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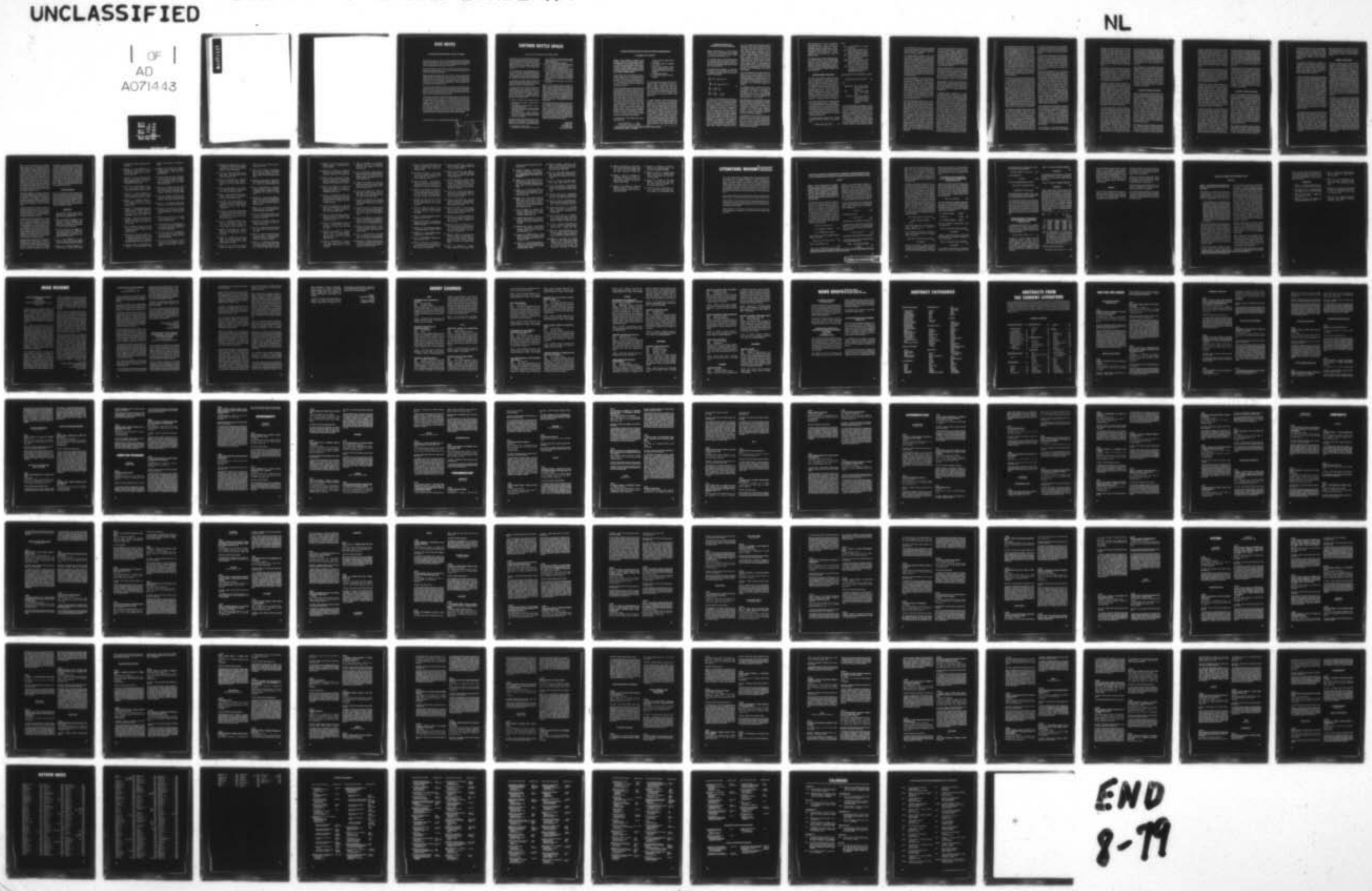

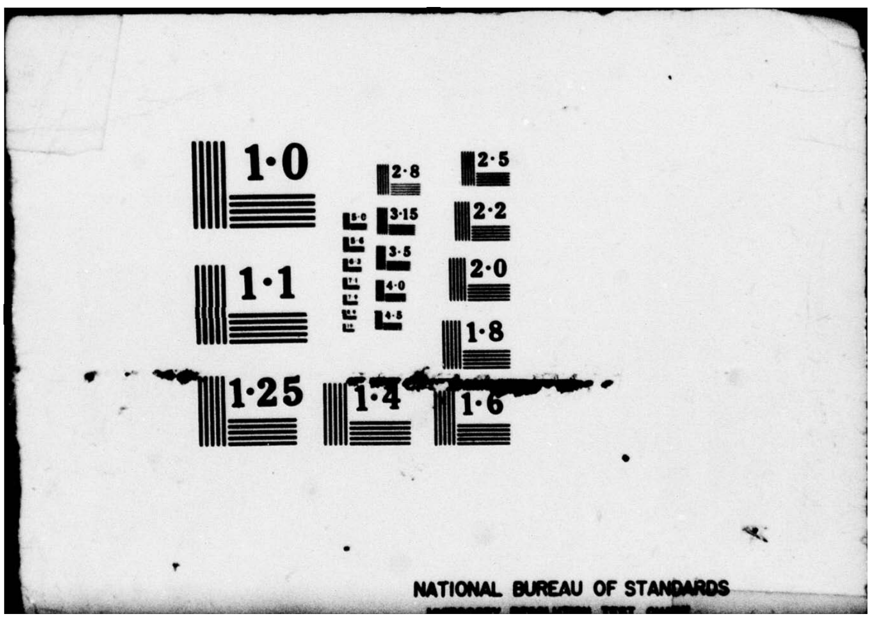
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NATIONAL BUREAU OF STANDARDS

SVIC NOTES

Awareness of the International Shock and Vibration Technology

By the time you read this column the SVIC **International Survey of Shock and Vibration Technology** will have been published. Writing the report wasn't easy, and one of the reasons was the large volume of material available. The decision on what to include and what to omit was very often painful.

One of the purposes of this study was to identify foreign research results and applications that might be useful in the U.S., and to make the U.S. shock and vibration community aware of their existence.

Nearly a year ago on this page* Henry Pusey noted that many new developments originate abroad; those having to do with shock and vibration are not exceptions. He also pointed out that, although the U.S. has a highly effective mechanism for disseminating our own technological developments, there is no organized effort to learn of or exploit foreign technical developments. In effect a universally effective technology interchange does not exist.

The survey might be considered as one way to provide for a more effective international shock and vibration technology interchange. Many technical meetings are held in this country and abroad, and the international participation is significant. Both the survey and meetings are steps in the right direction because they make people aware of the existence of foreign technology.

