaunt and C.D. Sutton
Joint Highway Research Project, Purdue Univ., Lafayette, IN, Rept. No. FHWA/IN/JHRP-81/11, 120 pp (July 1, 1981)
PB82-162918

Key Words: Bridges, Moving loads, Traffic-induced vibrations, Vibration measurement, Vibration analysis

The general objectives of this research have been to obtain a better understanding of the dynamic performance of highway bridges and of the vibrations sensed by bridge users in order to aid in the development and implementation of a dynamic-based design criterion which can more effectively ensure the comfort of pedestrians, maintenance workers, cyclists, etc. Because the human body is primarily sensitive to changes in motion, the investigations have focused on accelerations. Special purpose computer programs were used for parametric studies of the bridge vehicle system. Significant parameters were found to be span length, weight and speed of the vehicle, and the roughness of the bridge deck.

BUILDINGS

82-1859
Dynamic Response of the Imperial County Services Building during the 1979 Imperial Valley Earthquake
J.M. Pauschke
Ph.D. Thesis, Stanford Univ., 222 pp (1982)
DA8208886

Key Words: Buildings, Multistory buildings, Concretes, Reinforced concrete, Earthquake damage, Seismic response

This dissertation investigates the response of the Imperial County Services Building during the Imperial Valley earthquake of October 15, 1979. The response of this six-story reinforced concrete frame and shear wall building is of significance to earthquake engineering because it is the first response recorded in a building which suffered major structural damage due to strong ground motion. Because the building was extensively instrumented, a nonparametric analysis of the response using all records obtained in the building and at the nearby free field site is derived to study important response features during the earthquake. A time-varying spectrum is generated for each acceleration record which decomposes the acceleration into a function of time and frequency. This enables the translational and torsional responses and the influence of pile-foundation-structure interaction to be studied.

TOWERS

(Also see No. [illegible])

82-1860

Evaluation of Percent Critical Damping of Process Towers

K.C. Karamchandani, N.K. Gupta, and J. Pattabiraman

Engineers India Ltd., New Delhi, India, Hydrocarbon Processing, 61 (5), pp 205-208 (May 1982) 2 figs, 4 tables, 7 refs

Key Words: Towers, Seismic excitation, Wind-induced excitation, Damping

It is suggested that for wind and seismic analysis of tall process towers, percent critical damping should be assessed by considering several contributing factors judiciously for a more economic design. These factors are analyzed here.

FOUNDATIONS

(Also see No. 1912)

82-1861

Body Wave Excitation of Embedded Hemisphere

V.W. Lee and M.D. Trifunac

Dept. of Civil Engrg., Univ. of Southern California, University Park, Los Angeles, CA 90007, ASCE J. Engrg. Mechanics Div., 108 (EM3), pp 546-563 (June 1982) 15 figs, 13 refs

Key Words: Rigid foundations, Elastic half-space, Seismic excitation, Interaction: structure-medium

Solutions of three-dimensional vibrations of an embedded hemispherical foundation are presented for excitation by incident plane, P, SV, and SH waves with arbitrary angles of incidence. The effects of embedment are illustrated by comparing the motion of the embedded hemispherical foundation with those of a rigid disc bonded to a half space of equal radius and excited by the same waves. The impedance matrix and the foundation motion are analyzed and compared with similar and related approximate solutions. In the context of Fourier synthesis, the results can be viewed as representing the transfer functions for the forces and motions of the foundation. For arbitrary transient excitation which can be represented by plane body waves, the results can be used to calculate the transient motion of the foundation.

82-1862

Incremental Constitutive Law for Sands and Clays: Simulations of Monotonic and Cyclic Tests

F. Darve and S. Labanieh

Institut de Mécanique, Université Scientifique et Médicale, Grenoble, France, Intl. J. Numer. Anal. Methods Geomech., 6 (2), pp 243-275 (Apr-June 1982) 18 figs, 5 tables, 43 refs

Key Words: Soils, Sand, Clays, Cyclic loading, Constitutive equations

An incremental formulation of constitutive laws is presented and the fundamental notion of incremental nonlinearity, necessary for the description of cyclic behavior of soils, is emphasized. The incremental constitutive law for soils and its principal assumptions, which make it more general than the classical elastic-plastic models, are detailed. The constitutive parameters of Hostun sand and Grundite clay are given, as well as a comparison of theoretical results with experimental axisymmetrical and true triaxial measurements. Different cyclic behavior simulations are presented, as well as an example of cyclic liquefaction of Monterey loose sand. Finally, a simple shear test is simulated.

HARBORS AND DAMS

82-1863

Earthquake Induced Longitudinal Vibration in Earth Dams

A.M. Abdel-Ghaffar

Dept. of Civil Engrg., Princeton Univ., NJ, Rept. No. 80-SM-14, NSF/RA-800625, 135 pp (Dec 1980) PB82-147844

Key Words: Dams, Earthquake response, Seismic response, Natural frequencies, Mode shapes, Longitudinal vibration

Two-dimensional analytical elastic models were developed for evaluating natural frequencies and modes of vibration of a wide class of earth dams in a direction parallel to the dam axis. The nonhomogeneity of the dam materials was considered as well as both shear and normal (axial) deviations. Dynamic properties of three real earth dams in Southern California estimated from their earthquake records and the dynamic test results of one dam, are compared with those from the suggested models. It was found that the models in which both the shear modulus and the modulus of elasticity of the dam material vary along the depth provide the most appropriate representations for predicting the dynamic characteristics. The theoretical results from some of the models compared favorably with the experimental and earthquake data.

82-1864

Shear Vibration of Vertically Inhomogeneous Earth Dams

G. Gazetas
Dept. of Civil Engrg., Rensselaer Polytechnic Inst., Troy, NY 12181, Intl. J. Numer. Anal. Methods Geomech., 6 (2), pp 219-241 (Apr-June 1982) 12 figs, 3 tables, 21 refs

Key Words: Dams, Seismic response

Closed-form solution to the problem of free vibrations of vertically inhomogeneous earth dams, modeled as truncated-wedge-shaped shear beams, has been obtained by implementing an inverse procedure in which the determination of the function describing the inhomogeneity constitutes part of the problem. The resulting cube-root variation of the shear-wave velocity with distance from the crest compares favorably with measurements in two Japanese dams. The results of the method are presented in the form of natural periods, modal shapes and average seismic coefficients for a number of truncation ratios. Compared with an equivalent homogeneous dam, the inhomogeneous experiences sharper amplification of modal displacements and greater average seismic coefficients near the crest and has natural periods which are closer to each other.

POWER PLANTS

(Also see Nos. 1955, 2023)

82-1865

Response of Fast-Reactor Core Subassemblies to Pressure Transients

J. Donea, S. Giuliani, J.P. Halleux, P. Granet, P. Hamon, and P. Permezel
Appl. Mechanics Div., Joint Res. Ctr. of the Commission of the European Communities, Ispra Establishment, I-21020 Ispra (Va), Italy, Nucl. Engrg. Des., 68 (2), pp 153-174 (1981) 23 figs, 21 refs

Key Words: Nuclear reactor components, Interaction: structure-fluid, Ducts, Finite element technique

An Arbitrary Langrangian-Eulerian (ALE) finite element method for analyzing the transient, nonlinear fluid-structure interaction in fast-reactor core subassemblies is presented. The method combines the basic attributes of the finite element technique – namely, ease in modeling complex geometries and in mixing fluid elements with structural elements – and the flexibility in moving the fluid mesh offered by the ALE description. The result of this combination is a very versatile modeling technique which permits accommodation of large fluid and structure displacements and logically simple, but accurate fluid-structure coupling. Numerical results are presented to illustrate the effectiveness of the proposed method. These include the response of a single hexagonal duct to internal, static or dynamic, pressure loading for which numerical predictions are compared to experimental data, and applications to clustered hexcans.

82-1866

A Study on the Dynamic Behaviour of a Prestressed Burst Protection System with Varying Boundary Conditions

W. Matthees
Bundesanstalt f. Materialprüfung (BAM), Referat "Konstruktionstechnische Reaktorsicherheit," Unter den Eichen 87, D-1000 Berlin 45, W. Germany, Nucl. Engrg. Des., 67 (2), pp 227-243 (1981) 20 figs, 3 tables, 63 refs

Key Words: Nuclear power plants, Nuclear reactors, Pressure vessels, Nuclear reactor containment, Containment structures

A burst protection system for a nuclear reactor signifies an additional passive safeguard. In case of a hypothetical failure of the prestressed reactor pressure vessel, this system serves to avoid the accidental release of radioactivity from the containment building. This paper contains a numerical study of the burst protection construction, including a study of the sensitivity of results to mechanical and numerical parameters. It shows to what extent an accurate evaluation of the important parameters for the numerical computation is needed when discretizing the structural system.

OFF-SHORE STRUCTURES

(Also see No. 1850)

82-1867

Development of Offshore Structural Analysis Programme (OSAP). Part 2: Wave-Structure and Soil-Structure Interaction of Offshore Structures Using OSAP

K. Munasamy, K. Subbaraj, and A.S.J. Swamidas
Indian Inst. of Tech., Madras, India, Rept. No. TR-16, 227 pp (Nov 1980)
PB82-167982

Key Words: Pile structures, Towers, Off-shore structures, Wave forces, Interaction: soil-structure, Computer programs

The work done on wave force estimation using deterministic wave profiles and Morison-O'Brien's equation and soil-structure interaction of vertical and inclined piles using modified Mindlin's equations of Penzien and p-y curves, is presented. Wave forces are calculated for any direction of wave heading in a three-dimensional tower with a general directional orientation of members. Soil-structure interaction of vertical or inclined piles are considered for sandy, stiff clay or soft clay soil strata.

82-1868

Measurement and Prediction of Vibration Response of Deepwater Offshore Structures

N. Doelling
Marine Industry Advisory Services, Massachusetts Inst. of Tech., Cambridge, MA, Rept. No. MITSG-81-3, OPPORTUNITY BRIEF-22, NOAA-81102108, 25 pp (July 1,1981)
PB82-148305

Key Words: Offshore structures, Wave forces, Natural frequencies, Resonant frequencies, Damping coefficients

Good engineering practice for the design of very large deepwater structures leads to structures with lower resonance frequencies. These natural resonance frequencies are within a range at which waves from small storms are quite energetic. The dynamic amplification of the motion at the natural resonances leads to a serious possibility of damage due to moderate stress, high cycle fatigue. For this reason, detailed knowledge of the vibration response of large offshore structures excited by wave forces is essential for making a safe and effective design. This brief focuses on three related aspects. First, a powerful new method is described for predicting displacement responses of a structure at its natural frequencies when excited by random wave forces. The second aspect of the work discusses new approaches to the measurement of damping. The third area describes analytical and experimental work in predicting damping of structures in the ocean environment, and especially the dependence of damping on sea state. Progress in understanding and forecasting of damping arising from nonlinear interaction of structural vibration and wave motion is described.

VEHICLE SYSTEMS

GROUND VEHICLES

(Also see Nos. 1898, 1899, 1903, 1906, 1909, 1910, 1976, 2049, 2051, 2055, 2056)

82-1869

The Use of Acoustic-Intensity Scans for Sound Power Measurement and for Noise Source Identification in Surface Transportation Vehicles

J. Pope, R. Hickling, D.A. Feldmaier, and D.A. Blaser
Engrg. Mechanics Dept., General Motors Res. Labs., Warren, MI, SAE Paper No. 810401

Key Words: Transportation vehicles, Ground vehicles, Diesel engines, Trucks, Automobile engines, Locomotives, Noise source identification, Noise measurement, Measurement techniques

The results are reported of near-field, acoustic-intensity scans of a diesel-engine truck, chassis-mounted passenger-car engines, and a railroad locomotive. The measurements were made using the two-microphone, cross-spectral method of measuring acoustic intensity. The results demonstrate the value of the method for measuring the overall sound power of a vehicle as well as for identifying its component noise sources. A review of theory and methodology is provided.

82-1870

Validation of Rail Vehicle System Dynamic Models

P.V. RamaChandran, A.J. Gilchrist, M.M. ElMadany, and K. Cappel
Wyle Labs., Colorado Springs, CO, Intl. J. Vehicle Des., 3 (2), pp 202-233 (May 1982) 34 figs, 2 tables, 18 refs

Key Words: Railroad cars, Freight cars, Mathematical models

This paper presents results of a validation effort carried out on several analytical models that deals with the dynamic behavior of railway freight cars. Model validation criteria for the four principal performance regimes – lateral stability, trackability, steady state curve negotation and ride quality – are developed. The validation criteria and results are discussed in the context of available field test data.

82-1871

A Study on Drum-Brake Noise of Heavy Duty Vehicle

Y. Suzuki and H. Ohno
Hino Motors, Ltd., Japan, SAE Paper No. 811399

Key Words: Ground vehicles, Brakes (motion arresters), Noise generation, Resonant response

An experimental study on brake noise having a main frequency of about 500 Hz is presented. From the vibration modes of the brake components during the brake noise occurrence, some resonance systems which might be the cause of the noise were investigated. From the resulting evaluation of the noise by changing the vibration characteristics of the resonance system through modification of the brake components, it was found that the spring constant and the damping coefficient of the wheel brake component correlate well to the brake noise level.

82-1872

Automotive Applications of Three-Dimensional Acoustic Finite Elements

S.H. Sung
Engrg. Mechanics Dept., General Motors Res. Labs., General Motors Technical Ctr., SAE Paper No. 810397

Key Words: Automobiles, Interior noise, Cavity resonators, NASTRAN (computer programs), Finite element technique

Three-dimensional acoustic finite elements have been applied to calculate the knock-induced cavity resonances for combustion chambers and the cavity booming frequencies for passenger compartments. The NASTRAN finite element program is employed to solve the acoustic free-vibration problems, and resonant frequencies obtained from these numerical predictions are compared with experimental results. Resonant mode shapes are shown and illustrate the acoustic pressure distributions and nodal surfaces for particular resonant frequencies. Results are presented for a prismatic passenger compartment with bench-seat model and for a general bucket-seat model with irregular cross-sectional seat contours. A rather complicated cavity model such as a combustion chamber is included to illustrate the capabilities of the finite element analysis. Results illustrated are of interest in combustion chamber thermodynamic property studies, knock-sensor designs, and vehicle interior noise studies.

82-1873

Digital Experimental Techniques Applied to Low Frequency Shake Phenomena

J.M. O'Keeffe, W.G. Sutcliffe, I. Scheelke, and U. Proepper
SDRC-Engineering Services (UK/Scan), Ltd., SAE Paper No. 810094

Key Words: Automobiles, Testing techniques, Low frequencies, Steering gear, Shakers, Modal tests

Digital experimental techniques have been used to investigate the dynamic behavior of vehicles. The desire to combine experimental and analytical data in a compatible form led to a test program which applied these techniques to provide design insight into low frequency shake phenomena. Operating tests defined the forces responsible for low frequency shake using narrow band spectra and order tracking techniques. Total deformation patterns were measured under operating conditions to determine the controlling elements participating in the vibration perceived at the steering wheel. Modal testing of the vehicle provided a mathematical model of the car over the frequency range 10-50 Hz. This model predicted the effect of modifications to the vehicle before they were implemented. The change in steering column response was monitored to assess the effect of these changes. Analytical predictions were confirmed by testing the modified vehicle.

82-1874

Crush Strength Analysis of Lightweight Vehicle Frame Components

C.M. Ni
Engrg. Mech. Dept., General Motors Res. Labs., Warren, MI, SAE Paper No. 810232

Key Words: Automobiles, Automobile bodies, Compressive strength, Energy absorption, Steel, Aluminum, Fiber composites, Experimental test data

An analytical technique is presented to analyze the crush strength (or force-deflection curve) of lightweight vehicle frame components which are made of high-strength steel, aluminum alloy, and fiber-reinforced composite. Experimental data are also included. It has been found that plastic flow of material and local buckling of sections are the key factors influencing the crush strength of metal structures, while elastic modulus and fracture strain are the dominant factors for fiber-reinforced composites such as glass-polyester and graphite-epoxy in their crush strength.

82-1875

Dynamic Computer Simulation of a Vehicle with Electronic Engine Control

R.G. DeLosh, K.J. Brewer, L.H. Buch, T.F.W. Ferguson, and W.E. Tobler
Advanced Engine Engrg. Office, Ford Motor Co., Allen Park, MI, SAE Paper No. 810447

Key Words: Automobiles, Computerized simulation

A computer model which simulates the dynamic interactions among the components of the engine, electronic control system, and drivetrain is described. The model consists of a combination of experimental data and mathematical submodels representing components and physical phenomena. The model also contains a simulation of the human driver which can follow the FTP speed trace, and which can perform a variety of other tests. Use of the model is demonstrated with a study of air/fuel transients due to manifold filling.

82-1876

Crash Data Analysis and Model Validation Using Correlation Techniques

J. Jovanovski
Ford Motor Co., SAE Paper No. 810471

Key Words: Automobiles, Collision research (automotive), Computerized simulation, Experimental test data, Error analysis, Correlation techniques

A quantitative comparison technique for evaluating similarities between sets of data resulting from a common random process is presented. The normalized integral square error (NISE) criterion is derived using correlation techniques and is applied to deceleration-time histories obtained from six vehicle crash tests in an attempt to relate the vehicle response to the crash event. Intercomparison of the six sets of data using NISE suggests that differences in amplitude and phase shift may account for much of the discrepancy between sets of test data. That is, the magnitude and the time of occurrence of deceleration peaks determine to a large extent the value of the comparator, NISE.

82-1877

Development and Application of a Multi-Channel Load Sensing System for Research of Crashworthiness

K. Ogata, Y. Tanaka, and K. Shibata
Toyota Motor Co., Ltd., Japan, SAE Paper No. 810381

Key Words: Automobiles, Crashworthiness, Collision research (automotive), Impact tests, Guard rails, Energy absorption

A multi-channel load sensing system has been developed to measure impact loads of all required vehicle structure parts independently during impact against a fixed barrier. By using the above load cell for rear-end collision against a fixed barrier for two different rear body types, the distribution of the impact loads and the energy absorption of the required vehicle structural parts is clarified.

82-1878

Energy Absorption of Glass Polyester Structures

P.A. Kirsch and H.A. Jahnle
The Budd Co. Technical Ctr., SAE Paper No. 810233

Key Words: Automobiles, Passenger vehicles, Energy absorption, Glass reinforced plastics, Compressive strength

This study, conducted in two parts, was directed toward the characterization of glass fiber reinforced polyesters and their ability to absorb crash energy. The first part of the study entailed evaluating the crushing characteristics of various hand lay-up and commercially available glass fiber reinforced polyester samples. The second part of the study used compression molded low profile sheet molding compound material for the crushing samples. Evaluation of foam filled samples was also performed in each half of the study.

82-1879

Application of a Structural-Acoustic Diagnostic Technique to Reduce Boom Noise in a Passenger Vehicle

C.A. Joachim, D.J. Nefske, and J.A. Wolf, Jr.

Engrg. Dept., General Motors Holden's Ltd., Port Melbourne, Australia, SAE Paper No. 810398

Key Words: Automobiles, Passenger vehicles, Vibration control, Noise source identification, Noise reduction

An acoustic finite element capability and a Fourier analysis capability are employed to identify the structural areas that cause boom noise in a vehicle. The noise occurs in the 127-140 Hz frequency range and results from the forces transmitted to the body structure from the vibration of the engine on its mounts. The phenomenon is diagnosed as being caused by panel vibrations exciting the second longitudinal acoustic resonance of the passenger compartment. Several panels around the front of the compartment are identified as being significant to the excitation of this resonance, and weights are added to various panels to change their vibration characteristics. The noise in the compartment is thereby reduced by 8 dB, and the suggested change is, therefore, the modification of these panels.

82-1880

Crash Tests of Minnesota Mailbox Supports

H.E. Ross, Jr., A. Arnold, and R.A. Zimmer

Texas A&M Res. Foundation, College Station, TX, Rept. No. RR-4461-1F, FHWA/MN-81/8, 50 pp (July 1981)

PB82-164377

Key Words: Collision research (automotive), Mailboxes

Because snow presents a special problem for rural mailbox installations, the Minnesota Department of Transportation developed cantilevered mailbox support designs. Recent studies showed that certain rural mailbox installations easily penetrated the passenger compartment of an impacting vehicle. These same studies pointed out that a large number of people are seriously injured or killed each year as a result of mailbox collisions. A full scale crash test was initiated to ascertain the crashworthiness of the cantilevered design.

82-1881

Static-to-Dynamic Amplification Factors for Use in Lumped-Mass Vehicle Crash Models

P. Prasad and A.J. Padgaonkar

Ford Motor Co., SAE Paper No. 810475

Key Words: Collision research (automotive), Compressive strength, Energy absorption, Lumped mass method

One-dimensional, lumped-mass models for predicting the dynamic response of vehicles in crashes have been used extensively in recent years. The energy-absorbing characteristics, i.e., the load/deflection data, for use in the models are determined from static crusher tests of actual vehicle components. In order to account for the crush rate effects on the structure, a transformation is needed to extrapolate the statically obtained data to the dynamic case. The transformation factors – the static-to-dynamic amplification factors – are empirically derived and have been reported by some investigators to be linearly and by others to be logarithmically related to crush rate. This paper reports on the development of dynamic amplification factors for vehicles with framed structures; e.g., light trucks and S-framed cars, and unibody cars. The factors were developed by exercising lumped-mass models with various forms of dynamic amplification factors and comparing the model results with results from crash tests.

82-1882

Van Crashworthiness and Aggressivity Study

S. Davis and S. Peirce

Dynamic Science, Inc., SAE Paper No. 810090

Key Words: Collision research (automotive), Vans, Guardrails, Dynamic tests

Six van tests were conducted against a unique load-measuring barrier to study the crashworthiness and aggressivity of two typical van models at speeds of 15, 25, and 30 mph. Two additional tests were conducted between each of the two van models and a typical full size passenger car.