Unfortunately barriers to the effective interchange of foreign technology still exist, and it might be worthwhile to mention a few. The proceedings of some international conferences are often not available to non-registrants, or if they are, their source is obscure. Various technical organizations in non-English speaking countries have investigators who are doing excellent work; however, translations of their papers and reports are not available. There is a lack of any systematic effort in the U.S. to learn of the new developments in foreign technology that might be applicable to our own problems. These barriers contribute to the lack of awareness of worthwhile foreign technology. Until these barriers are broken down, international technology interchange will remain ineffective, regardless of the technology considered.

R.H.V.

*See "Director Notes," July, 1978, **Shock and Vibration Digest**

EDITORS RATTLE SPACE

An Open Letter to the Presidents of IEEE, ASME, & NSPE

Recent events at the Three Mile Island nuclear power plant should give every engineer a great deal of food for thought. Not all of the facts are known, as yet. However, a preliminary summary published in the April 8, 1979, edition of the Los Angeles Times gives rise to a number of grave questions related not only to the nuclear industry but also to engineers and the engineering profession -- if in fact it really exists -- in general.

For the past several years, such engineering publications as the IEEE "SPECTRUM," ASME's "MECHANICAL ENGINEERING," and NSPE's "PROFESSIONAL ENGINEER" have had a great deal to say about the engineering profession; e.g., does it really exist, the pros and cons of registration, and the establishment of a Code of Ethics for all engineers.

If we consider the man-machine interface problem as an engineering responsibility (often referred to as human engineering), the entire chain of events that occurred at the Three Mile Island nuclear plant is an engineering problem.

It should be pointed out that I am not a nuclear engineer but am speaking as an expert on engineering in general. I am presently Manager of Advanced Design, Marine Systems, at the Northrop Corporation, Ventura Division. I am a registered professional electrical and mechanical engineer in California, and I hold a Ph.D. in Engineering from UCLA. One of my past positions was Manager of Reliability Engineering at one of the divisions of TRW.

The problems that occurred can be classified as follows:

- Component reliability problems - repeated failures of various devices
- Failure reporting and analysis problems - failure to follow established procedures
- Human engineering problems - green lights indicating valve closure, lack of alarms or indicators when temperatures exceeded 700°F
- Human factors problems - failure to recognize the impact of operator fatigue in a hazardous environment, punishment for reporting potential safety problems if they could not be verified

There may be others, but these problems support my point: engineering has received a black eye at best, and, at worst, the attempt to raise engineering to a professional level is heading toward a slow death. The questions that arise are:

- **Were engineers in charge at any time?**
- **If engineers were in charge, should they be working for an employer that can take economic sanctions against its employees unless they follow orders blindly given by administrators?**
- **Were they registered professional engineers?**
- **Were any of them members of ASME, IEEE, NSPE?**
- **If so, what happened to the social responsibility expounded by the various engineering societies?**
- **Will those engineering societies take some action?**
- **A true professional makes decisions based on fact and technical merit, without fear of reprisals. Does this not answer once and for all the question whether or not an engineer working for an employer is a professional?**
- **Should economic incentives be given to corporations without constraints on performance and reliability, particularly on a high technology project affecting public safety?**
- **Are the engineering societies going to do something about that?**

There are no easy answers to some of the questions. In addition, not all of the facts are available. At this point I am neither condemning nor condoning any of the actions taken before or during the crisis. But I believe that these and other questions must be answered soon and that this near catastrophe presents an opportunity for the engineering and professional societies to assert their leadership. This letter is a request to the ASME, IEEE, NSPE, and other engineering societies to take an active part in the investigations of the incident and to insist on a number of changes that will substantially reduce the risk of future accidents in high technology projects.

Advances in technology always increase risk. In recent years, up to 50,000 people have been killed annually in automobile accidents, yet no one has suggested seriously banning the automobile. It is not clear that banning nulcear power is the answer. But I believe that a decision regarding the survival or death of nuclear power must be made soon. It is not even clear if the leadership of the IEEE and ASME can participate in an unbiased manner. A great deal of soul searching will be required by the technical societies. Their actions and decisions will indicate whether or not their desires to raise engineering to a professional level and their codes of ethics are really meaningful or simply empty promises.

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CURRENT METHODS FOR ANALYZING DYNAMIC CABLE RESPONSE

H.J. Migliore* and R.L. Webster**

Abstract *- Various methods for analysis of cable dynamics are reviewed. Even though emphasis is given to developments in ocean cable analysis, much of the review has broader application. Static analytic methods are included because of their importance in dynamic solutions. Specific discussions are given on the lumped parameter and finite element methods and the method of weighted residuals.*

Strings, hanging chains, and cables have been analyzed for centuries. Not only has cable behavior been of interest because it has many applications but also because of the fundamental nature of problem solution. The catenary and vibrating string problems can be found in most elementary texts of mechanics and engineering mathematics.

During the late 1960s cables were studied with regard to both application and analysis. Cable systems were being considered as structural components in three-dimensional networks; the cable supported roof used in the Munich Olympics in 1972 [1] is an example. Ocean requirements in both the private and military sector placed greater emphasis on complex cable systems for mooring and undersea structures [2]. The complexity of these applications over-extended the classical approaches for analyzing such cable systems. Specifically, the catenary solution was difficult to apply to highly branched networks under transient loading. In addition, the wave equation approach, such as solving by separation of variables, was difficult to apply to nonlinear terms. As a result, the use of computer based numerical solutions became an important aspect of cable analysis.

A complete review of cable analysis should encompass the following

- initial configuration -- i.e., steady-state equilibrium under the influence of gravity loads and steady environmental loads
- vortex-induced loading as manifested by strumming
- nonlinear material behavior including nonlinear stress-strain behavior, rotational degrees of freedom, and hysteresis effects
- nonlinear geometric effects
- nonlinear and stochastic environmental loading

All of these aspects must be accounted for in a comprehensive method for analyzing the dynamic response of cables; a comprehensive method is not presently available, however. Rather, three major areas of investigation currently exist: cable strumming, cable material characterization, and dynamic cable response. The last will be emphasized in this review, particularly as it has been applied to ocean cable systems.

The reader interested in vortex-induced strumming is referred to the recent review by Rail, Hafen, and Meggitt [3] and to other studies in this area [4-25]. Strumming will be incorporated in the dynamic equations of motion as a modified drag term. Drag forces would thus reflect viscous effects as well as the increased drag component due to strumming. The reader interested in material properties is referred to manufacturer's literature and summary articles [26-29]. For most cable modeling, the effects of permanent deformation due to local kinking, rotational effects, bending stiffness, and untwisting of stranded cable are treated as secondary effects. The authors are aware of a few studies directed toward modeling generalized cable material behavior [30-36].

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EQUATIONS OF MOTION AND TRADITIONAL SOLUTION TECHNIQUES

Reviews of cable analysis as of 1974 are available [37-40]. Some of this information will be repeated in this paper to set the stage for solution methods currently under development or in use.

It is important to point out that several derivations of the governing equations have been published [41-48]. These derivations can be recast to be equivalent, aside from some differences in assumptions or modeling of environmental forces.

The equations can be expressed in a particularly compact form if they are transformed to the normal and tangential coordinates. Breslin [47] has shown the transformed equations.

$$\frac{\partial T}{\partial s} = m(\dot{V}_t - V_n\dot{\phi}) + w \sin \phi + F_t$$

$$T\frac{\partial \phi}{\partial s} = m(\dot{V}_n + V_t\dot{\phi}) + w \cos \phi + F_n \tag{1}$$

$$\frac{\partial V_t}{\partial s} = V_n \frac{\partial \phi}{\partial s} + \frac{\dot{T}}{AE}$$

$$\frac{\partial V_n}{\partial s} = V_t \frac{\partial \phi}{\partial s} - (1 + \frac{T}{AE})\,\dot{\phi}$$

T is tension, s is the distance along the cable, ϕ is the angle between the horizontal and the tension vector, and V_t and V_n are the components of cable velocity in the tangential and normal directions. In these equations, the unknowns are V_t, V_n, T, and ϕ. The nonlinearities are apparent in the products of the variables and their derivatives. Because this formulation assumes small strains and linear materials, the nonlinearities (the geometric nonlinearities previously referred to) are caused by significant rotations (slope changes); these require use of the deformed state rather than the initial state during development of the equations of motion. Additional nonlinearities are introduced in the expression for F_t and F_n, external loads per unit length, which are functions of the cable position and the square of the relative velocity between the cable and the fluid.

The set of coupled partial differential equations shown above can be used as the starting point for treatments of cable motion; however, some investigators neglect the strain component in the last equation. Because closed form solutions to this system are not readily apparent, numerical solutions are employed. Numerical integration of the equations shown is possible. A popular technique [41, 42, 44-46] transforms the equations to a set of ordinary differential equations using the method of characteristics. Shore et al. [49, 50] chose to write the motion equations relative to a static catenary configuration rather than to the unstretched configuration. They then proceeded directly to the numerical integration using finite differences in the time and space variables.

The static configuration of underwater cables can be treated using the dynamic equations with zero acceleration. Wang [51] developed a similar set of equations generalized to three dimensions, and then used a predictor-corrector integration scheme to solve the equations. The reference state may be the unloaded state or some intermediate preloaded configuration.

An interesting approach to solving the cable equations involves rate variables [52]. The equation can be linearized in the absence of fluid loading by differentiation with respect to time; a backward finite difference relation is used to express the higher order time derivatives in terms of the velocities. The resulting equations are solved numerically.

Other techniques that have been applied to the cable differential equations include separation of variables [53] and perturbation methods [44, 54]. The first approach seeks to define the spatial variables in terms of generalized coordinates and thus reduce the equations to a set of discrete ordinary differential equations in time. The perturbation techniques linearize the equations by focusing on a small variation about an equilibrium configuration.

The advantages of such semi-analytical techniques are dependent on the specific problem and the orientation of the analyst. All have a common disadvantage: they tend to become cumbersome when they are applied to more general situations. As a result, special procedures must be introduced to deal with branching and interconnecting systems.

These procedures tend to make the techniques configuration-dependent. Further difficulties are encountered with the consideration of material nonlinearities. Because of these problems, the semi-analytical techniques are generally limited to simple configurations involving single spans -- primarily single-point moors, towed bodies, guy cables, and suspension cables.

Such network systems as cable roofs have been treated by shifting the focus from the individual cable component to the overall structure level. The global behavior is viewed as equivalent to that of a thin membrane that passes approximately through the network grid points. A relatively successful application of this equivalent membrane approach has been reported [55].

DISCRETE ELEMENT APPROACHES

The quest for more general modeling procedures led to the development of a general class of techniques that begin with a discrete element model. When the system was assumed to be composed of an interconnected set of simple elements, many of the limitations of the semi-analytical methods could be avoided. In particular, the governing partial differential equation for a complex system need never be derived because the form of the spatial variation is implied by the collection of discrete elements. Furthermore, if simple forms are chosen for the elements, the entire solution process can be reduced to a relatively simple set of operations.

Early intuitive knowledge led to a technique called the lumped parameter method. The technique involves lumping the effects of mass, internal reactions, and external loads at a finite number of points (nodes) in the system. The equations of equilibrium and continuity are applied to these points, and a set of discrete equations is developed. In effect, the continuous system is modeled as a set of discrete masses and massless springs.

The discrete equations resulting from a lumped parameter model can be written in the following form:

$$[M]\left\{\ddot{x}\right\} + \left\{f_D\right\} + \left\{f_I\right\} = \left\{f_E\right\} \qquad (2)$$

where

- $\{\ddot{x}\}$ are the components of the nodal accelerations
- $\{f_D\}$ are the nodal components of any internal dissipative forces (usually neglected in underwater problems)
- $\{f_I\}$ are the components of the internal element forces at the nodes (functions of nodal positions)
- $\{f_E\}$ are the nodal components of the external forces (functions of nodal positions and relative velocity between the structure and fluid)
- $[M]$ is a matrix of the lumped mass coefficients. (This can also be a position-dependent term and may be populated off the diagonal.)

The usual discrete form of the equations of motion is:

$$[M]\left\{\ddot{u}\right\} + [C]\left\{\dot{u}\right\} + [K]\left\{u\right\} = \left\{f\right\} \qquad (3)$$

where

- $\{u\}, \{\dot{u}\}, \{\ddot{u}\}$ are the nodal displacements, velocities and accelerations
- $\{f\}$ are the nodal components of the external loads
- $[M], [C], [K]$ are the mass, damping, and stiffness matrices, respectively; they are generally square symmetric matrices

For small displacement linear analyses, the magnitude of $\{u\}$ is limited and the coefficient matrices are constant. The effects of the various nonlinearities show up in the components of equation (3). For example, the goemetric nonlinearity is manifest by the fact that the stiffness matrix is a function of the displacements. The material nonlinearity can be expressed with a load-dependent stiffness matrix. The nonlinearities from the fluid loading are manifest by the external loads being a function of position and velocity squared and the mass matrix being a function of position. It is also possible to represent the fluid resistance in still water using a damping matrix, which is dependent on velocity and position. Other nonlinearities are introduced if the boundary conditions are position-dependent.

The governing equation, equation (1), can be cast into a discrete form such as equation (3) by various methods. This is basically what is accomplished by the spatial finite difference method and the weighted residual method. The lumped parameter method bypasses the governing equations, and the discrete equations are assembled directly from simple discrete elements. Comparison of equations (2) and (3) reveals that they are essentially the same. The solution methods used most often in the lumped parameter method render the stiffness and damping matrices superfluous; thus, the equations in the form of equation (2) are preferred.