82-1883

Experimental Investigation of Crash Barriers for Measuring Vehicle Aggressiveness – Fixed Rigid Barrier Initial Results

R.A. Saul, T.F. MacLaughlin, and D. Cohen

Vehicle Res. and Test Ctr., Natl. Highway Traffic Safety Administration, U.S. Dept. of Transportation, East Liberty, OH, SAE Paper No. 810093

Key Words: Collision research (automotive), Guardrails

This paper presents the initial results of a crash test program designed to evaluate the ability of three different barriers to measure vehicle aggressiveness. The barriers included in the study are the fixed rigid, load cell fixed and moving deformable. Previous crash tests and analytical studies conducted to determine causes of aggressiveness and ways of measuring aggressiveness are reviewed. Full frontal car-to-car and fixed rigid crash test results of an aggressive and a non-aggressive car are presented and compared.

SHIPS

82-1884

Design Procedures for Embedment Anchors Subjected to Dynamic Loading Conditions

H.G. Herrmann

Naval Civil Engrg. Lab., Port Hueneme, CA, Rept. No. NCEL-TR-888, 76 pp (Nov 1981)

AD-A110 325

Key Words: Ship anchors, Dynamic response, Impact shock, Cyclic loading, Seismic excitation

This report provides procedures for determining allowable design loads for embedment anchors under all types of dynamic loads, including impact (as from a ship driving into a mooring), cyclic (as from a buoy or ship riding in a mooring system during a storm), and earthquake loading. The design procedures are simplified in the form of guidelines applicable to most site conditions.

AIRCRAFT

(Also see Nos. 1919, 1927, 2019, 2020, 2021)

82-1885

Large Scale Model Measurements of Airframe Noise Using Cross-Correlation Techniques

W.R. Miller, W.C. Meecham, and W.F. Ahtye

Univ. of California, Los Angeles, CA 90024, J. Acoust. Soc. Amer., 71 (3), pp 591-599 (Mar 1982) 7 figs, 4 tables, 22 refs

Key Words: Aircraft noise, Sound measurement, Cross correlation techniques

Cross-correlation techniques are used to measure the sound radiated by wing/flap airfoil configurations in the NASA-Ames 40- by 80-ft wind tunnel using a 6.7-m semispan model with three deployed flaps. The sound from the flap side edges exceeds other airframe noise sources by more than 10 dB, with the noise from the side edges of the leading flaps the strongest. The radiated sound is estimated using two formulas based on the standard aeroacoustic theory and one method using only the near and farfield cross correlation. The last method is essentially independent of such theory. The classic dipole angular distribution pattern is modified by wing diffraction effects to yield stronger radiation in the forward direction.

82-1886

Fundamental Torsional Frequency of a Class of Solid Wings

E.H. Mansfield

Royal Aircraft Establishment, Farnborough, UK, AIAA J., 20 (6), pp 845-848 (June 1982) 2 figs, 4 refs

Key Words: Aircraft wings, Torsional vibration, Fundamental frequency, Natural frequencies

This paper determines the fundamental torsional frequency of certain wings whose polar moment of inertia is proportional to the torsional rigidity at any section, as in a solid wing with a fixed t/c ratio. An inverse method of analysis is used in which the spanwise variation of rigidity and polar moment of inertia is related to an assumed spanwise variation of rotation in the fundamental torsional mode. The usefulness of this apparently hit-or-miss technique stems from the ease with which families of solutions may be generated. The results, which are augmented by a direct solution for wings with a constant taper, are expressed graphically in a form which relates the fundamental torsional frequency to the derived spanwise variation of the chord.

82-1887

Tailoring the Composite Mission Profile Environments for Reliability Testing

D. Everett

Pacific Missile Test Ctr., "Enhancement of Quality through Environmental Technology," Proc. of 28th Annual Technical Meeting of the Institute of Environmental Science, Atlanta, Georgia, Apr 21-23, 1982, pp 3-6, 3 refs

Key Words: Aircraft wings, Wing stores, Simulation, Flight simulation, Standards and codes

Some instances of tailoring associated with a new MIL-STD-810D test method "Composite Mission Profile Combined Environment Reliability Test for Externally Carried Aircraft Stores" are reviewed. The test method is an outgrowth of ten years of successful test experience with Navy air launched missiles. In that time period, more than 60,000 flight hours have been simulated in thermo acoustic test facilities with nine different missile types. The simulated flight environment has been limited to temperature and vibration, corresponding to the captive flight part of the life cycle and conducted in reverberant acoustic chambers. Since the test results have been realistic in failure rates and failure modes, the limits in the environmental simulation are considered instances of successful test tailoring incorporated in the method. Each of the environmental simulation limits is discussed. The method requires and controls some limits in the complexity, intensity and techniques in the application of the test environments. Each of these limits and how they can contribute to a cost effective test design is also discussed.

82-1888

Evaluation of Methods for Prediction and Prevention of Wing/Store Flutter

S.J. Pollock, W.A. Sotomayer, L.J. Huttsell, and D.E. Cooley
Air Force Wright Aeronautical Labs., Wright-Patterson AFB, OH, J. Aircraft, 19 (6), pp 492-498 (June 1982) 16 figs, 19 refs

Key Words: Aircraft, Wing stores, Flutter, Vibration control

In response to the need to reduce costs and improve safety for flutter evaluation of aircraft carrying external stores, the Flight Dynamics Laboratory has sponsored several efforts in the technical areas of unsteady aerodynamics, flutter prediction, and active flutter suppression. This paper discusses each of these three areas as they relate to wing/store flutter and presents specific examples from analyses and tests. NLR, the Netherlands, measured aerodynamic data in the wind tunnel at subsonic, transonic, and supersonic speeds on a fighter wing with tip mounted launcher and store and also with underwing pylon and store. Store flutter calculations were performed using both calculated and measured aerodynamics to determine the influence of store aerodynamics on the flutter characteristics.

82-1889

Analysis of Missile Response to Gunfire

R.G. Merritt and S.N. Tanner
Naval Weapons Ctr., "Enhancement of Quality through Environmental Technology," Proc. of 28th Annual Technical Meeting of the Institute of Environmental Science, Atlanta, Georgia, Apr 21-23, 1982, pp 33-41, 6 figs, 2 tables, 3 refs

Key Words: Missiles, Gunfire effects, Aircraft equipment response

Response measurements have been made on a missile exposed to pressure pulses from a gun mounted adjacent to the missile in two aircraft captive-carry configurations. In order to provide a basis for laboratory simulation of the environments an analysis based on an input/output model is performed, with careful attention given to the response relationships at three stations along the axis of the missile.

82-1890

Sting Interference Effects on the SDM Aircraft as Determined by Measurements of Dynamic Stability Derivatives and Base Pressure for Mach Numbers 0.3 through 1.3

F.B. Cryan and M.J. Chaney
Arnold Engrg. Dev. Ctr., Arnold AFS, TN, Rept. No. AEDC-TSR-80-P70, 52 pp (Oct 1980)
AD-A110 324

Key Words: Aircraft, Supports, Dynamic stability, Experimental test data

An investigation was conducted to determine the effects of sting-support interference on the measurement of pitch damping, yaw-damping, pitching-moment slope, yawing-moment slope, pitching moment, and base pressure. The forced oscillation technique was used to obtain data at Mach numbers 0.3 to 1.3 and Reynolds numbers, based on the model mean aerodynamic chord, of 0.3 million to 3.1 million. Amplitudes of oscillation were 1.0, 1.5, and 2.0 deg, and the reduced frequency parameter ranged from 0.009 to 0.032 radians.

82-1891

Status of Dynamic Flight Test Technology -- Model Identification for Flight Simulation

J.A. Mulder and J.G. den Hollander
Delft Univ. of Tech., SAE Paper No. 810597

Key Words: Aircraft, Flight simulation, Parameter identification technique, Mathematical models

Dynamic flight test technology has by now emerged as a valuable tool for assessment of aircraft performance characteristics and stability and control characteristics. In this paper emphasis is on applications in the context of flight simulation. It is shown that after flight path reconstruction and reconstruction of the motion of the primary control

system a linear and stepwise identification procedure can be applied for the development of aerodynamic models and models of primary control force characteristics. These models can be implemented in mathematical models for aircraft flight simulation.

puted for different flight Mach numbers, thickness to chord ratios, flight altitudes, and wing loadings. It is noted that the booms due to volume and lift are of comparable magnitude even for high flight altitudes.

82-1892

Shock Associated Noise of Supersonic Jets from Convergent-Divergent Nozzles

C.K.W. Tam and H.K. Tanna

Lockheed-Georgia Co., Marietta, GA 30063, J. Sound Vib., 81 (3), pp 337-358 (Apr 8, 1982) 13 figs, 26 refs

Key Words: Aircraft noise, Nozzles, Jet noise, Noise generation, Shock excitation

Results of experimental and theoretical studies of the characteristics of shock associated noise from imperfectly expanded supersonic jets over an extensive range of underexpanded and overexpanded operating conditions are described. This kind of broadband noise is believed to be generated by the weak but coherent interaction between the downstream propagating large scale turbulent flow structures in the mixing layer of the jet and the nearly periodic shock cell system. The noise intensity, directivity and spectra of supersonic jets from a convergent-divergent nozzle of design Mach number 1·67 were measured in an anechoic facility over the Mach number range of 1·1 to 2·0. The effect of jet temperature was investigated by operating the jet at three temperature conditions. These sets of data provide sufficient information for fully assessing the relative importance and characteristics of shock associated noise of supersonic jets from convergent-divergent nozzles. Comparisons between theoretical results and measurements show very favorable agreement.

82-1893

Lift/Drag Ratios and Sonic Boom Intensities of a Circular Wing

K. Padmanaban and T.K. Bose

Madras Inst. of Tech., Madras, India, J. Acoust. Soc. Amer., 71 (3), pp 612-615 (Mar 1982) 5 figs, 9 refs

Key Words: Airfoils, Circular plates, Aircraft wings, Sonic boom

The order of attainable lift/drag ratios of a wing of circular planform with biconvex profile has been estimated based on the linearized supersonic flow theory. For this wing, the ground over pressures due to volume and lift have been com-

82-1894

Structural Modification to Achieve Antiresonance in Helicopters

B.P. Wang, L. Kitis, W.D. Pilkey, and A. Palazzolo

Univ. of Virginia, Charlottesville, VA, J. Aircraft, 19 (6), pp 499-504 (June 1982) 8 figs, 1 table, 12 refs

Key Words: Helicopters, Tuning, Structural modification effects, Periodic excitation

A design method is developed to create an antiresonance (by modifying structural properties) of a vibrating system under sinusoidal loading. A local modification method in which appendant systems are added to the original structure is used to analyze such systems. Since the original system and added systems are treated entirely separately, this method allows for efficient repetitive searching until the appendant system produces a meaningful reduction in vibration. The direct design of appendant structures to create antiresonance is presented. These methods are illustrated by numerical results obtained for a 44-degree-of-freedom elastic line helicopter model.

MISSILES AND SPACECRAFT

(Also see No. 2020)

82-1895

Dynamics of Bi-Periodic Structures

T.J. McDaniel and M.J. Carroll

Dept. of Aerospace Engrg., Iowa State Univ., Ames, Iowa 50010, J. Sound Vib., 81 (3), pp 311-335 (Apr 8, 1982) 12 figs, 29 refs

Key Words: Spacecraft, Periodic structures, Natural frequencies, Mode shapes

Many structures considered for space applications are bi-periodic in their construction. Bi-periodicity means that two types of structural subassemblies, alternating in one or more directions, make up the structure. To gain insight into the dynamics of bi-periodic space structures a variety of one and two dimensional bi-periodic structures are considered. Results indicate that bands in which natural frequencies lie

for periodic structures are further subdivided as a consequence of the bi-periodicity. Analytical solutions for the modes and frequencies of finite length one dimensional bi-periodic structures are obtained for general boundary conditions. A transmission method is developed to simplify the application of boundary conditions. It is found that some modes occur at frequencies which are outside the frequency bands predicted for bi-periodic structures. Two dimensional bi-periodic crossed beam grillage and truss structures are considered in this study. For cases where a separation of variables solution is possible the two dimensional structures exhibit similar properties to the one dimensional bi-periodic structures. Analytical solutions for the one and two dimensional bi-periodic structures considered above lead to a compact solution form similar to that of periodic structures analysis.

82-1896

Nonlinear Dynamic Phenomena in the Space Shuttle Thermal Protection System

J.M. Housner, H.H. Edighoffer, and K.C. Park
NASA Langley Res. Ctr., Hampton, VA, J. Spacecraft, 19 (3), pp 269-277 (May-June 1982) 11 figs, 10 refs

Key Words: Protective shields, Tiles, Ceramics, Viscous damping, Hysteretic damping, Space shuttles, Periodic excitation

The development of an analysis for examining the nonlinear dynamic phenomena arising in the space shuttle orbiter tile/pad thermal protection system is presented. The tile/pad system consists of ceramic tiles bonded to the aluminum skin of the orbiter through a thin nylon felt pad. The pads are a soft nonlinear material which permits large strains and displays both hysteretic and nonlinear viscous damping. Application of the analysis to a square tile subjected to sinusoidal motion of the orbiter skin is presented and the following nonlinear dynamic phenomena are considered: highly distorted waveforms; amplitude-dependent resonant frequencies which initially decrease and then increase with increasing amplitude of motion; magnification of substrate motion, which is higher than would be expected in a similarly highly damped linear system; and classical parametric resonance instability.

82-1897

Vibroacoustic Modeling for Space Shuttle Orbiter Thermal Protection System

G.R. Doyle, Jr.
Battelle, Columbus, OH, J. Spacecraft, 19 (3), pp 263-268 (May-June 1982) 5 figs, 5 tables, 5 refs

Key Words: Protective shields, Ceramics, Tiles, Space shuttles, Acoustic excitation, Random excitation

A ceramic tile has been developed as part of the thermal protection system of the space shuttle orbiter. These tiles are individually attached to the panels of the orbiter through a flexible pad. Closed-form and numerical linear random vibration models were formulated to predict tile dynamic stresses due to the broadband acoustic field on the outer surface and the base excitation on the bonded surface. Analytical results were compared to a full-scale random test. The analytical models were then used to predict dynamic stresses on selected tiles. Conditions were established as to the accuracy of the closed-form techniques.

BIOLOGICAL SYSTEMS

HUMAN

82-1898

Numerical Simulation of Dummy Head Impact Tests on Steering Wheels

S.-J. Ying
Dept. of Mech. Components Engrg., Chrysler Corp., Highland Park, MI 48288, Intl. J. Vehicle Des., 3 (2), pp 234-242 (May 1982) 5 figs

Key Words: Collision research (automotive), Anthropomorphic dummies, Head (anatomy), Crash victim simulation, Steering gear

The numerical simulation of dummy head impact tests on steering wheels is presented. In the theoretical formulation, the motion of the dummy before impact is studied, and its result serves as the initial condition for the impact. During the impact the frictions existing between the dummy head and the steering wheel and at the pivot are considered in addition to the change of momentum due to impact force alone. The load vs. deflection curves of the steering wheels are simulated by three segments of straight lines for the elastic region before yield point, the region after the yield point and the unload region. The curve produced from the numerical calculation matches well with the impact data as presented in this report. The causes of high-frequency oscillation which appeared in the testing data are discussed.

82-1899

Simulation of Head/Neck Impact Responses for Helmeted and Unhelmeted Motorcyclists

B.M. Bowman, L.W. Schneider, P.R. Rohr, and D. Mohan
Highway Safety Res. Inst., SAE Paper No. 811029

Key Words: Collision research (automotive), Helmets, Motorcycles, Human response, Computerized simulation

The purpose of this study was to assess, by use of computer simulations, the effectiveness of motorcycle helmets in reducing head and neck injuries in motorcyclist impacts. The study investigated a wide variety of impact conditions in order to establish a broad overall view of the effectiveness of helmets. It was found that helmet use invariably reduces dynamic responses which have a role in producing head injury and, in addition, almost always reduces the severity of neck response as well. For no configuration or condition does the helmet greatly increase the likelihood of neck injury. Thus, these simulations of a wide spectrum of motorcyclist impacts provide further evidence that helmet use significantly reduces the likelihood and severity of both head and neck injuries.

MECHANICAL COMPONENTS

ABSORBERS AND ISOLATORS

(Also see Nos. 1874, 1878, 1881, 1914, 1932, 1933, 2033, 2056)

82-1900

Dynamic Loads on Suspension Components Using Mechanisms Programs

F. Giannopoulos and A.K. Rao
Structural Analysis Dept., Ford Motor Co., SAE Paper No. 811307

Key Words: Suspension systems (vehicles), Surface roughness

A method is described for employing general purpose mechanisms programs to predict the loads induced in the suspension systems of ground vehicles traversing rough terrains. The mechanisms representation employed accounts for geometric nonlinearities of the kinematics as well as the material nonlinearities of the tire, shock absorbers, and rubber bushings, but neglecting the compliance of the body structure which is treated as a rigid link. Dynamic loads obtained using this procedure can serve as input to detailed finite element models of vehicle components for stress analysis.

82-1901

Development of a Cross-Braced Truck

H.W. Mulcahy and R.J. Weeks
Railroad Product Dev., American Steel Foundries, Chicago, IL, J. Engrg. Indus., Trans. ASME, 104 (2), pp 182-189 (May 1982) 12 figs, 1 table, 4 refs

Key Words: Suspension systems (vehicles), Trucks, Railroad cars, Freight cars

This paper describes the analytical, design, and test processes utilized in development of a cross-braced freight car truck intended for service on American railroads. Analytical techniques predict the stability boundaries and curving characteristics, and suggest ranges of suspension parameters to satisfy various service conditions. Within the constraints normally placed on truck suspension systems, a viable design is evolved and the system is further qualified by extensive dynamic testing.

82-1902

Wheel Hub Forces due to Vehicle Encountering a Bump

H.R. Harrison and A. Bassim
Dept. of Mech. Engrg., The City Univ., London, UK, Intl. J. Vehicle Des., 3 (2), pp 243-247 (May 1982) 5 figs, 4 refs

Key Words: Suspension systems (vehicles), Transient response

Forces transmitted to a vehicle suspension due to encountering a bump are measured during laboratory and track tests. The longitudinal (rearwards acting) loads are shown to be of significant magnitude when compared with the vertical components of the transient response. The implications of this on suspension design are discussed.

82-1903

Finite Element Analysis of Viscoelastic Structures Vibrating about Non-Linear Statically Stressed Configurations

K.N. Morman, Jr., B.G. Kao, and J.C. Nagtegaal
Ford Motor Co., SAE Paper No. 811309

Key Words: Automobiles, Structural elements, Elastomers, Vibration isolation, Vibration control, Viscoelasticity theory, Computer programs, Finite element technique

This paper concerns the finite element method as applied to the analysis of small oscillations about the nonlinear equilibrium position in elastomeric components. The capability has been implemented in the general-purpose finite element program, MARC. The material behavior is treated by use of a modified form of the constitutive equations derived by Lianis using the finite linear viscoelasticity theory of Coleman and Noll. In order to establish numerical accuracy, program predictions are compared with a closed form solution for the torsional and axial vibrations in a cylinder under axial and twisting preloads: differences between the finite element solutions and exact results are less than two percent.

82-1904

Influence of Gap Size on the Dynamic Behaviour of Piping Systems

J.P. Vayda
FIDES Trust Co., Zurich, Switzerland, Nucl. Engrg. Des., 67 (2), pp 145-164 (1981) 24 figs, 8 tables, 3 refs

Key Words: Shock absorbers, Snubbers, Piping systems, Dynamic response

This paper addresses the effects of dynamic events induced by support motion on piping systems with snubbers having variable gap sizes. The investigation consists of 3 parts: mathematical examination of a linear 1 DOF mass-spring-snubber system with gap size zero or infinity; numerical analysis of a piecewise linear 1 DOF mass-spring-snubber system with varying gap sizes, by means of a simple computer code; and numerical analysis of a realistic three-dimensional piping system with three snubbers, each having four different gap sizes, with the aid of a nonlinear FE code.

82-1905

A Study of Vibroimpact Systems

C.N. Bapat
Ph.D. Thesis, The Univ. of Manitoba (Canada) (1982)

Key Words: Shock absorbers, Impact pairs, Periodic excitation

A general theory is developed for the general stable periodic motion of an impact-pair and impact damper when subjected to a prescribed, sinusoidally time varying external load or displacement. Any one impact is considered instantaneous and representable by the somewhat macroscopic coefficient of restitution. The theory is compared with previous but sparse theoretical results and more comprehensively with new experimental data. Agreement is found to be quite good. The presently employed procedure for designing an impact damper seems reasonable for constant speed mechanisms operating at or just above their fundamental natural frequency. Similarities between various vibroimpact mechanisms is demonstrated for specific conditions.

82-1906

Large Deflection and Impact Performance of Reinforced Polyurethane Foam Beams

M.L.A. Gaafar and G.H. Tidbury
School of Automotive Studies, Cranfield Inst. of Tech., Cranfield, Bedford, UK, SAE Paper No. 811308

Key Words: Beams, Polyurethane resins, Foams, Composite structures, Impact tests, Collision research (automotive)

The theoretical and experimental bending performance of rigid skin polyurethane foam beams, reinforced with thin walled steel sections, was investigated. The aim was to provide design data for the prediction of vehicle structures made of this composite material during accidents. The theoretical treatment assumes an interfacial shear between the core and the faces of the reinforcement. This method gave good agreement with experimental results when the errors due to cantilever support movements were quantified. It also represents a good basis for an inelastic analysis beyond the yield point of the reinforcement which was also developed. The inelastic analysis also showed good agreement with experimental results.

82-1907

Energy Absorption of Channel Beams during Gross Deformation

P.W. Sharman
Dept. of Transport Tech., Loughborough Univ. of Tech., UK, SAE Paper No. 811303

Key Words: Energy absorption, Beams, Aluminum, Dynamic buckling

The results of experiments to determine the energy absorbed by aluminium alloy channel sections when loaded with combined compression and bending causing gross deformation, plasticity and fracture are described. The lateral-torsional mode of buckling caused a radical redistribution of stress leading to large tensile strains developing in the initially compressed flange. Provided the material is able to flow, the energy absorbed showed a smooth monotonic increase with

increasing deformation, therefore suitable for crashworthy structures. A predictive method is outlined based on a coarse finite element division used in a nonlinear program accounting for the finite rotations and plasticity.

82-1908

Designing Cylinder Cushions on a Desktop Computer

G.R. Keller
Bellevue, WA, Mach. Des., 54 (12), pp 87-92 (May 20, 1982)

Key Words: Packaging materials, Cylinders, Computer-aided techniques, Design techniques

A digital desk-top computer technique is described for the design of damping spears in cylindrical cushions. The spears can be quickly designed for any set of dynamic requirements and a spear of any arbitrary shape can be analyzed to check its performance under various conditions. The techniques were developed for an HP-85A computer, but they are within the scope of any home or desk-top computer that can be programmed in basic. A calculation example is included.

82-1909

Application of Modal Modeling and Mount System Optimization to Light Duty Truck Ride Analysis

A.E. Duncan
Chevrolet Motor Div., General Motors Corp., SAE Paper No. 811313

Key Words: Mountings, Trucks, Modal models, Surface roughness, Natural frequencies, Random response, Vibration tuning, Optimization

A basic review of vehicle modal modeling techniques is presented and applied to determine the vibrational shake characteristics of a light duty pickup truck subjected to tire force variation and random road surface dynamic loads. Comparisons of natural vibration frequencies and random road response between a prototype pickup and the vehicle model are presented to establish the level of correlation. A computer optimization technique is applied to tune the body, engine, and transmission mount system of the vehicle model until the vibration levels are minimized. Simultaneous reduction in road and tire induced vibration response of the model is achieved.

82-1910

Reduction of Automobile Booming Noise Using Engine Mountings That Have an Auxiliary Vibrating System

H. Sakamoto, K. Yazaki, and M. Fukushima
Nissan Motor Co., Ltd., SAE Paper No. 810399

Key Words: Automobile engines, Engine mounts, Noise reduction

A new concept concerning engine mountings that can reduce engine booming noise by utilizing an additional vector is presented. Booming noise in passenger cars, particularly those with a four-cylinder engine, is caused by exciting forces such as the second harmonic of engine inertial force. Exciting forces transmitted from the engine to the body structure through the engine mountings are reduced by adding another vector which cancels out these exciting forces. This new vector can be obtained by using a mass-controlled region of a vibrating system possessing either a single degree or two degrees of freedom. When this optimally designed mechanism is adopted on a small passenger car, booming noise can be significantly reduced.

82-1911

Non-Linear Vibrations of a Harmonically Excited Autoparametric System

H. Hatwal, A.K. Mallik, and A. Ghosh
Dept. of Mech. Engrg., Indian Inst. of Tech. Kanpur, Kanpur 208 016, India, J. Sound Vib., 81 (2), pp 153-164 (Mar 22, 1982) 10 figs, 12 refs

Key Words: Absorbers (equipment), Pendulums, Harmonic excitation, Harmonic balance method

Harmonic forced vibration of a spring-mass-damper system with a parametrically excited pendulum hinged to the mass is investigated. Two types of restoring forces on the pendulum are considered. The method of harmonic balance is used to evaluate the system response. The results are also verified by numerical integration. Non-oeriodic system responses are possible if the excitation parameter is large. The performance of the pendulum as an absorber is also studied.

82-1912

Vibration Isolation of a Damped Skeletal Machine Foundation -- Theory and Experiment

R. Lunden and E. Kamph

Div. of Solid Mech., Chalmers Univ. of Tech., S-412 96 Gothenburg, Sweden, J. Acoust. Soc. Amer., 71 (3), pp 600-607 (Mar 1982) 6 figs, 1 table, 21 refs

Key Words: Vibration isolation, Machine foundations, Damped structures, Beams

The vibrational behavior of a lightweight skeletal machine foundation (grillage) is investigated numerically and experimentally. For the vibration isolation problem, a combination of blocking masses and discrete and distributed additive damping is shown to provide desired vibrational properties in a broad frequency interval. Considering the reduction of a given set of resonance responses, optimally distributed partial damping treatment is found to be an economic measure. In the numerical study, a theory for damped second-order Rayleigh-Timoshenko beams has been applied. The computer method used has proven to be an effective numerical tool in attacking general vibration isolation problems.

82-1913
Aseismic Base Isolation
J.M. Kelly
Div. of Struc. Engrg. and Struc. Mech., Dept. of Civil Engrg., Univ. of California, Berkeley, CA 94720, Shock Vib. Dig., 14 (5), pp 17-25 (May 1982) 48 refs

Key Words: Isolation, Base isolation, Seismic design, Reviews

The concept of base isolation is based on accepted physical principles. It has not, however, been readily accepted by the structural engineering profession, perhaps because the concept runs counter to conventional methods of aseismic design. A base-isolated structure is decoupled from the damaging horizontal components of earthquake ground motion by a mechanism that prevents or reduces the transmission of horizontal acceleration into the structure. Although many base isolation schemes have been proposed during the last century, virtually all remained unimplemented until the concept became a practical reality with the recent development of multilayered elastomeric bearings. This development began with the design of bearings for bridges and bearings used to isolate structures from groundborne acoustic vibration. This paper describes the development of base isolation, experimentation on the concept, and the application of the concept to several recently completed structures.

SPRINGS

82-1914
Vibration Characteristics of Helical Compression Springs (Zum Schwingungsverhalten von Schraubendruckfedern)
G.D. Go
Automobiltech. Z., 84 (5), pp 223-226 (May 1982) 6 figs, 1 table, 7 refs
(In German)

Key Words: Springs, Vibration response, Finite element technique, Suspension systems (vehicles)

Due to the requirement of driving comfort in the automotive industry a test procedure must be carried out to locate resonances and vibrations of the coil springs on test bed or terrain. If the experimental results are unsatisfactory, a new coil spring must be laid out in accordance with the empirical finding after evaluating the experimental results. Only by introducing a reliable algorithm can the development cost and time be considerably cut. The finite element method utilizes the Theory 1 order for straight beams. Obtaining the equation of motion the algorithms are developed for determining the eigenvalues and eigenvectors by adopting inverse iteration and for solving forced vibrations. The calculated results are compared with the experimental results.

82-1915
A Mass-Spring System with Singular Control
M.A. Abdelkader
Alexandria, Egypt, Intl. J. Control, 35 (2), pp 281-289 (1982) 2 figs, 3 refs

Key Words: Differential equations, Springs, Mass-spring systems, Viscous damping

A vertically aligned spiral spring of negligible mass, fixed at its lower end, and carrying a heavy load which is constrained to move in the vertical direction, the motion being resisted by viscous damping, is considered. For a real spring, a large compression causes the coils to close up and ultimately form an impenetrable barrier to the load. Thus, the spring control force becomes infinite at a certain point, and the nonlinear differential equation of motion has a singularity at this point, in contrast to the classical cases of mass-spring systems. Assuming plausible analytic expressions for the singular control force, several exact solutions of the differential equation are obtained. The effects of the magnitudes of the damping, the control and the constant terms of the differential equation on the character of the motion (over-damped or oscillatory) are exhibited for several concrete cases that may be useful in applications.

BLADES
(Also see No. 2054)

82-1916
Rotating Blade Vibration Analysis Using Shells
A.W. Leissa, J.K. Lee, and A.J. Wang

Dept. of Engrg. Mech., Ohio State Univ., Columbus, OH, J. Engrg. Power, Trans. ASME, 104 (2), pp 296-302 (Apr 1982) 2 figs, 5 tables, 15 refs

Key Words: Blades, Turbomachinery blades, Natural frequency, Mode shapes, Shell theories, Ritz method

Shallow shell theory and Ritz method are employed to determine the frequencies and mode shapes of turbomachinery blades having both camber and twist, rotating with non-zero angles of attack. Frequencies obtained for different degrees of shallowness and thickness are compared with results available in the literature, obtained from finite element analyses of nonrotating blades. Frequencies are also determined for a rotating blade, showing the effects of changing the angular velocity of rotation, disk radius, and angle of attack, as well as the significance of the most important body force terms.

82-1917

Time-Variant Aerodynamics of High-Turning Blade Elements

M.D. Rothrock, R.L. Jay, and R.E. Riffel

Cascades and Flow Systems Res., Detroit Diesel Allison Div., General Motors Corp., Indianapolis, IN 46206, J. Engrg. Power, Trans. ASME, 104 (2), pp 412-419 (Apr 1982) 18 figs, 4 tables, 23 refs

Key Words: Blades, Turbine blades, Torsional vibration, Aerodynamic loads

Basic experimental data has been obtained from a linear cascade of five turbine airfoil sections undergoing torsional oscillation. A high-turning subsonic/transonic cascade was tested and both steady-state and time-variant data were obtained. A quasi-static investigation was conducted to compare static pressure distributions with the pressure distributions from the time-variant investigation. During the time-variant data acquisition, six values of interblade phase angle were investigated at each of four expansion ratios. Unsteady pressures were measured by flush-mounted Kulite pressure transducers on the center airfoil and compared with an oscillating flat-plate cascade analysis.

82-1918

Interactive Multimode Blade Impact Analysis

A. Alexander

Allegany Ballistics Lab., Hercules, Inc., Cumberland, MD, J. Engrg. Power, Trans. ASME, 104 (2), pp 286-295 (Apr 1982) 17 figs, 1 table, 4 refs

Key Words: Blades, Fan blades, Turbines, Bird strikes, Computer programs

This paper describes the theoretical methodology used in developing an analysis for the response of turbine engine fan blades subjected to soft body (bird) impacts and the computer program that was developed using this methodology as its basis. This computer program is an outgrowth of two programs that were previously developed for the purpose of studying problems of a similar nature (a three-mode beam impact analysis and a multimode beam impact analysis). The present program utilizes an improved missile model that is interactively coupled with blade motion which is more consistent with actual observations. It takes into account local deformation at the impact area, blade camber effects, and the spreading of the impacted missile mass on the blade surface. In addition, it accommodates plate-type mode shapes. The analysis capability in this computer program represents a significant improvement in the development of the methodology for evaluating potential fan blade materials and designs with regard to foreign object impact resistance.

82-1919

Noise from a Vibrating Propeller

H.L. Runyan

George Washington Univ., Hampton, VA, J. Aircraft, 19 (6), pp 419-424 (June 1982) 5 figs, 1 table, 3 refs

Key Words: Blades, Propellers, Aircraft propellers, Vibrating structures, Noise generation

An analytical study is made of the noise from a vibrating propeller. The influence of airfoil thickness as well as steady loading are also included in order to provide a basis for comparison. The analysis was based on the concept of distributing sources and doublets on the surface of the blade, which were multiplied by their appropriate strength factors. The noise in the plane of the propeller was dominated by the thickness noise. When the observation point was rotated 45 deg ahead of the propeller plane, the steady-state load noise and the vibration noise were greater than the thickness noise. Moving the observer's position to the propeller axis, the thickness noise and loading noise were zero and a pure sinusoidal noise was found, caused by the vibrations of the propeller.

BEARINGS

(Also see Nos. 2030, 2044)

82-1920

Development of Foil Journal Bearings for High Load Capacity and High Speed Whirl Stability

H. Heshmat, W. Shapiro, and S. Gray
Mechanical Technology Inc., Latham, NY 12110, J. Lubric. Tech., Trans. ASME, 104 (2), pp 149-156 (Apr 1982) 18 figs, 5 tables

Key Words: Bearings, Journal bearings, Whirling

The development of two types of air-lubricated foil journal bearings, designed for separate purposes, stability and load capacity, is described. The first was a three-pad configuration, with each pad forming a wedge whose convergence increases with operating speed. The net result is a highly stable bearing at high operating speed. The second was a single pad journal bearing that produced a load capacity of 352 KPa (51 psi) at an operating speed of 68,000 rpm.

82-1921
Empirical Design Procedure for the Thermohydrodynamic Behavior of Journal Bearings
A. Seireg and S. Dandage
Dept. of Mech. Engrg., Univ. of Wisconsin-Madison, Madison, WI 53706, J. Lubric. Tech., Trans. ASME, 104 (2), pp 135-148 (Apr 1982) 14 figs, 2 tables, 11 refs

Key Words: Bearings, Journal bearings, Sommerfeld number

This paper describes an empirical procedure for predicting the performance of journal bearings based on experimental thermohydrodynamic consideration. The developed relationships are utilized to construct design nomograms for evaluating a modified Sommerfeld number which can replace the isoviscous Sommerfeld number in evaluating the performance characteristics of the bearing for any given oil and inlet temperature. The procedure is simple to implement and would consequently provide the designer with an alternative predictive method to consider in selecting the bearings parameters for critical applications.

82-1922
Effect of Preset on the Performance of Finite Journal Bearings Supporting Rigid and Flexible Rotors
A. Singh and B.K. Gupta
Motilal Nehru Regional Engrg. College, Allahabad, India, J. Lubric. Tech., Trans. ASME, 104 (2), pp 203-209 (Apr 1982) 12 figs, 12 refs

Key Words: Bearings, Cylindrical bearings, Journal bearings, Rigid rotors, Flexible rotors

A large number of cylindrical bearings are manufactured in two halves and assembled in such a way that there exists a possibility that the center may get displaced along the parting line. Very little published data are available on the effect of this displacement on the performance of journal bearings. This paper is directed toward the theoretical study of the static and dynamic behavior of the finite displaced lobe or offset bearings where the displacement or preset is either accidental due to the faulty manufacture or intentional to improve the performance. It has been found that the static dynamic properties of journal bearings are greatly influenced by preset. Data on load capacity, dynamic coefficients and stability are presented in this paper for several values of preset, L/D ratio and shaft flexibility. Offset bearings are found to be much more stable in comparison to conventional cylindrical journal bearings, especially for low loads.

82-1923
Frequency-Domain Estimation of Linearized Oil-Film Coefficients
C.R. Burrows and M.N. Sahinkaya
School of Engrg. and Appl. Sciences, Univ. of Sussex, Falmer, Brighton, Sussex, BN1 9Qt, UK, J. Lubric. Tech., Trans. ASME, 104 (2), pp 210-215 (Apr 1982) 3 figs, 5 tables, 22 refs

Key Words: Bearings, Lubrication, Squeeze-film bearings, Frequency domain method

A frequency domain algorithm for estimating linearized oil-film bearing coefficients is developed and evaluated under controlled conditions. Its ability to produce meaningful coefficient estimates from noisy data is examined, and a confidence bound is provided for the estimates. Results obtained from both simulated and experimental data show that the technique is more efficient than the time-domain algorithm described in earlier work. A comparison of experimentally estimated and theoretically derived coefficients for a squeeze-film bearing suggests that closed-form expressions for the velocity coefficient obtained by assuming a 180 deg oil-film are valid for a wider range of eccentricity ratios than have been previously demonstrated.

82-1924
The Effects of Friction between Cylinders and Rubber Staves of Finite Thickness
J.A. Walowit and O. Pinkus
Mechanical Technology Inc., Latham, NY 12110, J. Lubric. Tech., Trans. ASME, 104 (2), pp 255-261 (Apr 1982) 13 figs, 1 table

Key Words: Bearings, Elastomeric bearings, Shafts, Stick-slip excitation

An analysis was conducted which predicts the contact stresses and deflections in rubber staves of finite thickness loaded against a shaft in rubbing contact. Results are given which cover the practical range of coefficients of friction and thickness ratios likely to occur in bearings and similar applications. The main conclusions of the analysis are that friction shifts the contact zone toward the trailing edge of the stave and that the contact zone increases as rubber thickness is increased. Thick staves, therefore, are prone to edge loading at the trailing edge.

82-1925

Determination of Load Spectra of Crane Bearings

V. Jasaň

High Technical School, Košice, Czechoslovakia, Strojnícky Časopis, 33 (2), pp 223-232 (1981) 6 figs, 2 tables, 7 refs

(In Slovak)

Key Words: Bearings, Cranes (hoists), Fatigue strength

The paper presents a developed method – an algorithm and example – which allows determination of a loading spectrum from statistical distributions of various influencing factors. This especially concerns supports and bearings of a bridge crane.

GEARS

82-1926

Effect of Hardness on Tooth Strength and Surface Durability and on Failure Modes of Gears

K. Fujita, A. Yoshida, and K. Nagamori

School of Engrg., Okayama Univ., Tsushima, Okayama City, 700 Japan, Bull. JSME, 25 (201) pp 452-458 (Mar 1982) 8 figs, 5 tables, 6 refs

Key Words: Gear teeth, Fatigue tests

In order to elucidate the effect of surface hardness on tooth strength and surface durability and on failure modes of gears, fatigue tests were conducted. The results obtained are summarized as follows: there are hardness ranges in which pitting, tooth breakage and spalling will break out; the degree of tooth profile deterioration can be used as a measure to evaluate the life for pitting; at the fatigue limit load the dynamic load increase which is induced by tooth profile deterioration is not so large as to be taken into consideration; and the failure mode and fatigue life can be affected by the performance of lubricant.

FASTENERS

82-1927

Advanced Concepts for Composite Structure Joints and Attachment Fittings. Volume I. Design and Evaluation

J.V. Alexander and R.H. Messinger

Hughes Helicopters, Culver City, CA, Rept. No. HH-80-402-VOL-1, USAARADC-TR-81-D-21A, 127 pp (Nov 1981)

AD-A110 212

Key Words: Joints (junctions), Helicopters, Fiber composites

The purpose of this program was to develop the technology of applying fiber-reinforced composite materials to helicopter joints and attachment fittings that permit disassembly of major components. A generic design methodology approach was used to make the data developed applicable to ongoing and future helicopter programs. A detail design, analysis, and testing program was carried out on the three joint and fitting concepts selected: wrapped tension fittings, gearbox attachment fittings, and seat attachment fittings. The scope of the study included analytical design tools, including finite element computer analysis; fabrication techniques, with special emphasis on weight and cost effectiveness considerations; structural integrity testing, including static, dynamic, failsafe/safe-life, and ballistic tolerance considerations; and nondestructive inspection techniques.

82-1928

Avoiding Failure in Bolted Joints

D.T. Curry

Mach. Des., 54 (12), pp 79-82 (May 20, 1982)

Key Words: Joints (junctions), Bolts, Torsional response, Vibration control

Failure of fasteners caused by improper torquing and corrosion is discussed and measures to prevent such failures are described.

82-1929

Fatigue of Welded Steel Structures Due to Strong Earthquakes – II. Deteriorations of Welded Beam-to-Column Joints Due to Low-Cycle Fatigue

K. Kaneta and I. Kohzu
Dept. of Architectural Engrg., Kyoto Univ., Kyoto, Japan, Mem. Fac. Engrg., Kyoto Univ., 43 (4), pp 360-387 (Oct 1981) 28 figs, 8 refs

Key Words: Joints (junctions), Welded joints, Steel, Fatigue life, Earthquake response

This experiment was carried out from the viewpoint of evaluating the strength and the ductility of actual welded beam-to-column joints of steel structures in the event of earthquakes. The experiment consisted of three features to reveal the above-mentioned objectives: a monotonic increasing load test to clarify the strength and toughness of steel plates stressed in the thickness direction, a cyclic loading test to estimate the overall load-deflection characteristics and the energy absorbing capacity of the welded joint, and a low-cycle fatigue test to gain a quantitative criterion of ductility requirement for the structural safety against earthquakes.

VALVES

82-1930

Performance and Design of Plug-Type Check Valves

J. Kubie
Health and Safety Dept., Nuclear Safety Branch, Central Electricity Generating Board, Courtenay House, Warwick Lane, London EC4, UK, IMechE Proc., 196, pp 47-56 (Mar 1982) 8 figs, 2 tables, 5 refs

Key Words: Valves, Pumps, Power plants (facilities)

Plug check valves are frequently used in high pressure systems where parallel pump operations are envisaged, in order to prevent flow recirculation through the out-of-service pump. Serious operational problems are sometimes encountered with these valves during pump changeovers. Full equations of the dynamic behavior of the plug check valves are derived and results are obtained for their performance in a typical power plant system. Criteria for the design of the plug check valves are also developed.

SEALS

82-1931

Analysis of Face Seals with Shrouded Pockets

J.A. Walowit and O. Pinkus
Mechanical Technology Inc., Latham, NY 12110, J. Lubric. Tech., Trans. ASME, 104 (2), pp 262-270 (Apr 1982) 12 figs, 2 tables, 3 refs

Key Words: Seals, Design techniques, Optimization

The paper offers an analysis of face seals, using incompressible fluids, aimed at arriving at a quantitative basis for the design and optimization of seals. To improve its hydrodynamic and dynamic capabilities, the parallel face seal is provided with pockets pressurized by the sealed fluid, and shrouded at both the inner and outer peripheries. The relevant Poisson equation is solved for its hydrodynamic, hydrostatic, and squeeze-film components. A parametric study of various geometric permutations and operating conditions is then obtained from the computerized solutions. The results show that the contribution of the hydrostatic forces to stiffness is insignificant, and that both K_3 and W_3 can be ignored in the optimization of seal dimensions. For high seal pressures, the dominant force and leakage are geared to the hydrostatic component, whereas for low seal pressures, both the hydrodynamic and squeeze-film effects are important.

82-1932

Some Comments on Comfort Shock Absorber Seals

E.M.v. Arndt, K.H. Spies, W. Trauth, and C. Freudenberg
SAE Paper No. 810203

Key Words: Seals, Shock absorbers, Automobiles

The unique demands of down-sized cars on the engineering departments of spring strut manufacturers have forced their seal suppliers to design new rod seals. The spring loaded lip seal is now a standard element of McPherson struts. An improved lip seal design with a lubrication groove provides even better riding comfort for the new generation of lighter cars.

82-1933

A Study of Oil Seals for Shock Absorbers of Automotive Suspensions

Y. Ohtake, Y. Kawahara, H. Hirabayashi, Y. Yamamoto, and S. Iida
Nippon Oil Seal Industry Co., Ltd., Japan, SAE Paper No. 810204

Key Words: Seals, Shock absorbers, Suspension systems (vehicles)

Types of oil seals for automotive shock absorbers and their characteristics are given and necessary items for designing seals are clarified based on experiments and experiences upon required performances of products.