The earliest application of a lumped parameter approach to the underwater cable dynamics problem was apparently in 1959 [56]. In recent years a number of computer programs have been developed using this technique. The most common approach assumes that the cable is a straight line (constant tension) element between the lumped masses (nodes). The discrete contributions to the equations of motion are summed at each node such that a specific arrangement of cables is assumed. Cable element tensions are determined from the instantaneous position of the nodes using a $\Delta \ell / \ell$ strain approximation and a nonlinear stress strain relation.

Griffin and Patton [57] solved this set of simultaneous ordinary differential equations using a fourth-order Runge-Kutta solution routine. Others [58-60] used predictor-corrector methods. Walton and Polacheck [56] used an explicit finite difference scheme. Burroughs and Benz [61] dealt with noncircular towing cables by including lift forces and torsional resistance in the model and solved the equations with an analog computer. Patel [53] represented the cable segments with a trigonometric series instead of a straight line. In each formulation the spatial coordinates of the lumped masses or the displacements of the masses are the unknowns. Most of the computer programs allow treatment of snap-loading phenomena; they occur when motion causes a cable segment to slacken and subsequently snap back into a tensile state. Lumped parameter estimates of snap loading have been compared with experimental results [62].

Some computer programs [53, 57, 58] approximate the effect of cable payout by assuming that the reference length of a segment changes with time. All of the programs reviewed in this article were formulated for a particular problem. They are configuration-dependent because the assembly of the components in the motion equations is by nodes rather than by elements. Such dependence generally means that no more than two cable segments are connected to each mass; dependence can be avoided by reordering the operations.

Morris and Birnstiel [63] used a lumped parameter approach which they call an intuitive form of the finite element method to develop the mass and stiffness matrices for a cable network. They compared various linear and nonlinear solutions to experimental data. This work evolved from an earlier lumped parameter approach to cable roof structures [64].

Static solutions for cable structures have been obtained [65, 66]. A lumped parameter technique was used with a successive approximation solution. Tugcu [67] applied Greenberg's work to the analysis of circular cable roofs with the cables loaded beyond the elastic limit.

A somewhat different application of a lumped parameter approach to the static problem is a technique called the method of imaginary reactions [68]. The technique, similar to the cut structure approach used in redundant frame analysis, involves the identification of a primary anchor or support point, secondary anchors, and redundant members. The structure is assumed to be cut at the secondary anchors; redundant members and the values of the reactions and internal loads at the cuts are estimated. The structure is modeled as a set of straight elements and lumped bodies or weights. The solution procedure involves summing the internal and external forces across the structure from the cuts to the primary anchor. The sequence is then reversed and the constitutive relations (which may be nonlinear) and joint compatibility relations are used to determine the new configuration of the structure. New estimates of the forces at the cuts move toward satisfaction of continuity requirements at the cuts. The procedure is repeated in an iterative fashion until continuity at the cuts is achieved within a specified tolerance. Because the unknowns are the forces at the cuts and not the nodal displacements, much detail can be included by using a large number of nodes. As long as the number of cuts is small (which is the case in most underwater cable structures), the solution will be significantly less costly than methods using nodal displacements as unknowns. It is necessary to identify the redundant members and the path from the cuts to the primary anchor; this technique is thus configuration-dependent and is a well known feature of force methods in frame analyses. Two relatively efficient cable analytic programs use the imaginary reactions technique [69, 70]. They minimize configuration dependence by assuming that the cut structure has the topological form of a tree: the primary anchor is the root, and the cut ends represent the ends of branches. Unfortunately the method cannot be generalized for dynamic analyses; a model change is required between static and dynamic analytic steps.

The method of imaginary reactions has been utilized [71] to generate flexibility influence coefficients for dynamic analyses of cable structures. The method was used to determine the static configuration of the structure under the influence of a given set of loads and currents. After a set of nodal positions were selected for the dynamic model, small loads were applied individually in each nodal coordinate direction to obtain the flexibility coefficients. The flexibility matrix was inverted to get a tangential stiffness matrix. This result and a lumped mass matrix were used with traditional modal analysis techniques. This approach implies that the fluid damping has negligible effect on the natural frequencies of the structure and that the damping effects can be linearized and made proportional to the mass or stiffness matrix. Furthermore, the method is limited to small motions about the static equilibrium configuration.

The finite element method can also be used to develop a spatial discrete element model. Less intuitive than the lumped parameter approach, the finite element method utilizes interpolation functions to describe the behavior of a given variable internal to the element in terms of a set of generalized coordinates (usually the displacements of the nodes defining the element). The interpolation function that defines the relationship between the generalized coordinates and the displacement at any point on the element is applied to classical kinematic relations (strain/displacement), constitutive relations (stress/strain), and the equations of dynamic equilibrium; the equations of motion for a single element can thus be obtained. The contributions of all elements in the system are assembled and the boundary conditions are introduced to derive a set of equations having the form of equation (3).

The finite element method grew out of the efforts of investigators [72, 73] studying aircraft structural problems in the 1950s. This area of research has been vigorously pursued since then, and the finite element method is now recognized as a general tool for dealing with boundary value problems of mathematical physics. (See, for example, the work of Norrie and deVries [74].) Excellent reviews of the method are available [75-77].

Among various applications of the finite element method to the cable structural response problem, the best known is perhaps the design and analysis of the cable roofs for the Munich Olympics. Two solution methods based on a finite element discrete element model have been described [78]. One is a sequence of linear steps using updated estimates of the tangent stiffness matrix; the other is a direct iterative solution that does not use a stiffness matrix. In both methods, the numerical integration technique is referred to as finite elements in time [79]. It is essentially a fit of a cubic interpolation function in the time domain. Some useful single-degree-of-freedom test cases are given: the results of the analysis of a guyed tower, and examples of two cable roof structures. A straight-line element was used, and fluid effects were not included. Static solutions using a modified Newton-Raphson solution have been reported [80], as have estimates of dead load configurations using cubic splines [81].

Leonard [82] used incremental solution techniques and a composite set of interpolation functions to study the dynamics of cables with low initial tension. He chose two separate forms for the displacement and slope of the element. The displacement was modeled with a linear shape function; the slope was expressed as a function of the nodal displacements using Chebyshev polynomials. In earlier work [83], he used straight-line elements. Neither paper dealt with fluid effects. A computer program [84] extending Leonard's work to include underwater effects has been developed.

Other applications of finite element techniques to the cable dynamics problem have been published

[85, 86]. One paper [85] dealt only with axial wave propagation, but higher order elements were used. The other [86] used straight elements in a three-dimensional formulation and has been incorporated in a general purpose nonlinear computer program called NONSAP [87]. Static solutions have been reported [88, 89]. Both works used straight elements; the latter used a mixed formulation in which both loads and displacements were treated as unknowns. No effort has been directed at underwater effects.

Felippa [90] dealt with the static response of underwater structures using finite element techniques. He discussed straight-line and higher order elements and presented the details of a modified Newton-Raphson solution procedure. Of particular interest is a technique for dealing with structures that pass through configurations characterized by singular or poorly conditioned stiffness matrices.