STRUCTURAL COMPONENTS

STRINGS AND ROPES

82-1934

Simple Inequalities in the Vibrating String and Heat Conduction Problems

M. Pachter and R.I. Becker

Natl. Res. Inst. for Math. Sciences of the CSIR, P.O. Box 395, Pretoria 0001, South Africa, J. Franklin Inst., 313 (3), pp 165-184 (1982) 1 fig, 5 refs

Key Words: Strings, Vibrating structures, Differential equations, Heat transfer

Certain inequalities are presented, related to the L^2 norms of the solutions to the vibrating string and heat conduction partial differential equations; in particular, an L^2 maximum principle is derived for the heat equation, and similar inequalities for the vibrating string problem.

CABLES

82-1935

Nonlinear Dynamic Analysis of Cable and Membrane Structures

A. Lo

Ph.D. Thesis, Oregon State Univ., 173 pp (1982) DA8209915

Key Words: Cables, Membranes, Nonlinear theories, Finite element technique

The nonlinear dynamic analysis of cable and membrane structures is presented in this study. Attention is given to the nonlinearities arising from large displacements, from nonlinear stress-strain relationships and from nonconservative loadings. The finite element method is used to model the cables and membranes. Curvilinear geometries of the elements are approximated by using higher-order interpolation polynomials. The relative advantages and disadvantages of adopting elements with various orders of approximating functions are determined by a variety of example problems.

BARS AND RODS

82-1936

State of Stress and Deformations in the Neighborhood of Notches of Impact Loaded Cylindrical Bars

J. Vrbka

Mechanical ingeneering fakulty Brno, Technical Univ. of Brno, Czechoslovakia, Strojnicky Casopis, 33 (2), pp 209-222 (1982) 12 figs, 2 tables, 5 refs

(In Czech)

Key Words: Bars, Impact response, Computer programs, Finite element technique

The computation of stress field and of the deformations was performed with the aid of the SADUS program, which employs the finite element method for the solution of the dynamic problem of an axial symmetrical body from an elastic continuum.

82-1937

Wave Propagation in Nonhomogeneous Thin Elastic Rods Subjected to Time-Dependent Velocity Impact

M.C. Singh and W. Frydrychowicz

Dept. of Mech. Engrg., The Univ. of Calgary, Alberta, Canada, J. Acoust. Soc. Amer., 71 (5), pp 1069-1076 (May 1982) 10 figs, 14 refs

Key Words: Rods, Elastic media, Wave propagation, Impact response, Time-dependent excitation

Response of a thin long nonhomogeneous elastic rod subjected to a time-dependent velocity impact is studied by the use of similarity transformations. Similarity representation of the original equation of motion and the associated conditions has been obtained in the form of an ordinary differential equation with variable coefficients and the corresponding boundary conditions. A general solution of the similarity representation is obtained in the form of series. Relations between the parameters of the problem for which the results hold have been obtained in the form of inequalities. The displacement and stress distribution in the rod is obtained for the admissible values of the parameters of the problem and the results are plotted for some of their discrete values.

BEAMS

(Also see Nos. 1906, 1912)

82-1938

The Steady-State Response of an Internally Damped Double-Beam System Interconnected by Several Springs

T. Irie, G. Yamada, and Y. Kobayashi

Dept. of Mech. Engrg., Faculty of Engrg., Hokkaido Univ., Sapporo, 060 Japan, J. Acoust. Soc. Amer., 71 (5), pp 1155-1162 (May 1982) 13 figs, 8 refs

Key Words: Beams, Multibeam systems, Internal damping, Periodic excitation, Transfer matrix method

The steady-state response of an internally damped double-beam system interconnected by several springs to a sinusoidally varying force is determined by the transfer matrix technique. For this purpose, the Timoshenko equations of transverse vibration of an internally damped beam are written as a coupled set of the first-order differential equations by using the transfer matrix of the beam. Once the matrix has been determined, the response of a double-beam system is obtained by the product of the transfer matrices of each beam and the point matrices at each connecting point. In this case, the elastic moduli of internally damped beams and springs are assumed to be complex quantities. The method is applied to double-beam systems interconnected by several springs of the same stiffness located at equal intervals, and the driving-point impedance, transfer impedance and force transmissibility of the systems are calculated numerically.

82-1939

Minimum-Weight Multi-Constraint Vibrating Cantilevers

B.L. Karihaloo and R.D. Parbery

Dept. of Civil Engrg., The Univ. of Newcastle, New South Wales 2308, Australia, Intl. J. Solids Struc., 18 (5), pp 419-430 (1982) 7 figs, 1 table, 15 refs

Key Words: Beams, Cantilever beams, Fundamental frequency, Natural frequencies, Minimum weight design, Longitudinal vibration, Flexural vibration

The problem of minimizing the mass of vibrating cantilevers whose fundamental frequencies of natural vibrations in longitudinal and transverse modes exceed prescribed values is considered. The cantilevers are supposed to perform longitudinal and transverse harmonic vibrations at different times during their design life. Solutions are presented for members whose cross-section is of solid construction. It is shown that the optimally designed members are substantially lighter than the corresponding prismatic members.

82-1940

Optimal Design of Rigid-Plastic Simply Supported Beams under Dynamic Pressure Loading

Ü. Lepik

Univ. of Tartu, Estonian SSR, U.S.S.R., Intl. J. Solids Struc., 18 (4), pp 285-295 (1982) 6 figs, 1 table, 6 refs

Key Words: Beams, Variable cross section, Impact response, Optimization

Optimal design of a rigid-plastic stepped beam, loaded by a uniform pressure over a time interval $0 < t < t_1$, is discussed. Such beam dimensions are sought for which the beam of constant volume attains minimal central deflection. This optimization problem is solved by the method of mode form solutions. Exact solutions are also found. By numerical calculations a good accordance between the exact and approximate solutions is stated.

82-1941

Low Velocity Impact of a Viscoelastic Beam

R.E. Llorens and E.J. McQuillen

Radnor Ctr. for Graduate Studies, Pennsylvania State Univ., Radnor, PA 19081, J. Engrg. Indus., Trans. ASME, 104 (2), pp 210-215 (May 1982) 2 figs, 1 table, 9 refs

Key Words: Beams, Viscoelastic properties, Impact response

A theoretical solution for the response of a viscoelastic beam to off-center low speed transverse impact is presented. The flexural model adopted for investigation consists of a uniform Bernoulli-Euler beam whose behavior has been generalized to include a linear viscoelastic constitutive relation for each element of the beam. Further, the beam and rigid impactor are assumed to remain in contact during the resulting motion and a consistent set of initial displacement and velocity distributions is adopted for the beam. The solution method utilizes two Laplace transforms; i.e., one with

respect to space and the other with respect to time. Comparison of the numerical predictions of the theoretical model with central impact test results on graphite-epoxy composite laminates indicates a good agreement between theory and experiment.

CYLINDERS

82-1942

The Frequency Components of Fluid-Lift Forces Acting on a Cylinder Oscillating in Still Water

K.G. McConnell and Y.-S. Park
Dept. of Engrg. Sci. and Mechanics, Iowa State Univ., Ames, IA 50011, Exptl. Mech., 22 (6), pp 216-222 (June 1982) 10 figs, 13 refs

Key Words: Cylinders, Underwater structures, Submerged structures, Periodic response, Wave forces, Fluid-induced excitation

A circular cylinder oscillating with sinusoidal motion in still water is a simple experimental model of circular structural members exposed to continuous wave motion. The measured fluid forces are analyzed using a unique Fourier technique from which fluid-force components can be understood and predicted for structural analysis.

82-1943

Torsional Vibration of Dissimilar Materials Containing a Cylindrical Crack

K.K. Bandyopadhyay
Ph.D. Thesis, City Univ. of New York, 116 pp (1982)
DA8205752

Key Words: Cracked media, Cylinders, Torsional vibration

This dissertation studies the torsional vibration of two cylinders of different elastic materials. The two cylindrical media are assumed to be perfectly bonded along their entire contact surface except for a cylindrical crack of finite length near the boundary surface. The time-dependent torsional load is applied on the free surface of the inner cylinder. Both the steady-state and the transient vibrations are considered, and the corresponding axisymmetric wave equations are solved separately. The determination of the stress and displacement fields is reduced to the solution of Fredholm integral equations of the second kind in the physical complex plane for the steady-state vibration, and in the Laplace domain for the transient case. The local dynamic stress fields in the vicinity of the crack tip are determined in elementary closed form, and are observed to have square-root singularity like other crack problems in linear elastic fracture mechanics.

MEMBRANES, FILMS, AND WEBS

(See Nos. 1935, 1947)

PANELS

82-1944

Use of Decoupling to Reduce the Radiated Noise Generated by Panels

G. Maidanik, R. Biancardi, and T. Eisler
David W. Taylor Naval Ship Res. and Dev. Ctr., Bethesda, MD 20084, J. Sound Vib., 81 (2), pp 165-185 (Mar 22, 1982) 8 figs, 11 refs

Key Words: Panels, Submerged structures, Vibrating structures, Noise generation, Noise reduction, Dampers

Four types of sources that induce on a panel four different responses are considered. The differences show up also in the way the responses radiate to the far field. A decoupling device in a form of a layer is placed adjacent to the top surface of the panel. The decoupling layer modifies the radiated fields that the sources generate. The modifications in terms of radiation reduction factors and levels are defined. These factors and levels are analyzed for two kinds of decoupling layers. The first is a compliant coating and the second is a layer of a mixture of gas and fluid. The compliant coating may induce on the fluid a velocity field that is different from that of the panel. The mixture of gas and fluid introduces a surface impedance discontinuity between the top surface of the panel and the top surface of the layer, the top surface being in contact with the semi-infinite fluid above the panel.

82-1945

Single-Point Excitation for Determination of Modal Characteristics of Shuttle Panels

R. Brillhart and H. Himelblau
Structural Dynamics Res. Corp., San Diego, CA, SAE Paper No. 811045

Key Words: Panels, Space shuttles, Modal tests, Single point excitation technique

Single-point excitation techniques for conducting modal testing have gained wide acceptance in recent years. Improvements in mini-computer hardware and software have resulted in significant reductions in test time when coupled with single-point excitation. This has been achieved without sacrificing accuracy. This paper discusses the results of single-point excitation as used on space shuttle orbiter panels to determine their modal characteristics.

PLATES

82-1946
Cyclic Bending of Plates under Transverse Loading
Y. Fukumoto and H. Kusama
Dept. of Civil Engrg., Nagoya Univ., Nagoya, Japan, ASCE J. Engrg. Mech. Div., 108 (EM3), pp 477-492 (June 1982) 9 figs, 14 refs

Key Words: Plates, Flexural vibration, Periodic excitation, Seismic design

The cyclic bending behavior of simply supported steel square plates under transverse loads is studied. Three cyclic conditions, the fixed deflection amplitude, and the fixed load amplitude are considered. A method of elastic and perfectly plastic large deflection small strain analysis is explained and the hysteretic characteristics of plates are obtained for three width-thickness ratios (b/t = 40, 60 and 80) under two loading conditions, uniformly distributed load and center patch load. The influence of membrane action and the spread of the plastic zone on the shape of the hysteretic loops, the variation of the force and bending moment intensities, and the deterioration of plates are also theoretically clarified.

82-1947
Free Transverse Vibrations of Uniform Circular Plates and Membranes with Eccentric Holes
W.H. Lin
Components Tech. Div., Argonne Natl. Lab., Argonne, IL 60439, J. Sound Vib., 81 (3), pp 425-435 (Apr 8, 1982) 2 figs, 4 tables, 33 refs

Key Words: Plates, Circular plates, Membranes (structural members), Hole-containing media, Flexural vibration, Wave equations

An analytical method, based on the transformation of cylindrical wave functions, is presented for calculating the free transverse vibrations of uniform circular plates and membranes with eccentric holes. The wave equations governing the small transverse motion of the plates and membranes are solved exactly to satisfy the boundary conditions at both inner and outer edges, and the associated frequency equations for the plates and membranes are derived. The analysis also includes the vibrations of uniform circular plates and membranes with concentric holes as special cases. Numerical examples are presented to show the dependence of the eigenfrequency on the eccentricity and on the ratio of the inner radius to outer radius. The main purpose of the paper is to illustrate that an exact, analytical solution of the vibrations of eccentric annular plates and membranes can be obtained.

82-1948
The Effect of Plate Thickness on the Fatigue Crack Propagation of Very Thin Steel Plate Specimens
Y. Hagiwara, T. Yoshino, and T. Kunio
Musashi Inst. of Tech., 1-28-1 Tamazutsumi Setagaya-ku, Tokyo, Japan, Bull. JSME, 25 (201), pp 307-314 (Mar 1982) 13 figs, 4 tables, 15 refs

Key Words: Plates, Geometric effects, Fatigue life, Steel, Crack propagation

Using very thin steel plate specimens, the effect of the plate thickness on the fatigue crack propagation was studied. Results showed that in very fine grained specimens, the crack propagation rate becomes slow with an increase of plate thickness. Based on the fatigue crack propagation resistance in the plane stress (in case of extremely thin plate specimens) and plane strain (in case of relatively thick specimens) conditions and the crack tip plastic zone sizes under maximum stress and cyclic stress conditions, the effect of plate thickness on fatigue crack propagation was estimated. The experimental results coincide with this estimation.

82-1949
Studies on Shock-Wave Loaded, Clamped Circular Plates
W. Idczak, Cz. Rymarz, and A. Spychala
Warsaw, Poland, J. Tech. Phys., 22 (2), pp 175-184 (1981) 8 figs, 1 table, 16 refs

Key Words: Plates, Circular plates, Shock excitation

Methods of investigating the circular, shock-wave loaded plates that are subjected to small, moderately large and finite deflections are presented. Results of theoretical analyses are compared with experimental analyses.

SHELLS

82-1950

The Theory of Shell Structures: Aims and Methods

C.R. Calladine

Engrg. Dept., Cambridge Univ., Cambridge CB2 1PZ, UK, Intl. J. Mech. Sci., 24 (4), pp 219-230 (1982) 9 figs, 18 refs

Key Words: Shells, Shell theories, Vibration analysis, Love's shell theory, Rayleigh waves

Some aspects of the theory of shell structures, and the nature of the theory itself are discussed. The importance of the interaction between bending and stretching effects in shells is emphasized and it is shown that the two surface model of shells provides a useful way of investigating this interaction at both the conceptual and the computational level. A cylindrical shell under various simple kinds of loading demonstrates how the key dimensionless groups emerge from this type of analysis. Some fresh light is thrown on the famous controversy between Love and Rayleigh on the vibration of simple shells. Various problems which arise in the numerical computation of shell structures are discussed.

82-1951

Free Torsional Vibrations of a Hollow Cylinder with Laminated Periodic Structure

R.K. Kaul and C.S. Lee

State Univ. of New York at Buffalo, Amherst, NY 14260, Intl. J. Solids Struc., 18 (4), pp 297-314 (1982) 6 figs, 16 refs

Key Words: Cylinders, Shells, Cylindrical shells, Layered materials, Torsional vibration, Variable material properties

The theory of torsional vibrations of a circular, hollow cylinder with a piecewise constant periodic variation of rigidity modulus and mass density is developed in terms of Floquet waves. The dispersion spectrum is shown to have a band structure, and the arrangement of characteristic sequence at the end-points of the Brillouin zone is studied. The problem of co-existence of periodic solution is examined in detail and the regions of stability and lability are charted.

82-1952

Modal Coupling in the Vibration of Fluid-Loaded Cylindrical Shells

P.R. Stepanishen

Dept. of Ocean Engrg., Univ. of Rhode Island, Kingston, RI 02881, J. Acoust. Soc. Amer., 71 (4), pp 813-823 (Apr 1982) 12 figs, 19 refs

Key Words: Shells, Cylindrical shells, Fluid-induced excitation, Sound propagation, Interaction: solid-fluid

An approach is presented to evaluate the pressure field and vibratory response of a finite fluid-loaded cylindrical shell with infinite rigid extensions which are connected to the shell. The approach combines a generalized Fourier series or in vacuo eigenfunction expansion of the velocity field of the shell with a Green's function and integral equation representation of the acoustic loading on the shell. Although modes with different circumferential wavenumbers are decoupled, all modes with identical circumferential wavenumbers are coupled via the fluid. The algebraic equations which account for this coupling include both shell impedances and acoustic impedances which are mode dependent. General integral expressions are presented for the acoustic impedances which include both self radiation and interaction impedances.

82-1953

Elastic-Pulse Propagation in Thin Hollow Cones

J.M. Lifshitz and G. Mor

Mech. Engrg., Technion-Israel Inst. of Tech., Haifa, Israel, Exptl. Mech., 22 (5), pp 166-170 (May 1982) 8 figs, 4 refs

Key Words: Shells, Conical shells, Pulse excitation

Elastic pulses were generated in a thin (3-mm) right circular conical shell with apex angle of 20 deg, by an axial impact of a drop weight. Radial-strain pulses of about 250-μs duration were measured at three locations along the cone by semiconductor strain gages. The relative amplitude decrease of the strain pulse was determined as a function of the distance traveled. An approximate analytical solution for this problem is presented. It is shown that, for cones made of material with Poisson's ratio $\nu = 1/3$, the approximation leads to the one-dimensional spherical-wave equation and the wave velocity is that of longitudinal waves in thin plates.

PIPES AND TUBES

82-1954

Flow-Induced Vibration of Curved Pipe Structures

Y.-C. Liu

Ph.D. Thesis, Purdue Univ., 154 pp (1981)

DA8210221

Key Words: Pipes (tubes), Curved pipes, Fluid-filled containers, Fluid-induced excitation

Mathematical models and a general numerical approach based on the structural impedance are developed for the dynamic study of curved flow-conveying pipe structures. The primary advantage of the numerical approach is that the dynamic interactions between the flowing fluid and the pipe structures, as well as the coupling effects between the in-plane and the out-of-place pipe motions, can be fully accounted for. The algorithm also has the capability of considering the dynamic stability phenomenon. A procedure including the stability criterion is suggested. For the verification of the algorithm and the computer code, several dynamic stability problems which have been previously studied experimentally and analytically were considered. This includes straight pipes and simple curved pipe models. Special attention is focused on the assessment of the effect of torsional inertia.

82-1955

A Three-Dimensional Method for Integrated Transient Analysis of Reactor-Piping Systems

C.Y. Wang

Struc. Mech. Section, Engrg. Mech. Program, Reactor Analysis and Safety Div., Argonne Natl. Lab., 9700 S. Cass Ave., Argonne, IL 60439, Nucl. Engrg. Des., 68 (2), pp 175-184 (1981) 14 figs, 4 refs

Key Words: Piping systems, Nuclear reactor components, Transient response, Seismic response

A three-dimensional method for integrated hydrodynamic, structural, and thermal analyses of reactor-piping systems is presented. The hydrodynamics are analyzed in a reference frame fixed to the piping and are treated with a two-dimensional Eulerian finite-difference technique. The structural responses are calculated with a three-dimensional co-rotational finite-element methodology. Interaction between fluid and structure is accounted for by iteratively enforcing the interface boundary conditions.

DUCTS

(Also see Nos. 1855, 1865, 1971)

82-1956

Impedance of an Orifice under a Turbulent Boundary Layer with Pressure Gradient

A. Goldman and C.H. Chung

Dept. of Mech. Engrg., Texas Tech Univ., Lubbock, TX 79409, J. Acoust. Soc. Amer., 71 (3), pp 573-579 (Mar 1982) 7 figs, 1 table, 7 refs

Key Words: Ducts, Holes, Acoustic impedance

The acoustic impedance of an orifice under a turbulent boundary layer with a pressure gradient was measured. A single orifice was tested in a wind tunnel with freestream velocity varied from 10 to 30 m/s with an imposed pressure gradient which varied from mildy separating to strongly accelerating. The impedance of the orifice as a function of frequency was correlated with variations in the boundary layer parameters. The impedance was insensitive to changes in the outer layer variables; i.e., the boundary layer thickness and pressure gradient.

82-1957

Active Attenuation of Noise -- The Monopole System

Kh. Eghtesadi and H.G. Leventhall

Dept. of Electrical Engrg., Abadan Inst. of Tech., Abadan, Iran, J. Acoust. Soc. Amer., 71 (3), pp 608-611 (Mar 1982) 8 figs, 6 refs

Key Words: Ducts, Noise reduction

Proposals have been made to attenuate noise propagating down a duct by adding an antiphase copy of the primary noise. In a number of configurations, two or three sources had been used to produce the secondary noise, but a successful system with one source had not been realized. The conventional monopole system is analyzed and the reason why this type of monopole secondary source is not a practical solution is investigated. A modified system with a new solution of the problem is developed.

82-1958

Propagation of Spinning Acoustic Modes in Partially Choked Converging Ducts

A.H. Nayfeh, J.J. Kelly, and L.T. Watson

Virginia Polytechnic Inst. and State Univ., Blacksburg, VA 24061, J. Acoust. Soc. Amer., 71 (4), pp 796-802 (Apr 1982) 12 figs, 19 refs

Key Words: Ducts, Acoustic linings, Sound propagation

A computer model based on the wave-envelope technique is used to study the propagation of spinning acoustic modes in converging hard-walled and lined circular ducts carrying near sonic mean flows. The results show that with increasing spinning mode number the intensification of the acoustic signal at the throat decreases for upstream propagation. The influence of the throat Mach number, frequency, boundary-layer thickness, and liner admittance on the propagation of spinning modes is considered.

BUILDING COMPONENTS

82-1959

Sound Transmission Loss of Gypsum Wallboard Partitions. Report No. 2. Steel Stud Partitions Having Cavities Filled with Glass Fiber Batts

D.W. Green and C.W. Sherry

Domtar Inc. Res. Ctr., Senneville, Quebec, Canada H9X 3L7, J. Acoust. Soc. Amer., 71 (4), pp 902-907 (Apr 1982) 8 figs, 5 tables, 4 refs

Key Words: Walls, Sound transmission

Using the data bank of an acoustics laboratory, statistical equations based on density are derived for predicting the sound transmission loss and sound transmission class of double leaf wall partitions. The partitions are constructed from gypsum wallboard, light gauge steel studs, and have glass fiber batts in the cavity space. The results predicted, using these equations, are found to be in good agreement with results on similar assemblies tested at other laboratories. The equations are used to illustrate the effect of surface density, steel stud size, and method of board attachment on sound transmission loss. The effect of adding glass fiber batts to the cavity space is shown to depend upon the surface density of the partitions. Assuming equal surface densities, no improvement in STC was noted for partitions having unbalanced construction. The results, predicted for simple partition construction, are compared to test data for partitions constructed using resilient channels and for multiple rows of steel studs.