One attempt to bring the latest developments in nonlinear finite element technology to bear on the underwater cable problem is a computer program known as SEADYN [91, 92]. It has an extensive library of nonlinear solution methods for static and dynamic analyses. Only straight line three-dimensional elements are available, but because stiffness methods are used, there are very few restrictions on geometric configuration. In addition to geometric and material nonlinearities, the program treats nonlinear drag effects, line payout, and conditional surface and bottom constraints. A recent modification to the program allows the treatment of moored ships subjected to random wave effects [93].

A common approximation in dynamic analysis of cable structures involves nonlinear solution methods to obtain a steady-state reference state; linearized small displacement methods are used for dynamic effects. The finite element method is particularly well suited for such analysis because it is relatively easy to obtain the dynamic equations. The moored ship dynamics mentioned above is one example of this procedure. Other applications include modal analysis techniques [94-96]. The work of Henghold and Russell [94] is also noteworthy for the concise development of a quadratic isoparametric cable element. Various other recent papers apply finite element techniques to cable structures [97-101]. Most cable finite elements neglect bending stiffness and treat the element as completely flexible. In some cases, however, this has not been the case [102, 103], and the cable segment is modeled as a slender beam. Although traditional finite element concepts were not used an interesting cable dynamics model using elements in the form of catenaries has been developed [104]. Owen and Linfoot [105] used highly simplified cable elements, but their work shows the complex environment that ocean cable systems can experience.

Other applications of finite element techniques to the cable structural dynamics problem have not been included in this review because they are primarily linear procedures that deal with pretensioned systems. In fact, many cable roof and suspension structures can be treated by established linear methods provided the static configuration is known; the tensions in this state are sufficient to limit the dynamic motions to the small displacement range. The stiffness matrix must include a geometric term which is a function of the pretension, and any fluid effects would have to be linearized.

CABLE PAYOUT/REEL-IN DYNAMICS

Both the lumped parameter and finite element methods have the advantage of geometric versatility due to discrete elements. With cable systems that change length with time -- i.e., cable systems that are being paid out or reeled-in -- the element representing the payout end is lengthened at a rate equivalent to the payout velocity. Because integration in time is performed in a numerical step-wise fashion, each time step provides an opportunity to change this length. In order to assure numerical convergence, elements cannot be allowed to become excessively long or short. This condition can be overcome by adding or subtracting an element at the appropriate time step. However, the addition or subtraction of an element presents a relatively abrupt change in configuration, and this change has caused numerical oscillation. Numerical damping can control this problem but would also affect accuracy.

Most methods have employed the above procedure or have treated the system in a quasi-dynamic fashion [106, 107]. For example, a dynamic analysis has been performed at discrete points in time and lengths of cable. An alternative is to treat the system in a

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Most methods have employed the above procedure or have treated the system in a quasi-dynamic fashion [106, 107]. For example, a dynamic analysis has been performed at discrete points in time and lengths of cable. An alternative is to treat the system in a semi-analytical fashion; the overall system lengthens with time to represent the payout case. Element adjustments are no longer needed, but the partial differential equations must be solved directly. This is an example of the reversal of the trend toward spatially discrete methods to obtain a particular advantage.

The governing equations would be equation (1) normalized over an instantaneous length and constrained by a payout velocity boundary condition. Because of the nonlinear nature of the equations of motion, exact solution is difficult. The method of weighted residual (MWR) has been applied to this problem with some success [108, 109].

In MWR, a trial solution is developed that is generally a known function with adjustable coefficients. MWR is used to determine these coefficients and also provides rational control over the error. The modeling function must satisfy the boundary conditions, irrespective of the value of the coefficients. Substitution of the trial solution into the original differential equation will result in a residual quantity. If the trial solution is exact, the residual is zero. The adjustable coefficients in the trial solution are usually selected so that the residual is zero in an average sense. The specific method for driving the residual to zero and hence determining the coefficients of the trial solution depend on the selection of a weighting function. The averaging nature of the method is accomplished by setting the weighted integral of the residual to zero. The form of the trial solution, the specific weighting function, and the fact that the residual should be zero allow determination of the appropriate coefficients.

The collocation technique in MWR utilizes the Dirac delta function as the weighting function. The Dirac delta function has a value at certain points and is zero elsewhere. Thus, the residual can be driven to zero at these collocation points. As a number of collocation points increases, the residual is more commonly zero within the domain. Another MWR technique is the Galerkin method: the weighting function has the same form as the trial function. The Galerkin method forces the residual to be zero by making the residual orthogonal to the weighting function.

MWR provides a means to transform the partial differential equations of motion into a set of ordinary differential equations in time. The solution of these equations is a matter of numerical integration in time.

SUMMARY AND OUTLOOK

The highly nonlinear nature of cable mechanics equations has been recognized for some time. Up through the late 1960s the predominant analytical methods were semi-analytical in form; i.e., the governing differential equations for the entire structural system were solved with a combination of analytical and numerical procedures. The method of characteristics and various direct numerical integration schemes are representative of this era. The increasing use of cable network structures and the need for dealing with complex offshore cable systems has generated interest in more methods, namely, the spatially discrete methods that do not deal directly with the global governing equations. Initial efforts concerned with intuitive forms led to lumped parameter solutions. This led to the use of the more formal developments of the finite element method. By the mid 1970s some fairly general finite element computer programs for cable dynamics were available.

Although work in the discrete element procedure is continuing at a rapid pace, there is renewed interest in the semi-analytical techniques in the form of the method of weighted residuals. This interest is being stimulated by the payout/reel-in problem, in which the MWR offers some apparent advantages. Numerical studies comparing the various methods [110-112] have revealed that all three methods could give reasonable solutions for payout, but the MWR solution is less troublesome and more accurate. There is a relationship between the finite element method (FEM) and the MWR (FEM can be viewed as a special case of the Galerkin form of MWR); it is thus to be expected that the differences would be mainly in neglected terms and procedural details. An approach that may hold promise for the future is to use an MWR format with a sub-structure to obtain a procedural advantage for special effects and to combine that with the finite element form of the rest of the structure to obtain a convenient model of the complex geometry.

Based on current development plans, underwater cable dynamics work in the near future will emphasize modeling of environmental effects. As strumming studies are completed, efficient models will be incorporated into the finite element and lumped parameter programs. Experimental projects will better define the empirical parameters needed to do realistic dynamic analysis; e.g., added mass, drag, material properties. Emphasis will continue to be on descriptions of offshore environmental loads and methods for dealing with them. This will lead to more general use of random response methods rather than representative deterministic functions. Work will continue to incorporate frequency domain ship and platform responses into time domain analysis of ocean cable systems [113, 114].

Experimental validation of analytical methods and environmental approximations is an area that should be interesting. The broad scope of analytical work is just beginning to be subjected to experimental evaluation. Drag and mass models, internal damping, material characterizations, and physical approximations are strong candidates for review and improvements.