DYNAMIC ENVIRONMENT

ACOUSTIC EXCITATION

(Also see Nos. 1885, 1892, 1910, 2041)

82-1960

Decay Rates and Wall Absorption at Low Frequencies

F. Jacobsen

The Acoustics Lab., Technical Univ. of Denmark, DK-2800 Lyngby, Denmark, J. Sound Vib., 81 (3), pp 405-412 (Apr 8, 1982) 2 figs, 11 refs

Key Words: Enclosures, Reverberation chambers, Sound power levels, Acoustic absorption, Error analysis

This paper is concerned with evaluating the error of conventional estimates of the boundary absorption of rectangular enclosures, with particular reference to reverberation room sound power measurements. The reverberation process is examined theoretically; the relative contributions to the decay rate from different modes in a rectangular room are calculated from an ensemble average over rooms with nearly the same dimensions. It is shown that the traditional method of determining the absorption of the walls of reverberation rooms systematically underestimates the absorption at low frequencies; the error is computed from the ensemble average. An unbiased estimate of the sound power radiated by a source in a reverberation room is derived.

82-1961

Harmonic Waves in a Periodically Laminated Medium

A.H. Shah and S.K. Datta

Dept. of Civil Engrg., Univ. of Manitoba, Winnipeg, Canada, Intl. J. Solids Struc., 18 (5), pp 397-410 (1982) 13 figs, 20 refs

Key Words: Fiber composites, Layered materials, Wave propagation, Harmonic waves

A stiffness method using the continuity of displacement and traction at the interfaces of a periodically laminated composite medium and the Floquet's Theory has been presented here for studying harmonic wave propagation in a layered composite. Both plane strain and antiplane strain problems have been studied. The equations have been developed for both isotropic and anisotropic layers. Numerical results are presented for the dispersion spectrum for propagation in a periodic two-layered medium and these are shown to compare well with available exact results. Numerical results are presented for a boron-aluminum composite medium, which is modeled as a composition of anisotropic and isotropic layers.

82-1962

Diffraction of Sound by a Noise Barrier in the Presence of Atmospheric Turbulence

G.A. Daigle

Div. of Physics, Natl. Res. Council, Ottawa, Ontario, Canada K1A OR6, J. Acoust. Soc. Amer., 71 (4), pp 847-854 (Apr 1982) 9 figs, 17 refs

Key Words: Noise barriers, Acoustic diffraction, Turbulence

Although atmospheric turbulence influences many aspects of sound propagation outdoors, its effects have not previously been studied quantitatively when predicting the attenuation of sound by barriers. Traffic noise attenuated by a barrier alongside a highway has been measured with microphones positioned above an asphalt surface behind the barrier. The sound levels are analyzed and compared with certain aspects of diffraction theory to reveal discrepancies. To investigate the discrepancies, an idealized experiment was performed using a point source and a barrier erected on a flat asphalt surface. Because important discrepancies between theories were found, especially at shorter distances from the barrier, these more precise measurements are first compared with various diffraction theories. When subsequently compared with the diffraction theory that shows the best agreement with the measured points, another discrepancy in sound levels is observed that occurs at the higher frequencies. A calculation is described to estimate the amount of sound energy scattered by atmospheric turbulence above the barrier edge.

82-1963

Waveform Analysis of Acoustic Emission in Concrete

Y. Niwa, M. Ohtsu, and H. Shiomi

Dept. of Civil Engrg., Kyoto Univ., Kyoto, Japan, Mem. Fac. Engrg., Kyoto Univ., 43 (4), pp 319-330 (Oct 1981) 15 figs, 15 refs

Key Words: Concretes, Acoustic emission, Nondestructive tests

Extensive studies in correlations between AE parameters and mechanical behaviors of concrete materials and structures have been carried out and some recent developments on AE waveform analysis are described. In searching for the source mechanisms of AE, the aim of waveform analysis may be to separate the effects of the propagation media and the transducers from the detected AE waveforms, and to determine the kinetic and kinematic characteristics of sources. Therefore, the deconvolution techniques in both the time domain and the frequency domain are developed. They have been applied to investgate two basic types of sources; namely, a point force and a tensile crack. Results show that original notions concerning the source mechanisms of AE, which can be mathematically described by the dislocation model, are acceptable. The applicability of elastodynamics and the dislocation theory for studying the relation between the source mechanisms and wave motions of AE is also verified.

82-1964

Response of a Rectangular Parallelepiped to a Simulated Acoustic Emission Burst

E.v.K. Hill and D.M. Egle

Dept. of Mech. Engrg., Clemson Univ., Clemson, SC 29631, J. Acoust. Soc. Amer., 71 (4), pp 891-901 (Apr 1982) 8 figs, 1 table, 28 refs

Key Words: Acoustic emission, Rectangular bodies, Forced vibration

The forced vibrational response of the rectangular parallelepiped is of particular interest in the study of wave propagation in three-dimensional solids and especially in the characterization of acoustic emission sources. There has been considerable interest in studying source mechanisms in order to predict, and perhaps eventually control, flaw growth in structural materials. The acoustic emission source waves generated by flaw growth are thought to be pulselike functions of stress (force) which are produced by the step displacements associated with material yielding. Much of this type of emission in solids is produced internally and can, therefore, be modeled as a body force phenomenon; as such, this paper presents an exact, normal mode solution for the response of a rectangular parallelepiped to an impulsive body force. The numerical results prior to any reflections from the boundaries show agreement with the infinite space solution.

82-1965

Theory of Acoustic Emission

J.A. Simmons and R.B. Clough

Natl. Bureau of Standards, Washington, DC, 34 pp (1981) (Pub. in Proceedings of Intl. Conf. on Dislocation Modelling of Physical Systems, Gainesville, FL, June 1980, pp 464-497)

Key Words: Acoustic emission, Green function

A theory of acoustic emission is presented based on a Green's function type of formalism, rather than on the conventional count rate concept. Sources are represented by stress drop rate tensors and conditions are derived from which the source can be considered small in terms of wavelength and distance to the transducer. These pseudopoint sources are examined over a restricted frequency bandwidth, called the informative bandwidth. Such a bandlimited system may be described by a tensor transfer function type of formalism, facilitating the analysis and reducing the inverse problem -- where the source is not known a priori -- to a deconvolution operation.

82-1966

Scattering at a Rough Boundary -- Extensions of the Kirchhoff Approximation

E.G. Liszka and J.J. McCoy
Naval Sea Systems Command, Washington, DC 20362, J. Acoust. Soc. Amer., 71 (5), pp 1093-1100 (May 1982) 5 figs, 1 table, 16 refs

Key Words: Acoustic scattering

A Helmholtz integral formula gives the acoustic field reflected from a rough surface, in terms of the values of the acoustic field and of its normal derivative at all points on the surface. For surface reflection problems in which one or the other of these surface field values are specified, this formula can be used to derive a boundary surface integral equation on the unspecified field values. Further, a series of solution of this equation can be constructed by iteration, the zeroth-order term of the series being the result predicted by a Kirchhoff approximation. The nth-order iterate of this series requires an n-fold integration over the region of the rough surface, an integration that does not in general converge absolutely for unboundedly large surfaces. For a pressure release surface, the first two iterates are considered in detail and using stationary phase approximations the required integration is replaced by summations. In this way the source of the convergence difficulty is made clear and is demonstrated to result from the iteration procedure.

82-1967

Studies in Reverberation. II. Scattering of Sound by a Cylindrical Vortex Embedded in a Fluid at Rest

C.L. Pekeris
Dept. of Appl. Math., The Weizmann Inst. of Sci., Rehovot, Israel, J. Acoust. Soc. Amer., 71 (5), pp 1106-1108 (May 1982) 2 figs, 2 refs

Key Words: Acoustic scattering

A solution is obtained for the scattering of a plane sound wave incident normally on a cylinder of fluid rotating uniformly in a fluid at rest. In the long wave approximation, the amplitude of the scattered wave is proportional to the peripheral velocity of the cylinder and vanishes in the forward and backward directions as well as in directions normal to the direction of propagation of the incident wave.

82-1968

Analysis and Computation of the Acoustic Scattering by an Elastic Prolate Spheroid Obtained from the T-Matrix Formulation

L. Flax, L.R. Dragonette, V.K. Varadan, and V.V. Varadan
Naval Res. Lab., Washington, DC 20375, J. Acoust. Soc. Amer., 71 (5), pp 1077-1082 (May 1982) 4 figs, 1 table, 27 refs

Key Words: Spheres, Acoustic scattering

The T-matrix formulation is used to compute the form function of an elastic prolate spheroid. The method allows acoustic scattering computations to be made for finite bodies at frequencies into the resonance region, and the lowest order resonance observed is, as expected, due to the excitation of a Rayleigh surface wave.

82-1969

Solution of an Inverse, Elastic-Wave Scattering Problem

G.A. Baker, Jr.
Theoretical Div., Univ. of California, Los Alamos Natl. Lab., Los Alamos, NM 87545, J. Acoust. Soc. Amer., 71 (4), pp 785-789 (Apr 1982) 12 refs

Key Words: Elastic waves, Wave diffraction

A method is developed which in principle solves the inverse, elastic-wave scattering problem for scatterers of spherical symmetry which are described as a continuous variation of the material parameters of the isotropic, homogeneous, solid, host medium.

82-1970

Recent Developments in the Measurement of Acoustic Intensity Using the Cross-Spectral Method

J.Y. Chung and D.A. Blaser
Engrg. Mech. Dept., General Motors Res. Labs., SAE Paper No. 810396

Key Words: Sound measurement, Cross spectral method, Noise source identification

In recent years, the use of the cross-spectral method of measuring acoustic intensity has been shown effective in noise-source-ranking and noise-source-identification. Using a computerized data acquisition and analysis procedure, the method is efficient and accurate. Its applicability to a near-field and/or reverberant-field measurement enables the method to be used in situ. The method has a potential of replacing many conventional acoustical measurements, but results of many parametric studies of the method are not known to many interested noise control engineers. These parametric studies, in addition to a general review of the method, are presented in this paper.

82-1971

Circumferential Propagation of Acoustic Boundary Waves in Boreholes

B.J. Botter and J. van Arkel
Koninklijke/Shell Exploratie en Produktie Laboratorium, Postbus 60, 2280 AB, Rijswijk ZH, The Netherlands, J. Acoust. Soc. Amer., 71 (4), pp 790-795 (Apr 1982) 5 figs, 9 refs

Key Words: Cylindrical cavities, Sound propagation, Fluid-filled media.

Dispersion equations are derived to describe the circumferential propagation of elastic boundary waves along an empty and a fluid-filled borehole. These equations are solved for various Poisson ratios to yield velocity and attenuation curves as a function of the ratio of wavelength to borehole diameter. Theoretical data agree closely with data obtained in an actual borehole.

82-1972

Investigation of the Noise Emitting Zones of a Cold Jet Via Causality Correlations

M. Schaffar and J.P. Hancy
Institut Franco-Allemand de Recherches de Saint-Louis, 12, rue de l'Industrie, 68301 Saint-Louis, France, J. Sound Vib., 81 (3), pp 377-391 (Apr 8, 1982) 12 figs, 16 refs

Key Words: Noise source identification

Within the framework of Lighthill's acoustic analogy the causality method proposed by Ribner and Siddon is used to identify equivalent noise sources inside a cold jet. An exploration of a few cross-sections shows that a two-dimensional investigation suffices in a first approach for integrating the source function provided the upper frequency limit does not exceed a Strouhal number approximately equal to 0·5. Furthermore the transverse distribution of the source term shows the jet region located on the microphone side to be dominant; the effective diameter of the source region is comparable with that of the nozzle.

82-1973

Nearfield and Farfield of Pulsed Acoustic Radiators

J.N. Tjøtta and S. Tjøtta
Dept. of Math., Univ. of Bergen, Bergen, Norway, J. Acoust. Soc. Amer., 71 (4), pp 824-834 (Apr 1982) 8 figs, 52 refs

Key Words: Pistons, Acoustic pulses, Sound waves, Noise generation

The acoustic field of a baffled piston source of any shape and with nonuniform velocity distribution is considered, utilizing a generalized version of the impulse response approach developed by Stepanishen and with emphasis in obtaining analytical results and general properties. Effects of amplitude shading and rigidity at the edge are investigated for planar sources. Asymptotic farfield expressions are obtained, which show how the shape of the pulse as well as that of the source do influence the farfield directivity. Nonplanar sources are also considered briefly.

82-1974

Industrial Machinery Noise Impact Modeling. Volume I

C.H. Hansen and B.A. Kugler
Bolt, Beranek and Newman, Inc., Canoga Park, CA, Rept. No. BBN-4535-VOL-1, EPA-550/9-81/315, 191 pp (July 1981)
PB82-148099

Key Words: Machinery noise, Noise prediction, Computer programs

This study describes the development of a machinery noise computer model which may be used to assess the effect of occupational noise on the health and welfare of industrial workers. The purpose of the model is to provide EPA with the methodology to evaluate the personnel noise problem, to identify the equipment types responsible for the exposure and to assess the potential benefits of a given noise control action. Due to its flexibility in design and application, the model and supportive computer program can be used by other federal agencies, state governments, labor. and industry as an aid in the development of noise abatement programs.

82-1975

Industrial Machinery Noise Impact Modeling. Volume II. Appendices

B.A. Kugler and C.H. Hansen
Bolt, Beranek and Newman, Inc., Canoga Park, CA, Rept. No. BBN-4535-VOL-2, 513 pp (May 1981)
PB82-148107

Key Words: Machinery noise, Noise prediction, Computer programs

The report presents the computer program developed to ascertain noise levels to which workers in foundries and sawmills are exposed. Output data from computer input are delineated.

82-1976

Predicted Ground Effect for Highway Noise

K. Attenborough

Faculty of Tech., The Open University, Milton Keynes MK7 6AA, UK, J. Sound Vib., 81 (3), pp 413-424 (Apr 8, 1982) 9 figs, 3 tables, 17 refs

Key Words: Highway transportation, Traffic noise, Sound propagation, Noise prediction

The well-established theory for propagation from a point source over an impedance boundary predicts a surface wave for low frequencies and near grazing incidence. The implications of the theoretically predicted surface wave for propagation over a locally reacting boundary are explored in terms of real and imaginary parts of surface normal impedance. Available measurements of the surface normal impedance of the ground are collected together and reviewed. The computer predicted variation in A-weighted excess attenuation of a traffic line source with ground type is presented and discussed.

SHOCK EXCITATION

(Also see Nos. 1874, 1882, 1883, 1906, 2026, 2052)

82-1977

Amplitude Attenuation of Impulsive Waves in Random Media Based on Travel Time Corrected Mean Wave Formalism

H. Sato

Dept. of Earth and Planetary Sciences, Massachusetts Inst. of Tech., Cambridge, MA 02139, J. Acoust. Soc. Amer., 71 (3), pp 559-564 (Mar 1982) 6 figs, 15 refs

Key Words: Shock wave propagation, Wave propagation, Amplitude attenuation, Statistical analysis

Waves gradually collapse with propagation through media with random velocity fluctuation; however, impulsive waves propagate without large attenuation when the wavelength is shorter than the correlation distance. The Q^{-1} value predicted from the usual mean wave formalism monotonously increases with frequency even in the high-frequency limit, due to taking a mean over waves with large travel time fluctuations caused by the long scale velocity fluctuation compared with the wavelength studied. A new statistical averaging method is proposed appropriate for the amplitude attenuation measurement of impulsive waves, in which the mean wave is defined after the correction of travel time fluctuations. Impulsive scalar waves propagation in three-dimensional media with homogeneous and isotropic random fractional velocity fluctuation is investigated, based on the binary interaction approximation in this improved mean wave formalism.

82-1978

Collision between Stationary Synchronous Shock Waves of Finite Deformations in the Isotropic Elastic Medium Isentropic Approximation

E. Włodarczyk

Warsaw, Poland, J. Tech. Phys., 22 (2), pp 165-173 (1981) 4 figs, 6 refs

Key Words: Shock wave propagation

A system of synchronous waves is defined as two stationary shock waves of finite deformations propagating in the semi-space of isotropic elastic medium, in the same direction, one after the other, perpendicularly to the surface. It is proven that this system of synchronous waves is unstable. The second wave is moving faster than the first one and it will always overtake the first wave. In the moment of collision of the waves an arbitrary discontinuity is created in the medium, which is subjected to disintegration. The objective of this paper is to find the stable configuration of wave fronts after disintegration of arbitrary discontinuity and to define their parameters.

82-1979

Regular Reflection of a Weak Shock Wave from an Inclined Plane Isothermal Wall

K. Piechor

Inst. of Mech., Univ. of Warsaw, Poland, Arch. Mech., 33 (3), pp 337-346 (1981) 1 fig, 10 refs

Key Words: Shock wave reflection

The problem of reflection of a weak shock wave from an oblique plane wall is analyzed. Only the case of the isothermal wall is considered. The flow domain is divided into two parts: an outer domain containing both shock waves and a boundary layer close to the wall. In order to determine the outer flow, the Lighthill technique and the multiple

scales method are combined. The flow in the boundary layer is described by the linearized Prandtl equations. To determine some unknown functions, the matching principle is used. As a result, the structure and the trajectory of the reflected shock wave are obtained. The location of the trajectory of the reflected shock wave is influenced by the boundary layer. Also a criterion of regularity of the reflection is obtained.

82-1980

One-Dimensional Shock Waves in Magnetized Electrically Conducting Elastic Materials

M.F. McCarthy

Natl. Univ. of Ireland, Univ. College, Galway, Ireland, Arch. Mech., 33 (3), pp 443-450 (1981) 5 refs

Key Words: Shock wave propagation, Elastic media

In this paper the behavior of plane shock waves in elastic media of finite electrical conductivity which are subjected to a magnetic field whose direction lies in the plane of the wave is considered. The equation which governs the amplitude of shock waves is derived and its implications are examined in detail. The results which hold when the amplitude of the shock becomes infinitesimally small are also discussed.

82-1981

On Coupling Acceleration and Shock Waves in a Thermoviscoplastic Medium. II. One-Dimensional Waves

K. Wołoszyńska

Polish Academy of Sciences, Inst. of Fundamental Technological Research, Warsaw, Poland, Arch. Mechanics, 33 (3), pp 451-468 (1981) 3 figs, 8 refs

Key Words: Shock wave propagation, Thermoviscoplastic media

An analysis of one-dimensional shock waves in a thermoviscoplastic medium is given. In the linear theory, nonlinear ordinary differential equations were obtained for the thermal and mechanical amplitude. The governing equations for plane waves in the form of quasi-linear hyperbolic partial differential equations were solved by using Riemann's method.

82-1982

On Weak Solutions, Stability and Uniqueness in Dynamics of Dissipative Bodies

W. Kosiński

Polish Academy of Sciences, Inst. of Fundamental Technology Research, Warsaw, Poland, Arch. Mech., 33 (2), pp 319-323 (1981) 5 refs

Key Words: Boundary value problems

In order to include shocks in dynamic initial boundary-value problems weak solutions in the class of functions of bounded variation are investigated. The admissibility criterion for the weak solution is formulated. Stability and uniqueness results are obtained in this class of functions.

82-1983

A Boundary Method Applied to Elastic Scattering Problems

F.J. Sánchez-Sesma

Instituto de Ingenieria, Universidad Nacional Autonoma de Mexico, Mexico, Arch. Mech., 33 (2), pp 167-179 (1981) 7 figs, 2 tables, 47 refs

Key Words: Wave diffraction, Seismic waves

A boundary method for solving some elastic scattering problems is presented. The scattered field is represented in terms of a linear combination of wave functions which are particular solutions of the governing equations. Green's functions with singularities or sources located outside the region of interest have been chosen. Coefficients of these sources are determined such that, for each given frequency of excitation, boundary conditions at the interface of the scatterer and the rest of the region are satisfied in the least-squares sense. The scatterer can be a cavity or an inclusion. For elastic inclusions an interior problem arises and thus the refracted field is obtained using exterior sources. Results are presented for the problem of scattering and diffraction of harmonic SH waves by cavities or canyons in an elastic half-space. Comparison with known analytical and numerical solutions yields very good agreement.

82-1984

Studies on Shock Phenomena in Two-Phase Flow (2nd Report, Characteristics in Slug Flow Region)

K. Akagawa, T. Fujii, Y. Ito, T. Yamaguchi, and K. Fukuhara

The Faculty of Engrg., Kobe Univ., Rokkodai, Nada, Kobe, Bull. JSME, 25 (201), pp 387-394 (Mar 1982) 12 figs, 1 table, 16 refs

Key Words: Water hammer, Shock excitation

Shock phenomena caused by a rapid valve closure in a slug flow region were investigated. The experiment was conducted in a horizontal acrylic tube of 20.7 mm ID, 4.85 mm in thickness, and 18.5 m in length. The profiles of the transient pressure caused by a rapid valve closure in slug flow are affected by the flow configuration adjacent to the valve, and these are classified into two types according to the existence of a gas slug or a liquid slug at the valve at the instant of valve closure. The characteristics of the transient pressure in the former were analyzed by an oscillation system model composed of a mass (liquid slug) and a compressible capacity (gas slug). Those in the latter were also analyzed for a homogeneous two-phase flow model by a similar method to that in a waterhammer analysis. The experimental results were well explained by these analyses.

82-1985

Stationary-Shock-Wave Reflection from a Solid Partition by Deformable Damping Systems

E. Włodarczyk

Warsaw, Poland, J. Tech. Phys., 22 (2), pp 201-215 (1981) 16 refs

Key Words: Shock wave propagation, Shock wave reflection, Plates, Viscous damping

A solution to the problem of reflection of a stationary, plane shock wave from a solid non-deformable plate supported by the damping media and systems is presented. The shock waves under study, both incident and reflected, propagate in the polytropic gas. It is demonstrated that the support of the plate by the elastic half-space, can be modeled by the system of linear viscous dampers. Under laboratory conditions the action of the elastic half-space upon the plate under study can be exactly reproduced with the aid of appropriate viscous dampers.

VIBRATION EXCITATION

82-1986

Analytical Study on Engine Vibration Transfer Characteristics Using Single-Shot Combustion

Y. Hayaski, K. Sugihara, A. Toda, and Y. Ushijima

Nissan Motor Co., Ltd., Yokosuka, Japan, SAE Paper No. 810403

Key Words: Engine vibration, Vibration transfer

In order to demonstrate the generation mechanism of combustion noise separately from mechanical noise, the process of transfer in which vibration travels to each engine portion was analyzed through single-shot combustion of a propane-air mixture in the combustion chamber with the crankshaft fixed at a given angle. The effect of the natural frequency of each portion of the engine on the vibration transfer characteristics is discussed by introducing a vibration transfer function. The transfer paths of exciting forces which are caused by the combustion are quantitatively clarified.

82-1987

Limit Cycle Oscillations and a Perturbed Harmonic Oscillator

W.-H. Steeb and A. Kunick

Universität Paderborn, Theoretische Physik, D-4790 Paderborn, Fed. Rep. Germany, Intl. J. Nonlin. Mech., 17 (1), pp 41-45 (1982) 2 figs, 3 refs

Key Words: Harmonic response

This paper is concerned with the behavior of the dynamical system $\dot{x} = y$, $\dot{y} = -x - \mu \sin y$ which is important in electrical circuit theory.

82-1988

Estimation of the Variance of Steady Vibration Responses of Structures with Random Parameters and Method to Compute the Allowable Variance of the Parameters

K. Tanaka, H. Onishi, and M. Kaga

Mech. Engrg. Res. Lab., Hitachi Ltd., 502 Kandatsu, Tsuchirua-shi, Ibaraki, 300 Japan, Computers Struc., 15 (3), pp 329-334 (1982) 6 figs, 3 tables, 5 refs

Key Words: Random vibration

When parameters contributed to mass and rigidity of the structures have randomness, the steady vibration responses of the structures have random characteristics. In this paper the method to estimate the variance of the response and to compute the allowable variance are described. In the computation the partial derivative method is used and effectiveness of the method is examined for simple numerical examples.

82-1989

The Interaction of Self-Excited and Forced Vibration (Zum Problem des gegenseitigen Einflusses von selbsterregten und fremderregten Schwingungen)

G. Rudiger

Staatl. Forschungsinstitut f. Maschinenbau, Prague, Ch. SSR, Z. angew. Math. Mech., 62 (2), pp 103-113 (1982) 12 figs, 7 refs
(In German)

Key Words: Single degree of freedom systems, Self-excited vibrations, Forced vibrations

This paper is a contribution to the analysis of the interaction between self-excited and forced vibrations of a system with one degree of freedom having nonlinear characteristic of the restoring force. Both cases of soft and hard self-excitation are considered. The stability and reality of the semitrivial and non-trivial solutions (solutions having both excited and self-excited vibration components) at resonance are investigated.

82-1990
Developments in Low-Speed Aeroelasticity in the Civil Engineering Field
R.H. Scanlan
Princeton Univ., Princeton, NJ, AIAA J., 20 (6), pp 839-844 (June 1982) 3 figs, 64 refs

Key Words: Aeroelasticity, Fluid-induced excitation, Vortex-induced vibration, Galloping, Flutter, Buffeting

The field of low-speed aeroelasticity in civil engineering has grown in application over the last four decades. Benefiting in broad terms from the guidance of earlier work done in aeronautics, the field has developed a distinct character of its own, centered principally on the problems of flows about bluff bodies. These problems can be conveniently classified into the categories of vortex-induced oscillation, galloping, flutter, and buffeting. Each has developed specialized theory based upon key experimental inputs. In particular, the field of suspension bridge aeroelasticity has received extensive experimental and analytical treatment. The present paper briefly outlines the state-of-the-art in civil engineering aeroelasticity, accompanying this with a number of appropriate references.

82-1991
Prediction and Experimental Verification of Transient Airfoil Motion
S.M. Rock and D.B. DeBra
Systems Control Tech., Palo Alto, CA, J. Aircraft, 19 (6), pp 456-464 (June 1982) 11 figs, 5 tables, 28 refs

Key Words: Airfoils, Transient response, Flutter, Aerodynamic loads

The theory for aerodynamic loading associated with transient motion of an airfoil in a wind tunnel is extended and verified experimentally. A generalized Theodorsen function which includes wall effects is described and finite-state approximations are developed for large wing-semichord/wall-spacing ratios. Experimental results are presented which verify the theoretical predictions for transient airfoil motions. These results are obtained using a small, low-subsonic wind tunnel with a unique airfoil suspension design that provides uncoupled sensing and acutation for two degrees of freedom.

82-1992
Superresolution Ultrasonic Imaging System by Forced Vibration of Object
T. Sato, O. Ikeda, Y. Akiyama, and T. Hatsuzawa
The Graduate School at Nagatsuta, Tokyo Inst. of Tech., 4259 Nagatsuta, Midori-ku, Yokohama-shi, 227 Japan, J. Acoust. Soc. Amer., 71 (3), pp 635-640 (Mar 1982) 10 figs, 6 refs

Key Words: Forced vibration, Ultrasonic techniques

A superresolution ultrasonic imaging method by the forced vibration of an object is proposed. This method is based on the following fact: when a periodically vibrating object is illuminated, the signal components returned from different points on the object give corresponding different sets of the Fourier expansion coefficients. An optimum algorithm for estimating the object is formulated for the case of a general array imaging system. The algorithm obtained is a kind of deconvolution operation for the Fourier expansion coefficients of the received signal to obtain the coefficients of reflection of the object. The spacing of the image reconstruction points and the dimension of the deconvolving matrix are related to the size and the numbers of resolvable elements, respectively. It is shown, in terms of the effective rank of the matrix, that the resolution is increased with the increase of the amplitude or frequency of the vibration. Superresolution imaging is possible if the space is chosen so that it is less than a half of the wavelength of the ultrasonic wave. The effectiveness of the method is shown by numerical analyses, and is confirmed by basic experiments.

MECHANICAL PROPERTIES

DAMPING

(Also see Nos. 1860, 1868, 1915, 1944, 1985)

82-1993
Finite Element Model with Nonviscous Damping
L.A. Roussos, M.W. Hyer, and E.A. Thornton
NASA Langley Res. Ctr., Hampton, VA, AIAA J., 20 (6), pp 831-838 (June 1982) 6 figs, 3 tables, 32 refs

Key Words: Structural damping, Finite element technique

A procedure is developed by which many different structural damping functions (linear or nonlinear) may be incorporated in a structure through finite element matrices and also develops a solution technique for the resulting nonlinear equations of motion. Damping is incorporated through general strain and strain-rate dependent terms in the material constitutive law; general finite element matrices are derived through application of the principle of virtual work; and the solution technique is developed by modifying the Newmark method to accommodate an iterative solution and to treat nonlinear damping as a pseudoforce. The application of the analytical developments of the paper are demonstrated by investigating the effects of a specific nonviscous damping model on the transient motion of a free-free Timoshenko beam.

82-1994
Analysis of High Load Dampers
S.T. Bhat, D.F. Buono, and D.H. Hibner
Commerical Products Div., Pratt & Whitney Aircraft Group, United Technologies Corp., Rept. No. NASA CR-165503

Key Words: Dampers, Squeeze-film dampers, Rotors, Jet engines

This program focused on the definition of high load damping requirements for modern jet engines, and the evaluation, selection, and design of damping systems which could satisfy these requirements. In order to evaluate high load damping requirements, engines in three major classes were studied: large transport engines, small general aviation engines, and military engines. Four damper concepts applicable to these engines were evaluated: multi-ring, cartridge, curved beam, and viscous/friction. The most promising damper concept was selected for each engine and performance was assessed relative to conventional dampers and in light of projected damping requirements for advanced jet engines.

82-1995
Coulomb Friction in Mechanism Sliding Joints
G.T. Rooney and P. Deravi
Mechanisms Group, Liverpool Polytechnic, Liverpool, UK, Mech. Mach. Theory, 17 (3), pp 207-211 (1982) 14 figs, 1 table, 7 refs

Key Words: Coulomb friction, Joints (junctions)

Shortcomings in method of solutions of the Coulomb friction problem by other researchers are discussed and a direct method is proposed for introducing the nonlinearities of this type of friction into sets of dynamic equations of motion for mechanical systems. The proposed method is free of iterations and repeats its calculations only once at each change of sign of reaction force. Numerical results demonstrate the efficiency of this direct method. The method also shows up the existence of regions of exceptional solutions to the dynamic equations.

82-1996
Wave Propagation Analysis for Determining the Dynamic Properties of High Damping Alloys
Y. Sogabe, K. Kishida, and K. Nakagawa
Faculty of Engrg., Ehime Univ., Bunkyocho 3, Matsuyama, Japan, Bull. JSME, 25 (201), pp 321-327 (Mar 1982) 13 figs, 2 tables, 7 refs

Key Words: Material damping, Viscoelastic properties, Metals

The viscoelastic behaviors of two kinds of high damping alloys, Mn-Cu alloy and Fe-Cr-Al alloy, are studied with a view to assessing the damping characteristics. Under the assumption that the material is a linear viscoelastic body, the complex compliance is obtained from the wave propagation data on a long rod analyzed with Fourier transform technique. Copper is also examined for comparison. Experimental results reveal the frequency and amplitude dependences of damping capacity in each material. It is also found that the 4-element model should be applied for both high damping alloys, and the Maxwell model for copper, respectively.

82-1997
High Temperature Damping of Dynamic Systems
D.I.G. Jones
AF Wright Aero. Labs., Wright-Patterson AFB, OH 45433, Shock Vib. Dig., 14 (5), pp 13-15 (May 1982) 30 refs

Key Words: Material damping, Coulomb friction, Reviews

This article describes progress in three major areas of high temperature vibration control technology since 1979; namely: development of high temperature polymeric and vitreous enamel damping materials, and measurement and characterization of the damping behavior of these materials, practical design and application of damping treatments in industry and commerce; and frictional damping at interfaces.

FATIGUE

(Also see Nos. 1929, 2032)

82-1998

Designing to Avoid Fatigue Failure in Engineering Polymers

M.T. Takemori and T.A. Morelli
General Electric Co., Corporate Res. and Dev. Ctr., SAE Paper No. 811352

Key Words: Polymers, Fatigue life

For engineering, aesthetic and economic reasons, polymers are marketed in a multitude of compositional and structural variations. Unfortunately, complete (or even partial) fatigue data is seldom available. The design engineer must thus rely on an understanding of the fatigue mechanisms in order to establish meaningful measures of fatigue resistance. An ongoing research program on the fatigue behavior of polymers has been conducted. Two examples are discussed in this paper.

82-1999

Cumulative Damage with Interaction Effect Due to Fatigue under Torsion Loading

T. Bui-Quoc
Ecole Polytechnique, Montreal, Quebec, H3C 3A7 Canada, Exptl. Mech., 22 (5), pp 180-187 (May 1982) 11 figs, 26 refs

Key Words: Fatigue life, Torsional excitation, Periodic excitation

The cumulative-fatigue damage concept previously developed by means of the test results obtained under axial loading is adapted for the cyclic-torsion case. The development allows one to establish the fatigue diagram (shear strain versus cycles at failure) and to calculate the remaining life under several level straining. As the damage function is strain dependent, the predictions are different from those given by the linear-damage rule. An interaction effect between strain levels is considered to explain the strong deviation of the sums of cycle-ratios from unity. Empirical relations have been established for taking into account this effect. Essentially, this approach gives a theoretical sum of cycle-ratios greater than unity for two increasing strains; this sum is smaller than unity for the opposite case.

82-2000

Cumulation of the Fatigue Damage and Calculation of Fatigue Life under Programmable Loading

V. Kliman
Inst. of Materials and Machine Mech. of the Slovak Academy of Sciences, Bratislava, Czechoslovakia, Strojnícky Časopis, 33 (2), pp 193-208 (1982) 6 figs, 11 refs
(In Slovak)

Key Words: Fatigue life, Hysteretic damping

The method of fatigue life prediction under programmable loading is discussed. The rule of fatigue damage cumulation with respect to important characteristics of material used (cyclic stress-strain curve) and parameters of loading process (mode control, mean value, frequency), on the base of accumulated hysteresis energy is derived. The influence of the loading history and amplitudes below fatigue limit on the fatigue life prediction is also analyzed.

82-2001

Nonlinear Damage Cumulation in Solution-Treated and Aged Titanium 6A1-4V

J.H. Adams
Detroit Diesel Allison Div., General Motors Corp., Indianapolis, IN 46206, J. Engrg. Power, Trans. ASME, 104 (2), pp 354-359 (Apr 1982) 10 figs, 3 tables, 7 refs

Key Words: Metals, Fatigue tests

A procedure for determining the functional form of the exponent in the nonlinear damage equation from a limited number of block loading fatigue tests is presented. The theory and experimental details are demonstrated for solution-treated and aged Ti 6-4 at 278°C. The predictive accuracy of the derived functional fit is then shown for additional independent block loading fatigue tests.

82-2002

Fatigue Design of Machine Elements

C. Bagci

Dept. of Mech. Engrg., Tennessee Tech. Univ., Box 5014, Cookeville, TN 38501, Shock Vib. Dig., 14 (5), pp 3-11 (May 1982) 3 figs, 39 refs

Key Words: Machinery components, Design techniques, Fatigue life, Computer-aided techniques

This is the first of a series of literature review articles on the state of the art of fatigue design of machine elements. These articles describe recent developments and research results and their applications for industrial designs. The following are emphasized: new forms of design equations that are suitable for computer-aided-designs, factors affecting fatigue life and their incorporation in design equations, and evaluation of proposed criteria for the fatigue design of machine members experiencing complex stress fields. This article summarizes the historical background of fatigue design of machine elements and reviews recent forms of data and fatigue design equations.

82-2003

Evaluation of Methods for the Treatment of Mean Stress Effects on Low-Cycle Fatigue

M. Doner, K.R. Bain, and J.H. Adams

Detroit Diesel Allison Div., General Motors Corp., Indianapolis, IN 46206, J. Engrg. Power, Trans. ASME, 104 (2), pp 403-411 (Apr 1982) 18 figs, 6 tables, 13 refs

Key Words: Fatigue life, Crack propagation

Several methods proposed for the treatment of mean stress effects on time-independent low cycle fatigue (LCF) lifetime were critically evaluated using LCF crack initiation data on a number of materials used in gas turbine design. The methods evaluated included Jaske's equivalent strain formulation, Manson's mean stress correction method and nonlinear Goodman diagram representation of the strain-controlled LCF data. The evaluations were carried out in terms of each method's capability to back-predict the experimental data used in its construction. Also considered were the implications associated with the type and the extent of data required for each method.

82-2004

Influence of Load History on the Properties of Concrete

P. Chindaprasirt

Ph.D. Thesis, Univ. of New South Wales, Australia (1981)

Key Words: Concretes, Cyclic loading

The object of this investigation was to study the influence of load history on the properties of concrete. Two types of loading history, sustained and cyclic loads, were employed. A practical loading range; i.e., stress/strength ratio between 0.3 to 0.6, was investigated. The results indicate that a sustained compressive load produces a small increase in compressive strength, and a relatively large increase in elastic modulus, whereas cyclic compressive loading results in a small decrease in compressive strength and a relatively large decrease in elastic modulus. Both load histories decrease the compressive strain at peak stress on reloading.

82-2005

Axial Cyclic Response of Unnotched and Notched Carburized Cylindrical Members under Constant Amplitude Completely Reversed Loading

G.M. Newaz

Ph.D. Thesis, Univ. of Illinois at Urbana-Champaign, 119 pp (1982)

DA8209611

Key Words: Cylinders, Steel, Fatigue life, Experimental test data

This investigation pertains to the evaluation of fatigue resistance, primarily at long life, of axially-loaded circumferentially-notched cylindrical surface-hardened (carburized) members prepared from AISI 8620H steel. Concurrently, the fatigue behavior of smooth carburized cylindrical member is also analyzed. Completely reversed constant amplitude load controlled tests were conducted.

82-2006

How Fiber-Reinforced Plastics Behave in Fatigue

D.A. Riegner and J.C. Hsu

General Mot Technical Ctr., Warren, MI, Mach. Des., 54 (12), pp 59-62 (May 20, 1982)

Key Words: Fatigue life, Fiber composites, Plastics

Material, as well as environmental, loading, and geometrical effects on fatigue life of fiber reinforced plastics is described. Means to prevent fatigue failure are considered.

82-2007
Transient Response of an Inhomogeneous Elastic Solid to an Impulsive SH-Source (Variable SH-Wave Velocity)
K. Watanabe
Dept. of Mech. Engrg. II, Tohoku Univ., Sendai, 980, Japan, Bull. JSME, 25 (201), pp 315-320 (Mar 1982) 5 figs, 1 table, 17 refs

Key Words: Transient response, Elastic media, Impact response

Transient response of an inhomogeneous elastic solid to an impulsive SH-source is considered. Due to its inhomogeneity, SH-wave velocity vanishes at a coordinate origin and the wave rotates around the origin as if it were a diffracted wave. Deducing a summation formula of a Fourier series of Schlomilch type, the response is given by a finite sum of waves rotated around the origin. It is found that an increase of inhomogeneity parameter $|\lambda|$ causes rapid fluctuation in the response.

82-2008
Some Investigations of Condensation Methods for Elasto-Impact Contact Stress Analysis by Finite Element Method
N. Asano
Dept. of Mech. Engrg., Tamagawa Univ., Machida, Tokyo 194, Japan, Bull. JSME, 25 (201) pp 328-333 (Mar 1982) 9 figs, 1 table, 9 refs

Key Words: Elastic media, Impact response, Finite element technique

To calculate efficiently elasto-impact contact stresses and their distributions by the finite element method (FEM), the static, dynamic and mixed condensation methods are investigated. These methods are introduced in the formulation of the FEM and applied to a two-dimensional analysis of longitudinal impact of two prismatic rods with a uniform section and equal cross section.

EXPERIMENTATION

MEASUREMENT AND ANALYSIS

82-2009
Transient Process in Oscillatory Sensors
A. Jordan
Bialystokskii politekhnicheskii institut, Bialystok, Poland, Vibrotechnika, 2 (36), pp 113-123 (1981) 7 figs, 9 refs
(In Russian)

Key Words: Vibration measurement, Measuring instrumentation, Rotating machinery, Transient response

Three methods for measuring vibrations of rotating machines were investigated using vibration sensors. Transient response induced by sinusoidal and exponential excitations was measured. From the measured data metrological properties of vibration sensors during the start up of machinery were determined.

82-2010
A Simplified Frequency Deviation Transducer
E. Campbell and J.R. Schurz
Engrg. and Res. Ctr., Bureau of Reclamation, Denver, CO, Rept. No. REC-ERC-81-13, 15 pp (Nov 1981) PB82-150996

Key Words: Transducers, Frequency measurement, Monitoring techniques

A frequency deviation transducer with fast response has been developed using period comparison in CMOS and analog logic. The transducer is useful in monitoring frequency where frequency deviation is important and long-term accuracy is not required.

82-2011
An Improved Piezoelectric Acoustic Emission Transducer
T.M. Proctor, Jr.
Natl. Bureau of Standards, Washington, DC 20234, J. Acoust. Soc. Amer., 71 (5), pp 1163-1168 (May 1982) 10 figs, 13 refs

Key Words: Transducers, Piezoelectric transducers, Acoustic emission

A piezoelectric transducer has been designed and developed that has promise of being a high fidelity acoustic emission transducer. Small transducer contact area, elimination of acoustical interference effects associated with certain geometries, and redistribution of the arrival times of reflected signals originating from various elements of the transducer were the guiding criteria in the design. This transducer consists of a conical active element and an extended backing. The transducer's performance has been compared to a line capacitance transducer using surface wave signals. These comparisons indicate an amplitude response which is flat within ±3 dB for the frequency range of 50 kHz to 1 MHz. The over-all displacement sensitivity is nominally 2×10^8 V/m. Factors that influence frequency response such as backing geometry and aperture size have been experimentally investigated and results are reported.

82-2012

A Real-Time Vibration Controller

M.R. Serbyn and W.B. Penzes

Natl. Bureau of Standards, Washington, DC, 5 pp (1981) (Publ. in Proceedings of Intl. Instrumentation Symp. (27th), Indianapolis, IN (Apr 1981)) PB82-149899

Key Words: Vibration control, Interferometers

The Michelson interferometer is viewed as a noisy system whose noise input consists of unwanted changes in its optical path length, and whose desired output is a constant optical path-length difference. A technique for maintaining this quantity at a value equal to a multiple of quarter wavelengths of the light is described. This is accomplished by periodically comparing the phase difference between the fundamental and the second-harmonic components of the photodetector output. Using this information, a logic unit causes positive or negative-going ramp signals to be generated and applied to the fixed mirror as a path-length correction.

82-2013

Vibration and Performance Testing with Small Digital Test Systems

R.G. Smiley

Entek Scientific Corp., Cincinnati, OH, S/V, Sound Vib., 16 (4), pp 8-9, 12-15 (Apr 1982) 5 figs, 1 table, 4 refs

Key Words: Spectrum analyzers

Recent advances in electronics and testing techniques have made the smaller Fourier analyzer test system much more attractive as a portable, flexible alternative to large, rack-mounted minicomputer-based test systems. In this article, a review of numerous experimental tests used by mechanical engineers in the areas of structural dynamics and operating performance evaluation is presented. Such parameters as CPU speed, data base size, calculation complexity, and transducer interface requirements are discussed in an attempt to clarify the position of the smaller test system in the mechanical engineering test profession.

82-2014

Structural Dynamics Modification -- An Extension to Modal Analysis

D. Fomenti and S. Welaratna

Structural Measurement Systems, Inc., SAE Paper No. 811043

Key Words: Modal analysis, Structural modification effects

A mathematical technique for predicting the dynamic behavior of modified structures is presented. The dynamics of the structure before modification are represented by its modal properties. This paper begins with a review of modal analysis and discusses some aspects of measurement that influence the quality of modal parameter estimates.