It has been proposed that cables be analyzed as fluid-solid interaction problems rather than the uncoupled form generally used. The cable component has basically been solved, but work needs to be done on the fluid component. It is expected that MWR or finite element approaches will be used.

An area of study that is apparently not receiving sufficient attention is calculating the initial configuration of a cable system. Because of the strong geometric nonlinearity, it is difficult to obtain a stable numerical description of the dead loaded state. This is of significance in dynamic analyses because dynamic effects are usually treated as motion starting from or relative to an initial static state. Some of the methods reviewed address this problem for particular applications, but a general purpose, robust method compatible with the versatility of the discrete element methods has not yet been developed.

Solution efficiency as measured by cost, elapsed time, and accuracy will be major targets in future work. Nonlinear dynamic solutions tend to be costly and time consuming. Computer hardware improvements will play a major role in this area, but improved models and numerical procedures are also needed. The question of which method or technique is best is not likely to have a single answer [110]. In a realm in which nonlinearities, complexity, and variety abound, it is to be expected that a custom tailoring of model and solution technique to a specific problem will continue to be popular. The finite element based solutions have the best chance of providing a general purpose tool; however, the variety and complexity of the developments in this area continue to be substantial. Much work remains to be done before reliable and comprehensive computer programs for cable structures can be placed in the hands of an unsophisticated user [115].

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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 review articles on reduction methods for problems of vibration of orthotropic plates, and shock and vibration instrumentation.

Professor Sakata of the Chubu Institute of Technology, Kasugai, Japan, has concluded a two part article on reduction methods for problems of vibration of orthotropic plates. Part II describes a generalized reduction method for generally orthotropic plates with arbitrary shape.

Professor Plunkett of the University of Minnesota has written an article which briefly describes recent developments in instrumentation used to measure shock and vibration.

REDUCTION METHODS FOR PROBLEMS OF VIBRATION OF ORTHOTROPIC PLATES

Part II: Generalized Reduction Method for Generally Orthotropic Plates with Arbitrary Shape

T. Sakata*

Abstract - In this two-part article Part I describes three exact reduction methods. Part II describes a generalized reduction method. The reduction method is used to derive an approximate formula for estimating the natural frequency of an orthotropic plate. The natural frequencies of the isotropic plate are used. They are reduced without solving the differential equation governing free vibration of the orthotropic plate.

The generalized reduction method for orthotropic plates [21][1] is described. Denote the natural frequency of an orthotropic plate with flexural rigidities D_x, H, D_y, and D_1. The mass density and thickness of the plate and the typical length of the plate in the x direction can be described as a side or principal axis of the plate by $\omega(D_x, H, D_y)$, ρ, h_0, and a, respectively. The expression $\Omega = \omega^2\rho h_0 a^4/\pi^4$, $\Omega(D_x, H, D_y)$ can be considered a function of H and D_y when the boundary $\Gamma(x, y) = 0$ and D_x and D_1 are given. Then Ω can be approximately represented by Taylor's theorem. When higher order differentiations are negligible;

$$\begin{aligned} \Omega(D_x, H, D_y) &= \Omega(D_x, D_x, D_x) \\ &+ (H - D_x)[\partial\Omega(D_x, D_x, D_x)/\partial H] \\ &+ (D_y - D_x)[\partial\Omega(D_x, D_x, D_x)/\partial D_y] \end{aligned} \tag{45}$$

that is, $\Omega(D_x, H, D_y)$ may be represented approximately in such case by

$$\Omega(D_x, H, D_y) = C_1 D_x + C_2 H + C_3 D_y \tag{46}$$

C_j (j=1, 2, 3) are constants. Then

$$\omega(D_x, H, D_y)^2 = (\pi^4/\rho h_0 a^4)[C_1 D_x + C_2 H + C_3 D_y] \tag{47}$$

According to the exact reduction method for a generally orthotropic plate [20] the natural frequency $\omega(D_x, H, D_y)$ of a plate with the flexural rigidities D_x, H, D_y, and D_1, and with the simply supported or clamped boundary defined by $\Gamma(x, y) = 0$ coincides with the natural frequency $\omega^*(D_x, H^*, D_y^*)$ of the reduced orthotropic plate with the flexural rigidities D_x, $H^* = \lambda^2 H$, $D_y^* = \lambda^4 D_y$ and $D_1^* = \lambda^2 D_1$, and with the reduced simply supported or clamped boundary defined by $\Gamma(x, y^*/\lambda) = 0$.

Denote the typical lengths of an orthotropic plate and the reduced plates in the y and y* directions as those of sides or principal axes of the plates by b and b*, respectively;

$$\lambda = b^*/b \tag{48}$$

from equation (21). Then

$$\omega^*(D_x, H^*, D_y^*)^2 = (\pi^4/\rho h_0 a^4)[C_1 D_x + C_2 H^*(b/b^*)^2 + C_3 D_y^*(b/b^*)^4] \tag{49}$$

by substitution of $H = H^*/\lambda^2$ and $D_y = D_y^*/\lambda^4$ into equation (47). Because a/b is a constant, rewrite C_1, C_2, and C_3 by B_1^*, $B_2^*(a/b)^2$, and $B_3^*(a/b)^4$ respectively. Then

$$\omega^*(D_x, H^*, D_y^*)^2 = (\pi^4/\rho h_0 a^4)[B_1^* D_x + B_2^* H^*(a/b^*)^2 + B_3^* D_y^*(a/b^*)^4] \tag{50}$$

from equation (49). The natural frequency $\bar{\omega}(D_x)$ of an isotropic plate is given by

$$\bar{\omega}(D_x)^2 = (\pi^4 D_x/\rho h_0 a^4)[\bar{B}_1 + \bar{B}_2(a/\bar{b})^2 + \bar{B}_3(a/\bar{b})^4] \tag{51}$$

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[1] See Part I, May, 1979, issue of THE DIGEST, for a complete list of References

where a and $\overline{b}$ are the typical lengths of the isotropic plate in the x and $\overline{y}$ directions respectively, $\overline{B}_j$(j=1, 2, 3) are the constants corresponding to B_j^*(j=1, 2, 3), and the boundary of the isotropic plate is given by $\Gamma(x, \overline{y}b/\overline{b}) = 0$. The constants $\overline{B}_j$(j=1, 2, 3) can be obtained by solving a set of simultaneous equations derived by substituting the natural frequencies $\overline{\omega}(D_x)$ for three values of $a/\overline{b}$ into equation (51).