82-2015

A Simultaneous Frequency Domain Technique for Estimation of Modal Parameters from Measured Data

R.N. Coppolino

The Aerospace Corp., Los Angeles, CA, SAE Paper No. 811046

Key Words: Modal analysis, Frequency domain method, Least squares method

A new method for estimation of vibration mode parameters from measured frequency response functions is introduced. Response functions associated with selected independent degrees of freedom are employed simultaneously to deduce an effective dynamic matrix with a linear least-square technique. Vibration mode parameters are then deduced from the dynamic matrix. An additional least square relationship among independent and dependent degrees of freedom provides the means for estimation of mode shapes associated with all measurement locations.

82-2016

Anti-Resonant Analysis

G.F. Lang

Fox Technology Corp., Westwood, NJ, Test, Part 1: 44 (2), pp 14-17, 20-21 (Apr/May 1982); Part 2: 44 (3), pp 12-14, 16 (June/July 1982) 21 figs

Key Words: Anti-resonant analysis

In this two-part article the visualization of structural dynamics in terms of anti-resonant parameters (frequency, damping, and shape) is presented. Five areas of specific importance highlighted are: measurement of antiresonant parameters in an ignorable coordinate shake is an expedient means of measuring the resonant parameters of small and delicate structures not directly amenable to constrained condition testing; the reciprocity between point-free anti-resonances and point-constrained resonances can be exploited when examining constrained structures; driving point anti-resonances directly indicate the resonances that will result if the drive degree-of-freedom is completely constrained; resonance/anti-resonance maps are particularly useful in defining the spacial susceptibility of a structure to conventional tuning techniques; an appendant vibration absorber may be optimized by tuning its base anti-resonance to coincide with a resonance of the host structure.

82-2017

Development of High-Amplitude Vibration Exciter System

R.M. Miller

McDonnell Aircraft Co., McDonnell Douglas Corp., St. Louis, MO, "Enhancement of Quality through Environmental Technology," Proc. of 28th Annual Technical Meeting of the Institute of Environmental Science, Atlanta, GA, Apr 21-23, 1982, pp 75-82, 6 figs

Key Words: Vibration tests, Testing instrumentation, Periodic excitation

This paper describes a vibration test system that was developed to generate high amplitude-sinusoidal vibration. Small electrical assemblies, weighing two to five pounds, were to be tested to displacements of 171 mm (6.75 inches) double amplitude at 10 Hz and acceleration levels of 250g at 35 Hz. Time and cost limitations precluded the procurement of a hydraulic system, so a mechanical lever device was designed to magnify the limited excursion of existing electrodynamic exciters. Details of the construction and use of the system are discussed.

82-2018

Random Vibration Testing of a Single Test Item with a Multiple Input Control System

D.O. Smallwood

Sandia Natl. Labs., Albuquerque, NM 87185, "Enhancement of Quality through Environmental Technology," Proc. of 28th Annual Technical Meeting of the Institute of Environmental Science, Atlanta, GA, Apr 21-23, 1982, pp 42-49, 7 figs, 5 refs

Key Words: Vibration tests, Random vibration

An algorithm for a multiple shaker random vibration control system is developed. The system is designed for several shakers driving a single test item with full cross-coupling control. The method allows for cross-coupled mechanical systems with partially coherent control points.

82-2019

The Testing and Approval of Aircraft Engine Mounted Accessories

D.S. Pearson

Rolls-Royce Ltd., Derby, UK, IMechE Proc., 196, pp 57-64 (Mar 1982) 11 figs, 1 ref

Key Words: Aircraft engines, Vibration measurement, Measurement techniques

Vibration measurements on gas turbine engines are normally made using accelerometers. The environment to which engine accessories would be subject has been evaluated by comparing g peaks in the frequency spectrum individually with empirical yardsticks of severity. Endurance approval testing of accessories to withstand the environment so characterized is normally conducted by applying unidirectional single frequency excitation to simulate engine conditions at a particular shaft speed. These procedures have proved inadequate in predicting failure or verifying corrective measures where accessory problems due to wear phenomena are concerned. This paper analyzes reasons for this inadequacy in terms of measurement practice, engine severity assessment, environmental simulation and approval procedures. By recognizing the effect of multi-frequency vibration in three planes it further aims to provide a unified approach to accessory design and development by which service accessory reliability might be improved.

82-2020

Random Vibration Screening of Six Militarized Avionic Computers

R.K. Blake

Fed. Systems Div., Intl. Business Machines Corp., Owego, NY, J. Environ. Sciences, 25 (2), pp 15-24 (Mar/Apr 1982) 13 figs, 5 tables

Key Words: Random vibration, Screening, Computer systems hardware, Aircraft equipment response, Circuit boards

This paper is an overview of a random vibration screening being done on six types of digital computers produced for military avionic applications. The six computer types, referred to as programs, operate in five different in-service use environments. It is the purpose of this paper to examine the data gathered during this screening process for potential use in justification, planning, screening optimization and recommendation development. Major areas to be examined include: analyses of over 230 anomalies experienced during random vibration; the interplay between random vibration and subsequent thermal cycle screening; the effect of random vibration on subsequent reliability performance.

82-2021

An Evaluation of Light Vehicle Exterior Noise Test Procedures

R.H. Paddy

Ford Motor Co., SAE Paper No. 810400

Key Words: Measurement techniques, Noise measurement, Automobiles

The evaluation of four light vehicle exterior noise test procedures is reviewed. Vehicle test results from two part throttle and one multi mode test are compared to the results from a currently in use wide open throttle procedure. Each procedure is evaluated for clarity of instructions, time to test requirements, equipment requirements, vehicle changes required for the test, sound levels produced, how the procedures rank vehicles and the sources of sound.

82-2022

Computerization of a Vehicle Pass-By Noise Measurement Facility

R.A. Bishop, T.F. Foxlee, and J.M. Strang

Ford Motor Co., Michigan Proving Ground, SAE Paper No. 810402

Key Words: Noise measurement, Test facilities, Computer-aided techniques, Noise source identification, Fourier analysis, Automobiles

A computerized data acquisition system for exterior vehicle noise testing was developed to provide the sophisticated data analysis techniques and test site efficiency required to meet current and future regulations. The computer generates accurate, dependable data in a final test report at the conclusion of each test minimizing data reduction and turn-around time. Computer control of test sequences eliminates manual operations and provides efficient use of site time.

DYNAMIC TESTS

(Also see No. 1887)

82-2023

Constitutive Laws of Materials in Dynamics – Outline of a Programme of Testing on Small and Large Specimens for Containment of Extreme Dynamic Loading Conditions

C. Albertini and M. Montagnani

Commission of the European Communities, Joint Res. Ctr., Ispra Establishment, 1-21020 Ispra (Va), Italy, Nucl. Engrg. Des., 68 (2), pp 115-128 (1981) 12 figs, 1 table, 22 refs

Key Words: Dynamic tests, Constitutive equations, Materials, Steel, Nuclear reactors

A sound foundation of stress and/or strain criteria for the mechanical design of fast breeder reactor structures capable of bearing extreme dynamic loading conditions, passes through the experimental determination of dynamic mechanical properties of materials in end-of-life conditions with respect to the damaging processes to which the structures are submitted. Calculation codes must be implemented by constitutive equations describing the dynamic mechanical response of the materials, without the knowledge of which any calculation code is liable to important inaccuracies which provoke the use of high safety coefficients and, often, the uncertainty as to the effective capability of the structures to withstand the accidental loads. The results of a screening program of dynamic tensile tests performed on AISI 304 and AISI 316 austenitic stainless steels using small specimens showed that the dynamic response of such steels at temperatures of 400 and 550°C is not univocal, passing from a substantial dynamic hardening behavior to a dynamic softening behavior, probably due to residual microstructural differences caused by the transformation processes. From the discussion of the results obtained a testing program was developed.

82-2024

Influence of Support Systems on the Aerodynamics of an Inclined Ogive Cylinder

T.N. Canning and J.N. Nielsen

Nielsen Engrg. and Res., Inc., Mountain View, CA, J. Spacecraft, 19 (3), pp 205-210 (May-June 1982) 12 figs, 6 refs

Key Words: Supports, Wind tunnel testing

The influence of the model support system on an ogive cylinder at high angles of attack has been determined in subsonic and transonic tests. Stings of varying diameter and struts in various orientations were studied. The stings did not alter the development of large side loads resulting from asymmetric vortex separation and had only moderate progressive effects on in-plane forces and moments. Struts supporting the model through its leeward meridian seriously altered normal and side forces and sharply reduced base drag at several combinations of Mach number and angle of attack. A strut supporting the model at its windward meridian (near the base) yielded results similar to those for the stings.

82-2025

Separation of Isochromatics and Isopachics Using a Faraday Rotator in Dynamic-Holographic Photoelasticity

J.P, Lallemand and A. Lagarde

Lab. of Mech. of Solids, Univ. of Poitiers, 40 avenue du Recteur Pineau, 86022 Poitiers Cedex, France, Exptl. Mech., 22 (5), pp 174-179 (May 1982) 6 figs, 15 refs

Key Words: Holographic techniques, Disks

A method is presented that allows the simultaneous separation of isochromatic- and isopachic-fringe patterns for transient-plane stress problems. Isopachic fringes are obtained by means of holography with a Faraday cell and a pulsed ruby laser flashing dual pulses. As usual isochromatic whole-order fringes are recorded in a circular-light polariscope. The shock generator (air-gun) and its synchronizing system with the ruby laser is described. The procedure is applied to the recording of the isochromatic- and isopachic-fringe patterns in a disk under radial dynamic loads.

82-2026

Optimization of Classical Shock Waveforms

M.A. Underwood

Scientific-Atlanta, "Enhancement of Quality through Environmental Technology," Proc. of 28th Annual Technical Meeting of the Institute of Environmental Science, Atlanta, GA, Apr 21-23, 1982, pp 50-58, 22 figs, 10 refs

Key Words: Shock tests, Test instrumentation, Optimization

Optimization concepts are used to develop a mini-computer based digital vibration shock control system using electrodynamic exciters. The classical shock waveforms produced by this system using an optimized solution to a cost functional problem minimizes the waveform energy and power as well as minimizing the approximation error of the reproduced waveform. The maximum peak velocity and displacement of the exciter are also minimized. The reproduced waveforms have optimized pre-load and post-load pulses to enable the system constraints of initial acceleration, final acceleration, final velocity and final displacement be equal to zero to be met while making minimum energy and power demands on the exciter.

SCALING AND MODELING

82-2027

The Modelling Equation to Maintain the Level of the Two-Mass Vibration-Proof System

V.J. Katinas, A.A. Medžiauskiene, and Z.J. Pocius

Kauno polytechnikos institutas, Kaunas, Lithuanian SSR, Vibrotechnika, 2 (32), pp 137-141 (1981) 3 figs, 4 refs

(In Russian)

Key Words: Mathematical models, Two mass systems, Vibration control

A model for a two-mass vibration resistant system is presented along with control equations. Mean square deviation is used for the evaluation of quality.

DIAGNOSTICS

(Also see No. 2009)

82-2028

Hydraulic System Acoustical Diagnostics

R. Inoue and R.K. King

Fluid Power Res. Ctr., Oklahoma State Univ., Stillwater, OK, Rept. No. OSU-FPRC-80-A-F1, 87 pp (Dec 1980)

AD-A108 698

Key Words: Hydraulic equipment, Diagnostic techniques, Acoustic techniques, Vibration signatures

This project is a continuation of previous acoustics studies conducted to determine if the vibration signature of hydraulic components could provide information concerning the operational health of the system. The concept of using internally produced noise to detect incipient failure is not new (the screwdriver-to-the-block trick used by automobile mechanics is a good example); however, the technique has been more of an art than a science, especially where hydraulic systems are concerned. This study advances the previous work by applying the concept to vane pumps into which specific known degradation has been introduced. The study shows that, by using case-mounted accelerometers, significant vibratory differences can be detected and associated with given conditions.

BALANCING

82-2029

Balancing for a Flexible Rotor Considering the Vibration Mode (2nd Report, Balancing in which Modal Influence Coefficients Contain Phase Angle Errors)

K. Shiohata and F. Fujisawa

Mech. Engrg. Res. Lab., Hitachi, Ltd., Bull. JSME, 25 (201), pp 438-442 (Mar 1982) 10 figs, 4 refs

Key Words: Rotors, Flexible rotors, Balancing techniques, Least squares method, Modal balancing technique

The effectiveness of a modal-least squares balancing method is investigated with regard to a balancing of flexible rotors. The method combines features of both modal balancing and least squares balancing methods. Numerical simulations are carried out with influence coefficients which are assumed to have phase angle errors. The good balancing conditions that were obtained in the second balancing trial are also described.

MONITORING

(Also see No. 2010)

82-2030

The Fiber Optic Bearing Monitor

G.J. Philips

David W. Taylor Naval Ship Res. and Dev. Ctr., Annapolis, MD, InTech, 29 (5), pp 43-45 (May 1982) 2 figs, 18 refs

Key Words: Monitoring techniques, Fiber optics, Bearings, Ball bearings, Roller bearings

Fiber optic displacement sensors can be used to monitor ball and roller bearings in rotating machinery. The technique provides direct measurement of condition and performance while the bearings are in service. Use can extend life cycles, eliminate unnecessary replacement, and minimize maintenance downtime.

82-2031

Vibration Surveillance Now Covers Minor Equipment

V.R. Dodd and J.R. East

Chevron U.S.A. Inc., Pascagoula, MS, Oil Gas J., 80 (2), pp 63-70, 75 (Jan 11, 1982) 13 figs, 3 refs

Key Words: Monitoring techniques

A surveillance program for general purpose equipment of 1,000 hp or less, such as electric motors, steam turbines, centrifugal pumps, fans, etc., is described. The program includes the capability for the detection of rolling element bearing failures and is adaptable to remote locations and smaller plants. It employs the MEGA 5270 vibration meter and a portable tape recorder. To achieve the highest degree of success a 400 line real time analyzer with a frequency translator is recommended.

82-2032

Fatigue Life Prediction for Structural Composites by Acoustic Emission

L.K. Dijiauw and D.G. Fesko

Plastics Dev. and Application Office, Ford Motor Co., Detroit, MI, SAE Paper No. 811349

Key Words: Monitoring techniques, Acoustic emission, Computer-aided techniques, Fatigue life, Composite structures

Computer-linked acoustic emission (AE) monitoring instrumentation can record noises associated with crack growth in an FRP component when it is proof tested. Since defects in the part will cause additional noise and noise concentrations, AE data will relate to the structural performance of the part, particularly to the onset of visible damage and to the fatigue life. To obtain good results, AE data collection must be tailored to the geometry of the part and the FRP material, which exhibits high AE signal attenuation characteristics. However, after undergoing sophisticated analysis utilizing source location and attenuation corrections, acoustic emission of a part can be correlated with fatigue life.

ANALYSIS AND DESIGN

ANALYTICAL METHODS

(Also see Nos. 1915, 1934)

82-2033

Transfer Function Method for Investigating the Complex Modulus of Acoustic Materials: Rod-Like Specimen

T. Pritz

Central Res. and Des. Inst. for the Silicate Industry, 1034 Budapest, Bécsi ut 126/128, Hungary, J. Sound Vib., 81 (3), pp 359-376 (Apr 8, 1982) 7 figs, 2 tables, 7 refs

Key Words: Transfer functions, Modulus of elasticity, Isolation, Acoustic insulation, Vibration isolation

The complex Young's modulus of acoustic materials as a function of frequency is generally investigated by using a cylindrical or prismatic specimen of the material excited into longitudinal harmonic vibration at one end, the other end being loaded by a mass. The transfer function method is the most advantageous to use for the investigation, which involves the measurement of the vibration amplitudes of the specimen ends and the phase angle between them. In this paper, the transfer function method is analyzed theoretically and experimentally in that frequency range where the specimen can essentially be modeled by a longitudinally vibrating rod (rod-like specimen). The analysis includes the measurability of the transfer function, the role of the measurement errors, the frequency range of the method and the maximum dynamic strain of the specimen. A special application of the method is developed for investigating the complex modulus of low loss materials at the extremes of the absolute value of the transfer function, without measuring the phase angle. Experimental results obtained by both methods are presented.

82-2034

Infinite Dimensional Dynamical Systems

J.K. Hale

Lefschetz Ctr. for Dynamical Systems, Brown Univ., Providence, RI, Rept. No. LCDS-TR-81-22, AFOSR-TR-81-0877, 27 pp (Nov 12, 1981)
AD-A110 257

Key Words: Dynamic systems

An approach is outlined for the discussion of the qualitative theory of infinite dimensional dynamical systems. Retarded functional differential equations are used to illustrate the usefulness of the approach and the limitations of our present knowledge.

82-2035

Perturbation Analysis of Nonlinear Oscillations Using Symbolic and Numerical Computations

M.B. Dadfar

Ph.D. Thesis, State Univ. of New York at Binghamton, 145 pp (1982)
DA 8210140

Key Words: Nonlinear vibration, Perturbation theory

Perturbation solutions to some problems in nonlinear oscillations are analyzed. The method involves a numerical extension of the perturbation solution, followed by an analysis of the analytical structure of the solution as a function of the perturbation parameter.

82-2036

Improved Method of Free Vibration Analysis of Structures

M.I. Basci

D.Sc. Thesis, George Washington Univ., 243 pp (1982)
DA8207887

Key Words: Vibration analysis, Finite element technique, Stiffness methods, Mass matrices

The objective of this dissertation is to develop more accurate procedures in the generation of the stiffness and mass matrices of structural elements which can then be embedded in a usual finite element program. This is accomplished by the use of exact displacement functions for the elements, rather than approximate ones, obtained from the solution of the differential equations governing the statical and the free vibrational behavior of the structural components. Three types of elements are considered; namely, straight beam, curved beam, and rectangular plate elements, all of which have a uniform cross section. However, the general concepts developed in this study are equally applicable to other types of elements, such as shell elements.

82-2037

On a Stationarity Principle for Discrete Non-Linear Dissipative Dynamic Systems

C. Rajski

Warsaw Technical Univ., Warsaw, Poland, Intl. J. Nonlin. Mech., 17 (1), pp 35-40 (1982) 4 refs

Key Words: Dynamic systems, Dissipation factor

A new function depending upon the Lagrangian and upon the Rayleigh dissipation function is introduced. It is shown that for a certain class of discrete systems the requirement of stationarity of the new function with respect to generalized velocities is tantamount to the setting up of differential equations of motion for the system.

82-2038

Nonlinear Vibrations with Almost Periodic Parametrical Excitations (Nicht-lineare Schwingungen mit fast-periodischer Parametererregung)

F. Weidenhammer

Z. angew. Math. Mech., 61 (12), pp 633-638 (1981) 1 fig, 7 refs

(In German)

Key Words: Approximation methods, Periodic excitation, Nonlinear vibration

It is well known that even in the case of almost periodic parametrical excitations the zero solution for certain frequencies might become unstable. An approximate calculation is performed for nonlinear vibrations caused by some of these frequencies.

82-2039

Discrete Laplace-Transformation. An Appropriate Calculation Method for Weakly Damped Vibrating Systems under Nonperiodic Excitation (Diskrete Laplace-Transformation. Ein zweckmässiges Rechenverfahren für schwachgedampfte Schwingungssysteme bei nichtperiodischer Erregung)

L. Auersch

Bundesanstallt f. Meterialprufung, Berlin-West, W. Germany, Z. angew. Math. Mech., 62 (3), pp 171-181 (Mar 1982) 11 figs, 7 refs

(In German)

Key Words: Laplace transformation, Vibrating structures, Damped structures, Random excitation

The Laplace transformation is an appropriate tool not only for theoretical but also for numerical analysis of dynamical systems. A method to determine the reaction of a system using the numerical Laplace transformation is proposed. The possible sources of error are investigated, leading to statements that connect the numerical error with the physics of the special system. Error bounds give the information necessary for practical use. By example of a mechanical system it is demonstrated that the method yields good results even with little effort, and the error bounds are shown to be practicable.

82-2040

Approximate Dynamics Using Hamilton's Principle, Including Applications to Non-Conservative and Constrained Systems

M.S. Townend and A.H. Kerr

Dept. of Math., Liverpool Polytechnic, Liverpool L3 3AF, UK, Mech. Mach. Theory, 17 (3), pp 213-220 (1982) 8 figs, 2 tables, 4 refs

Key Words: Equations of motion, Hamiltonian principle, Approximation methods

There has been recent interest in simulating the dynamical behavior of mechanical systems using approximate techniques based on Hamilton's principle. A method is presented which does not require the user to form partial derivatives of the energy function and produces a solution which is an explicit function of time, not a numerical solution. The method is shown to be suitable for both multidegree of freedom and constrained systems; in the latter case being markedly superior to existing techniques.

82-2041

Forward and Backward Projection of Acoustic Fields Using FFT Methods

P.R. Stepanishen and K.C. Benjamin

Dept. of Ocean Engrg., Univ. of Rhode Island, Kingston, RI 02881, J. Acoust. Soc. Amer., 71 (4), pp 803-812 (Apr 1982) 11 figs, 10 refs

Key Words: Vibrating structures, Sound propagation, Fast Fourier transform

The forward and backward propagation of harmonic acoustic fields using Fourier transform methods is presented. In particular, the forward propagation of a velocity distribution to obtain a pressure field and the backward propagation of a pressure field to obtain a velocity distribution are addressed. Numerical examples are presented to illustrate the nearfield behavior of the pressure field from complex planar vibrators, e.g., an ultrasonic transducer or plate, with nonuniform velocity distributions. The numerical results, which were obtained via the use of FFT algorithms, are presented for vibrators which are operating above and below coincidence. These results illustrate the acoustic nearfield as a function of distance from the vibrator. Numerical results are also presented to illustrate the backward projection method.

82-2042

Non-Linear Oscillator Limit Cycle Analysis Using a Time Transformation Approach

T.D. Burton

Dept. of Mech. Engrg., Washington State Univ., Pullman, WA 99164, Intl. J. Nonlin. Mech., 17 (1), pp 7-19 (1982) 5 figs, 1 table, 21 refs

Key Words: Oscillators, Van der Pol method, Quadratic damping

A method is presented for the analysis of limit cycle behavior of autonomous nonlinear oscillators characterized by second order ordinary differential equations containing a small parameter. The method differs from the classical perturbation methods in that the dependent variable is not expanded in a power series in the small parameter. Rather, a new independent variable is sought such that in its domain the motion is simple harmonic. Use of this time transformation technique to generate limit cycle phase portrait, amplitude and period is presented. Results of the application of the method to the van der Pol oscillator, to an oscillator with quadratic damping, and to a modified van der Pol oscillator which is statically unstable in the limit of small motion are shown.

82-2043

Toward a Solution of Van der Pol Systems I

H.B. Chenoweth

Westinghouse Electric Corp., Baltimore, MD, J. Environ. Sci., 25 (2), pp 38-42 (May/Apr 1982) 6 figs, 17 refs

Key Words: Van der Pol method, Shafts, Whirling

The classical problem of nonlinear oscillations in one-dimensional electrical and structural systems posed by Van der Pol is reduced to a linear differential equation. The approach to solving this problem is to transform the Van der Pol nonlinear equation to the hodograph plane. The solution of this equation can be utilized to practically resolve the problems associated with the triode oscillator, whirling/whipping shaft vibration, some forms of space vehicle lift-off pogo, and sliding friction-induced vibration.

82-2044

The Influence of Fluid Inertia in Unsteady Lubrication Films

A. Sestieri and R. Piva

Instituto di Meccanica Applicata alle Macchine, Università di Roma, Rome, Italy, J. Lubric. Tech., Trans. ASME, 104 (2), pp 180-186 (Apr 1982) 13 figs, 2 tables, 14 refs

Key Words: Navier-Stokes equations, Lubrication, Inertial forces, Bearings

The influence of the inertial forces in steady and unsteady lubrication films has been analyzed by means of an accurate computational model of the complete set of Navier Stokes equations for incompressible flows. A coordinate transformation accounts for the geometrical shape of the film boundary and its variation in time, reducing the numerical integration to a rectangular constant domain in the transformed plane. A dimensional analysis of the equations, both in steady and unsteady conditions, is performed to deduce the most significant nondimensional variables and parameters to be considered for a proper evaluation of the inertial effects. The applications are restricted to two-dimensional fields and simple boundary conditions to test the simulation capabilities of the computational model, by comparison with analytical solutions available in literature. Several geometrical and kinematic conditions are discussed and the effect of the convective and time dependent inertial terms is quantitatively evaluated.

MODELING TECHNIQUES

82-2045

Structural Uncertainty in Dynamic Analysis

T.K. Hasselman

J.H. Wiggins Co., Redondo Beach, CA, SAE Paper No. 811049

Key Words: Mathematical models, Dynamic structural analysis

This paper presents a method for modeling structural uncertainty for generic classes of structures, based on actual analysis and test experience. It shows how the resulting generic statistical models can be applied to other structures of the same class, as a practical way of quantifying the accuracy of predicted frequencies, mode shapes and forced response, prior to testing. A realistic numerical example is presented to illustrate the general method. Statistical correlation is preserved throughout the process, and is traced through the numerical example.

82-2046

Dynamic Simulation of a Hydrostatically Propelled Vehicle

C.R. Cornell

Sci. and Tech. Lab., Electronics and Controls Tech. Ctr., International Harvester Co., SAE Paper No. 811253

Key Words: Hydrostatic drives, Simulation

This paper develops and discusses a digital computer simulation model of a total vehicle drive system. The vehicle studied utilizes a single hydrostatic engine, pump, fluid conductor, motor, wheel, soil, and weight transfer details. A model such as this can be used to investigate vehicle dynamics; various transmission control characteristics; the effects of major system changes, etc.; and work that would otherwise require actual vehicle build-up, modification, instrumentation, and testing.

STATISTICAL METHODS

82-2047

Entropy Stability of Continuous Dynamic Systems

Y.A. Phillis

Engrg. Systems Dept., School of Engrg. and Appl. Sci., Univ. of California, Los Angeles, CA 90024, Intl. J. Control, 35 (2), pp 323-340 (1982) 12 refs

Key Words: Statistical analysis, Dynamic systems, Stability

The problem of stochastic stability of continuous dynamic systems is examined from the point of view of entropy. The concept of entropy, as it was defined by Shannon, represents a measure of average uncertainty in a random situation. In this research, the entropy of the state of a system is considered and conditions for keeping it within certain bounds or minimizing it are sought. For this purpose several tools and results of the theory of stochastic differential equations are used.

82-2048

Simulation of Random Processes with Various Probability Density Functions

M. Bílý and J. Čačko

Inst. of Materials and Machine Mech. of the Slovak Academy of Sciences, 810 05 Bratislava, Czechoslovakia, J. Sound Vib., 81 (3), pp 393-403 (Apr 8, 1982) 3 figs, 3 refs

Key Words: Simulation, Random response, Probability density function

Various relationships are derived for simulation of random processes with simple or composite probability density functions. Depending on the properties of the corresponding parameters the resulting process is either stationary or nonstationary. Practical digital simulation with the formulas derived is fast enough to be used in real time with computer controlled simulators.

82-2049

A Theory for the Motion of a Wheelset on a Straight Track with Stochastic Imperfections (Theorie der Bewegung eines Radsatzes auf geradem Gleis mit stochastischen Gleislagefehlern)

A. Renger

Inst. f. Mech. der Ad W der DDR, Berlin, GDR, Z. angew. Math. Mech., 62 (3), pp 141-169 (Mar 1982) 11 figs, 12 refs

(In German)

Key Words: Interaction: rail-wheel, Wheelsets, Stochastic processes

A first order theory is developed for the motion of a wheelset connected with a vehicle frame by means of elastic springs. Not only the elastic rolling contact of wheel and rail but also stochastic imperfections of a real straight track are taken into account. The changes of normal forces are considered.

PARAMETER IDENTIFICATION

(Also see No. 1891)

82-2050

System Modeling and Modification via Modal Analysis

Y.-W. Luk

Ph.D. Thesis, Virginia Polytechnic Inst. and State Univ., 171 pp (1981)

DA8206923

Key Words: Modal analysis, Parameter identification technique

A new method is developed for experimentally determining the system parameters of a structure that is suitable for implementation in microprocessor-based systems. It uses single degree-of-freedom models to describe a multi-degree-of-freedom system. The system is assumed to be describable by a linear, proportionally and lightly damped, lumped parameter model. Two types of damping models, viscous and structural damping, are provided.

OPTIMIZATION TECHNIQUES

(See No. 2026)

DESIGN TECHNIQUES

(See Nos. 1908, 2002, 2014)

COMPUTER PROGRAMS

(Also see No. 1867)

82-2051

Development and Evaluation of the CRASH 2 Program for Use under European Conditions

I.S. Jones and P.W. Jennings

Oxford Road Accident Group, Dept. of Engrg. Sci., Univ. of Oxford, SAE Paper No. 810473

Key Words: CRASH (computer program), Computer programs, Collision research (automotive), Automobiles

This paper reports recent work undertaken to improve the utility of the CRASH 2 (Calspan Reconstruction of Accident Speeds on the Highway) program for use under European conditions. To improve the reconstruction accuracy of CRASH 2 for European sized vehicles, the stiffness coefficients used in the damage analysis routine have been reassessed for the minicar, subcompact and compact car categories. The data used for the update consisted of 42 frontal impacts performed in the UK. The new coefficients were derived using a statistical optimization technique to fit the damage equation to the test data. The new coefficients show a significant improvement in the accuracy of individual reconstructions. Provision for vehicles to be yawing at impact has also been added to the program.

82-2052

Underwater Shock Analysis of Nonlinear Structures: A Reference Manual for the USA-STAGS Code (Version 3)

J.A. DeRuntz and F.A. Brogan

Lockheed Missiles and Space Co., Inc., Palo Alto, CA, Rept. No. LMSC-D779760, DNA-5545F, 212 pp (Dec 9, 1980)

AD-A108 911

Key Words: USA (computer program), STAGS (computer program), Computer programs, Underwater explosions, Submerged structures, Shock waves, Doubly asymptotic approximation

This report is a reference manual for the third version of the USA-STAGS code that calculates the nonlinear transient response of a totally or partially submerged structure to a spherical shock wave of arbitrary pressure profile and source location. USA-STAGS is the result of interfacing USA (underwater shock analysis) and STAGS (stress analysis of general shells). The fluid is assumed to be an infinite acoustic medium whose response to motions of the structure is described by either of the Doubly Asymptotic Approximations, DDA1 or DDA2.

82-2053

Theoretical Basis for CTABS80: A Computer Program for Three-Dimensional Analysis of Building Systems

E.L. Wilson, H.H. Dovey, and A. Habibullah

Computers/Structures Intl., Oakland, CA, Rept. No. WES-TR-K-81-2, 132 pp (Sept 1981)

AD-A107 635

Key Words: Computer programs, Multistory buildings

This report presents the theoretical basis for CTABS80, a computer program for the linear three-dimensional structural analysis of multistory frame and shear wall buildings subjected to static or dynamic loadings.

82-2054

Computer Program for Aerodynamic and Blading Design of Multistage Axial-Flow Compressors

J.E. Crouse and W.T. Gorrell
NASA Lewis Res. Ctr., Cleveland, OH, Rept. No. NASA-TR-1946, NASA-E-280, USAAVRADC-TR-80-C-21, 105 pp (Dec 1981)
AD-A109 888

Key Words: Computer programs, Design techniques, Blades, Compressor blades

A code for computing the aerodynamic design of a multistage axial-flow compressor and, if desired, the associated blading geometry input for internal flow analysis codes is presented. The aerodynamic solution gives velocity diagrams on selected streamlines of revolution at the blade row edges. Blading is defined from stacked blade elements associated with the selected streamlines. The blade element inlet and outlet angles are established through empirical incidence and deviation angle adjustments to the relative flow angles of the velocity diagrams.

82-2055

A General Purpose Analytical Technique for Nonlinear Dynamic Response of Integrated Structures

C.M. Ni
Engrg. Mech. Dept., General Motors Res. Labs., SAE Paper No. 811304

Key Words: Computer programs, Linear theories, Nonlinear response, Dynamic response, Collision research (automotive)

This paper is concerned with a general purpose analytical technique and an associated computer program, NONDRIS, for analyzing the nonlinear dynamic response of integrated structures. The NONDRIS program includes beam, plate, spring (or truss), and rigid-body elements in its element library. This analytical technique has been developed for dealing with the linear and nonlinear dynamic response of both a single structural component and a multiple-member structural system, with special emphasis on the crash response of vehicle structures.

82-2056

Finite Element Crash Analysis of a Rear-Engine Automobile

R. Winter, A.B. Pifko, and M. Mantus
Grumman Aerospace Corp., Bethpage, NY, SAE Paper No. 811306

Key Words: Automobiles, Collision research (automotive), Computer programs, Finite element technique, Energy absorption

A finite element model of a rear-engine automobile having a fiberglass-reinforced resin body, was created and examined in a 30 mph frontal barrier impact analysis using the DYCAST nonlinear structural dynamic finite element computer code. Detailed results were produced, including load paths, material failures, and behavior of individual components, permitting an assessment of vehicle crash performance. A proposed energy-absorbing concept was evaluated and recommendations were made for specific structural improvements.

AUTHOR INDEX

TECHNICAL NOTES

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J. Sound Vib., 81 (4), pp 587-588 (Apr 22, 1982) 2 refs

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J. Sound Vib., 81 (4), pp 583-586 (Apr 22, 1982) 1 fig, 2 tables, 4 refs

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J. Sound Vib., 82 (1), pp 157-159 (May 8, 1982) 5 refs

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M.H.L. Hounjet
Calculation of Unsteady Transonic Flows with Shocks by Field Panel Methods
AIAA J., 20 (6), pp 857-859 (June 1982) 3 figs, 8 refs

CALENDAR

OCTOBER 1982

4-6 Convergence '82 [SAE] Dearborn, MI *(SAE Hqs.)*

4-6 Lubrication Conference [ASME] Washington, DC *(ASME Hqs.)*

4-7 Symposium on Advances and Trends in Structural and Solid Mechanics [George Washington University and NASA Langley Res. Ctr.] Washington, DC *(Prof. Ahmed K. Noor, Mail Stop 246, GWU-NASA Langley Res. Ctr., Hampton, VA 23665 (804) 827-2897)*

5-7 Western Design Engineering Show [ASME] Anaheim, CA *(ASME Hqs.)*

12-15 Stapp Car Crash Conference [SAE] Ann Arbor, MI *(SAE Hqs.)*

17-21 Power Generation Conference [ASME] Denver, CO *(ASME Hqs.)*

25-28 Advances in Dynamic Analysis and Testing [SAE Technical Committee G-5] 1982 SAE Aerospace Congress & Exposition, Anaheim, CA *(Roy W. Mustain, Rockwell Space Systems Group, Mail St. AB97, 12214 Lakewood Blvd., Downey, CA 90421)*

25-28 1982 SAE Aerospace Congress and Exposition [SAE] Anaheim, CA *(SAE Hqs.)*

26-28 53rd Shock and Vibration Symposium [Shock and Vibration Information Center, Washington, DC] Danvers, MA *(Henry C. Pusey, Director, SVIC, Naval Res. Lab., Code 5804, Washington, DC 20375)*

NOVEMBER 1982

8-10 Intl. Modal Analysis Conference [Union College] Orlando, FL *(Prof. Raymond Eisenstadt, Union College, Graduate and Continuing Studies, Wells House, 1 Union Ave., Schenectady, NY 12308 - (518) 370-6288)*

8-12 Acoustical Society of America, Fall Meeting [ASA] Orlando, FL *(ASA Hqs.)*

8-12 Truck Meeting & Exposition [SAE] Indianapolis, IN *(SAE Hqs.)*

14-19 American Society of Mechanical Engineers, Winter Annual Meeting [ASME] Phoenix, AZ *(ASME Hqs.)*

DECEMBER 1982

14-16 11th Turbomachinery Symposium [Texas A&M University] Houston, TX *(Peter E. Jenkins, Turbomachinery Labs., Dept. of Mech. Engrg., Texas A&M Univ., College Station, TX 77843 - (713) 845-7417)*

FEBRUARY 1983

28 - Mar 4 SAE Congress & Exposition [SAE] Detroit, MI *(SAE Hqs.)*

MARCH 1983

21-23 NOISE-CON 83 [Institute of Noise Control Engineering] Cambridge, MA *(NOISE-CON 83, Massachusetts Inst. of Tech., Inst. Information Services, 77 Massachusetts Ave., Cambridge, MA 02139 - (617) 253-1703)*

28-31 Design Engineering Conference and Show [ASME] Chicago, IL *(ASME Hqs.)*

APRIL 1983

18-20 Materials Conference [ASME] Albany, NY *(ASME Hqs.)*

18-21 Institute of Environmental Sciences' 29th Annual Technical Meeting [IES] Los Angeles, CA *(IES, 940 E. Northwest Highway, Mount Prospect, IL 60056 - (312) 255-1561)*

21-22 14th Annual Modeling and Simulation Conference [Univ. of Pittsburgh] Pittsburgh, PA *(William G. Vogt, Modeling and Simulation Conf., 348 Benedum Engineering Hall, Univ. of Pittsburgh, Pittsburgh, PA 15261)*

MAY 1983

9-13 Acoustical Society of America, Spring Meeting [ASA] Cincinnati, OH *(ASA Hqs.)*

9-13 Symposium on Interaction of Non-Nuclear Munitions with Structures [U.S. Air Force] Colorado Springs, CO *(Dr. C.A. Ross, P.O. Box 1918, Eglin AFB, Florida 32542 - (904) 882-5614)*

JUNE 1983

6-10 Passenger Car Meeting [SAE] Dearborn, MI *(SAE Hqs.)*

CALENDAR ACRONYM DEFINITIONS AND ADDRESSES OF SOCIETY HEADQUARTERS

AFIPS: American Federation of Information Processing Societies
210 Summit Ave., Montvale, NJ 07645

AGMA: American Gear Manufacturers Association
1330 Mass Ave., N.W.
Washington, D.C.

AHS: American Helicopter Society
1325 18 St. N.W.
Washington, D.C. 20036

AIAA: American Institute of Aeronautics and Astronautics, 1290 Sixth Ave.
New York, NY 10019

AIChE: American Institute of Chemical Engineers
345 E. 47th St.
New York, NY 10017

AREA: American Railway Engineering Association
59 E. Van Buren St.
Chicago, IL 60605

ARPA: Advanced Research Projects Agency

ASA: Acoustical Society of America
335 E. 45th St.
New York, NY 10017

ASCE: American Society of Civil Engineers
345 E. 45th St.
New York, NY 10017

ASME: American Society of Mechanical Engineers
345 E. 45th St.
New York, NY 10017

ASNT: American Society for Nondestructive Testing
914 Chicago Ave.
Evanston, IL 60202

ASQC: American Society for Quality Control
161 W. Wisconsin Ave.
Milwaukee, WI 53203

ASTM: American Society for Testing and Materials
1916 Race St.
Philadelphia, PA 19103

CCCAM: Chairman, c/o Dept. ME, Univ. Toronto,
Toronto 5, Ontario, Canada

ICF: International Congress on Fracture
Tohoku Univ.
Sendai, Japan

IEEE: Institute of Electrical and Electronics Engineers
345 E. 47th St.
New York, NY 10017

IES: Institute of Environmental Sciences
940 E. Northwest Highway
Mt. Prospect, IL 60056

IFToMM: International Federation for Theory of Machines and Mechanisms
U.S. Council for TMM
c/o Univ. Mass., Dept. ME
Amherst, MA 01002

INCE: Institute of Noise Control Engineering
P.O. Box 3206, Arlington Branch
Poughkeepsie, NY 12603

ISA: Instrument Society of America
400 Stanwix St.
Pittsburgh, PA 15222

ONR: Office of Naval Research
Code 40084, Dept. Navy
Arlington, VA 22217

SAE: Society of Automotive Engineers
400 Commonwealth Drive
Warrendale, PA 15096

SEE: Society of Environmental Engineers
6 Conduit St.
London W1R 9TG, UK

SESA: Society for Experimental Stress Analysis
21 Bridge Sq.
Westport, CT 06880

SNAME: Society of Naval Architects and Marine Engineers
74 Trinity Pl.
New York, NY 10006

SPE: Society of Petroleum Engineers
6200 N. Central Expressway
Dallas, TX 75206

SVIC: Shock and Vibration Information Center
Naval Research Lab., Code 5804
Washington, D.C. 20375

URSI-USNC: International Union of Radio Science - U.S. National Committee
c/o MIT Lincoln Lab.
Lexington, MA 02173

PUBLICATION POLICY

Unsolicited articles are accepted for publication in the Shock and Vibration Digest. Feature articles should be tutorials and/or reviews of areas of interest to shock and vibration engineers. Literature review articles should provide a subjective critique/summary of papers, patents, proceedings, and reports of a pertinent topic in the shock and vibration field. A literature review should stress important recent technology. Only pertinent literature should be cited. Illustrations are encouraged. Detailed mathematical derivations are discouraged; rather, simple formulas representing results should be used. When complex formulas cannot be avoided, a functional form should be used so that readers will understand the interaction between parameters and variables.

Manuscripts must be typed (double-spaced) and figures attached. It is strongly recommended that line figures be rendered in ink or heavy pencil and neatly labeled. Photographs must be unscreened glossy black and white prints. The format for references shown in DIGEST articles is to be followed.

Manuscripts must begin with a brief abstract, or summary. Only material referred to in the text should be included in the list of References at the end of the article. References should be cited in text by consecutive numbers in brackets, as in the example below.

> Unfortunately, such information is often unreliable, particularly statistical data pertinent to a reliability assessment, as has been previously noted [1].
>
> Critical and certain related excitations were first applied to the problem of assessing system reliability almost a decade ago [2]. Since then, the variations that have been developed and the practical applications that have been explored [3-7] indicate that . . .

The format and style for the list of References at the end of the article are as follows:

- each citation number as it appears in text (not in alphabetical order)
- last name of author/editor followed by initials or first name
- titles of articles within quotations, titles of books underlined
- abbreviated title of journal in which article was published (see Periodicals Scanned list in January, June, and December issues)
- volume, number or issue, and pages for journals; publisher for books
- year of publication in parentheses

A sample reference list is given below.

1. Platzer, M.F., "Transonic Blade Flutter - A Survey," Shock Vib. Dig., 7 (7), pp 97-106 (July 1975).
2. Bisplinghoff, R.L., Ashley, H., and Halfman, R.L., Aeroelasticity, Addision-Wesley (1955).
3. Jones, W.P., (Ed.), "Manual on Aeroelasticity," Part II, Aerodynamic Aspects, Advisory Group Aeronaut. Res. Devel. (1962).
4. Lin, C.C., Reissner, E., and Tsien, H., "On Two-Dimensional Nonsteady Motion of a Slender Body in a Compressible Fluid," J. Math. Phys., 27 (3), pp 220-231 (1948).
5. Landahl, M., Unsteady Transonic Flow, Pergamon Press (1961).
6. Miles, J.W., "The Compressible Flow Past an Oscillating Airfoil in a Wind Tunnel," J. Aeronaut. Sci., 23 (7), pp 671-678 (1956).
7. Lane, F., "Supersonic Flow Past an Oscillating Cascade with Supersonic Leading Edge Locus," J. Aeronaut. Sci., 24 (1), pp 65-66 (1957).

Articles for the DIGEST will be reviewed for technical content and edited for style and format. Before an article is submitted, the topic area should be cleared with the editors of the DIGEST. Literature review topics are assigned on a first come basis. Topics should be narrow and well-defined. Articles should be 1500 to 2500 words in length. For additional information on topics and editorial policies, please contact:

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THE SHOCK AND VIBRATION DIGEST

Volume 14, No. 9 September 1982

EDITORIAL

ARTICLES AND REVIEWS

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CALENDAR