According to this reduction method [20], an orthotropic plate with the flexural rigidities D_x, H^*, and D_y^* reduces to the isotropic plate with the flexural rigidity D_x when there exists $H^{*2} = D_x D_y^*$ among D_x, H^*, and D_y^*. Assume that the natural frequency $\overline{\omega}(D_x)$ of the reduced isotropic plate is given by equation (51) and consider the correlation between the natural frequencies $\omega^*(D_x, H^*, D_y^*)$ and $\overline{\omega}(D_x)$. By the transformation $\overline{y}_i = \lambda_i y^*$(i=1, 2, 3) -- in which $\lambda_i = \overline{b}_i/b^*$ -- three kinds of orthotropic plates with flexural rigidities D_x, $H_i^* = D_x/\lambda_i^2$, $D_{yi}^* = D_x/\lambda_i^4$, and $D_{1i} = \upsilon H_i^*$ and the same boundary $\Gamma(x, y^*) = 0$ reduce to three kinds of isotropic plates with flexural rigidity D_x, Poisson's ratio υ, and the boundaries $\Gamma(x, y_i) = \Gamma(x, \overline{y}_i/\lambda_i) = 0$. The typical lengths a and b^* in the x and y^* directions also reduce to a and $\overline{b}_i = \lambda_i b^*$ in the x and $\overline{y}_i$ directions respectively. The natural frequency is not changed by the transformation; therefore,

$$B_1^* D_x + B_2^* H_i^* (a/b^*)^2 + B_3^* D_{yi}^* (a/b^*)^4$$
$$= D_x [\overline{B}_1 + \overline{B}_2 (a/\overline{b}_i)^2 + \overline{B}_3 (a/\overline{b}_i)^4] \tag{52}$$
$$i=1, 2, 3$$

from equations (50) and (51). Substitute $H_i^* = D_x/\lambda_i^2 = D_x(b^*/\overline{b}_i)^2$ and $D_{yi}^* = D_x(b^*/\overline{b}_i)^4$ to obtain $B_j^* = \overline{B}_j$(j=1, 2, 3).

From the above, it follows that the natural frequency of an orthotropic plate with the boundary $\Gamma(x, y) = 0$ is given by

$$\omega(D_x, H, D_y)^2 = (\pi^4/\rho h_0 a^4)[B_1 D_x + B_2 H(a/b)^2 + B_3 D_y (a/b)^4] \tag{53}$$

where D_x, H, D_y, and D_1 are the flexural rigidities, and a and b are the typical lengths in the x and y directions. There are $B_j = \overline{B}_j$(j=1, 2, 3) when $\overline{\Gamma}(x, \overline{y}) = \Gamma(x, \overline{y}/\lambda)$ and $\lambda = \overline{b}/b$ exist between the orthotropic plate with the boundary $\Gamma(x, y) = 0$ and the reduced isotropic plate with the boundary $\overline{\Gamma}(x, \overline{y}) = 0$; that is, the approximate formula of an orthotropic plate can be determined from that of the reduced isotropic plate.

FUNDAMENTAL NATURAL FREQUENCY OF A CLAMPED SPECIALLY ORTHOTROPIC RECTANGULAR PLATE

Because an accurate natural frequency $\overline{\omega}(D_x)$ of an isotropic plate is often given by a numerical value rather than an approximate formula, the approximate formula for the natural frequency will be derived below from the numerical value. Classen and Thorne [17] obtained the natural frequency $\overline{\omega}(D_x)$ of a clamped isotropic rectangular plate with the boundary defined by

$$\overline{\Gamma}(x, \overline{y}) = x(x - a)\overline{y}(\overline{y} - \overline{b}) \tag{54}$$

The value is considered to be accurate, judging from upper and lower bounds calculated by others [17]. According to these results, $\overline{\Omega}$ = 5.16592, 13.2937, and 51659.3 for $a/\overline{b}$ = 0.1, 1.0, and 10.0 respectively, where $\overline{\Omega}$ denotes $\overline{\omega}(D_x)^2 \rho h_0 a^4/D_x \pi^4$. Substitute these values into equation (51).

$$\begin{aligned} \overline{B}_1 + 0.01\overline{B}_2 + 0.0001\overline{B}_3 &= 5.16592 \\ \overline{B}_1 + \overline{B}_2 + \overline{B}_3 &= 13.2937 \\ \overline{B}_1 + 100.0\overline{B}_2 + 10000.0\overline{B}_3 &= 51659.3 \end{aligned} \tag{55}$$

Then, $\overline{B}_1$ = 5.1352, $\overline{B}_2$ = 3.0234, and $\overline{B}_3$ = 5.1352. From equation (51),

$$\overline{\omega}(D_x)^2 = (\pi^4 D_x/\rho h_0 a^4)[5.1352+3.0234(a/\overline{b})^2 + 5.1352(a/\overline{b})^4] \tag{56}$$

However, numerical calculations for various ratios $a/\overline{b}$ shows that the error of equation 56 ranges from 0 to 0.1 percent. Then,

$$\overline{\omega}(D_x)^2 = (\pi^4 D_x/\rho h_0 a^4)[5.1301+3.0204(a/\overline{b})^2 + 5.1301(a/\overline{b})^4] \tag{57}$$

can be used as the approximate formula instead of equation (56). The error of equation (57) is less than 0.05 percent for $0.1 \leqq a/\bar{b} \leqq 10.0$. Furthermore, equation (54) is transformed to

$$\bar{\Gamma}(x, y\bar{b}/b) = (\bar{b}/b)^2 x(x-a)y(y-b) = 0 \qquad (58)$$

by the transformation

$$\bar{y} = (\bar{b}/b)y \qquad (59)$$

Then, from the generalized reduction method

$$\omega(D_x, H, D_y)^2 = (\pi^4/\rho h_0 a^4)[5.1301 D_x + 3.0204 H(a/b)^2 + 5.1301 D_y (a/b)^4] \qquad (60)$$

for estimating the natural frequency $\omega(D_x, H, D_y)$ of a clamped specially orthotropic rectangular plate with the boundary defined by equation (58).

A few approximate formulas for the clamped specially orthotropic rectangular plate have been derived [17, 22, 23] from the calculation for orthotropic plates. It is worth pointing out that equation (60) was not obtained from the calculation for the orthotropic plate but from the calculation for the reduced isotropic one, and that the error of equation (60) and the other approximate formulas is practically zero.

NATURAL FREQUENCY OF ELASTICALLY RESTRAINED SPECIALLY ORTHOTROPIC ELLIPTICAL PLATE

A fundamental natural frequency of an elastically restrained specially orthotropic elliptical plate will be derived from the procedure explained above. Consider the clamped isotropic elliptical plate with the boundary defined by

$$\bar{\Gamma}(x, \bar{y}) = (x^2/a^2) + (\bar{y}^2/\bar{b}^2) - 1 = 0 \qquad (61)$$

According to the results computed numerically by Sato [24], $\bar{\omega}(D_x)^2$ = 0.38211, 1.0710, and $97.820(\pi^4 D_x/\rho h_0 a^4)$ for the ratios $a/\bar{b}$ = 0.25, 1.0, and 4.0 respectively. Solve the simultaneous equations obtained by substituting these values into equation (51) to obtain $\bar{B}_1 = 0.35859$, $\bar{B}_2 = 0.35386$, and $\bar{B}_3 = 0.35859$. Then, the approximate formula is obtained

$$\bar{\omega}(D_x)^2 = (\pi^4 D_x/\rho h_0 a^4)[0.35859 + 0.35386(a/\bar{b})^2 + 0.35859(a/\bar{b})^4] \qquad (62)$$

for estimating the natural frequency of a clamped isotropic elliptical plate. The error of equation (62) lies from −1.18 to 0.0 percent; equation (63) can thus be used

$$\bar{\omega}(D_x)^2 = (\pi^4 D_x/\rho h_0 a^4)[0.36286 + 0.35807(a/\bar{b})^2 + 0.36286(a/\bar{b})^4] \qquad (63)$$

instead of equation (62). The error of equation (63) is less than 0.60 percent for $0.25 < a/\bar{b} < 4.0$. The table shows the constants $\bar{B}_j$ (j=1, 2, 3) of equation (51) determined for an elastically restrained isotropic elliptical plate as well as the error of the resultant approximate formulas. The low errors shown in the table show that accurate estimates can be made of the natural frequency of an elastically restrained elliptical plate and a simply supported or clamped plate from equation (51). The exact reduction method cannot be derived for the elastically restrained plate, however, only for the simply supported or clamped boundary.

Sa/D_x	$\bar{B}_1$	$\bar{B}_2$	$\bar{B}_3$	The maximum error (%)
0.0	0.080555	0.095309	0.080555	±1.21
0.1	0.086128	0.099296	0.086128	±1.31
1.0	0.12855	0.13055	0.12855	±1.36
10.0	0.27039	0.26016	0.27039	±0.94
100.0	0.34934	0.34488	0.34934	±0.65
∞	0.36286	0.35807	0.36286	±0.60

Table. The constants $\bar{B}_j$ (j=1, 2, 3) of equation (54) are determined for an elastically restrained elliptical plate, as is the maximum error of the resultant approximate formula, equation (54). The value S is the stiffness per unit length of the elastic restraining medium at the boundary. Poisson's ratio υ is 0.3.

Furthermore, equation (61) reduces to

$$\bar{\Gamma}(x, y\bar{b}/b) = (x^2/a^2) + (y^2/b^2) - 1 = 0 \qquad (64)$$

by the transformation, equation (59). The natural frequency of the elastically restrained specially orthotropic elliptical plate with the boundary defined by equation (64) can be estimated from equation (53) by using the constants $\overline{B}_j$ (j=1, 2, 3) tabulated in the table as the constants B_j (j=1, 2, 3) of equation (53). No error of the approximate formula can be described because no accurate value has been reported.

SUMMARY

Various reduction methods have been used to estimate the natural frequency of an orthotropic plate from that of the reduced isotropic plate without solving the differential equation governing the vibration of the orthotropic plate.

One reduction method is exact [18, 19] and requires no condition on the flexural rigidities. The application is limited to the continuous plate with two opposite simply supported sides.

Another exact reduction method [20] requires one condition on the flexural rigidities to reduce an orthotropic plate to an isotropic one. It is applicable to the plate with arbitrary shape.

The other reduction method introduced [21] is not exact but is applicable to the plate with arbitrary shape and with arbitrary flexural rigidities.

The reduction method was applied to various plates, but could be applied to many others...for example, a plate with a free boundary, a plate with nonuniform thickness, and a plate subject to in-plane forces and with arbitrary shape.

SHOCK AND VIBRATION INSTRUMENTATION

R. Plunkett*

Abstract - This article briefly describes recent developments in instrumentation used to measure shock and vibration.

Instrumentation for measuring shock and vibration is a difficult subject to review. First, there is little published literature in the conventional sense. The information that has been published is either tutorial, written to stimulate sales, or part of some study.

> This article describes some of the developments that the author thinks will affect future shock and vibration instrumentation. No attempt is made to cite individual articles that are not related to the trends chosen. Transducers used in vibration and shock instrumentation are based on the same principles as those used ten years ago. The problems remain about the same. Although design and material improvements have been made, the major advance has been in electronics, high gain operational amplifiers, integrated circuits, wide range logarithmic amplifiers, and hard wired FFT digital minicomputers. The end of the digital computer revolution is not yet in sight; small, inexpensive computers will certainly continue to influence vibration measurement techniques.[1]

There is no need to update the preceding paragraph. Since 1976 more versatile data processing equipment has been produced, and pressure transducers and accelerometers have become smaller and more rugged (but not more sensitive). Thousands of researchers and test engineers have acquired invaluable field experience with this instrumentation but have not published any results! Those of us working in the field can regale you with anecdotal and qualitative information about successes and failures, both our own and those of others, but almost none of this information has been put into a form that will be of real use to others.

There are a few exceptions to this picture of gloom and doom. Jackson [1] has published a lively set of articles, useful for anyone – particularly the novice. The articles are based on his several decades of experience in the field. Chapters 12-18 of the 2nd Edition of the Shock and Vibration Handbook [2] deal particularly with instrumentation and were extensively revised. The extensive lists of manufacturers are useful. Each year the March issue of **S/V, Sound and Vibration**, is devoted to instrumentation and includes a buyer's guide and review articles, most of which are written by engineers associated with manufacturers. The 1976 issue covers instrumentation for transfer functions and modal analysis and has the misleading title, "Understanding Vibration Measurements." Another article in that issue is on signature analysis. The 1977 issue covers accelerometers, spectrum analyzers, and amplitude distribution analyzers. The 1978 issue covers accelerometers and wave analyzers and FFT instruments. These articles are an excellent introduction to the advantages and limitations of digital FFT instruments. For more information, specialist publications such as those of Otnes and Enochson [3] or Bendat and Piersol [4] will be useful.

Other than review articles, manufacturers' literature and other in-house publications, and short course notes, there is very little published information on instruments and auxiliaries. Adler [5] published a valuable discussion of telemetry versus slip-rings. Several papers [6, 7, 8] on specific applications have appeared.

Optical holography is being increasingly used for mode shape verification. The technique is now so commonplace that authors seldom discuss instrumentation problems but instead publish pictures. It is surprising that laser Doppler is not used more for non-contact vibration amplitude work; it is extensively used in flow measurements.

As mentioned earlier, accelerometers have become smaller and more rugged. The same is true of pressure

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[1] Shock and Vibration Digest, 8 (12), pp 21-26 (Dec 1976)

pickups. The exact details are best obtained from the manufacturers' list [2] or the latest March issue of **S/V, Sound and Vibration**. The time is ripe for a good general purpose handbook on shock and vibration instrumentation.

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BOOK REVIEWS

CONTINUUM MODELS OF DISCRETE SYSTEMS

J.W. Provan, Editor
University of Waterloo Press, Waterloo, Ontario, Canada, 1978

This book is a collection of papers presented at the Second International Symposium on Continuum Models of Discrete Systems held in Canada from June 26 to July 2, 1977. The authors represented various disciplines -- physics, mathematics, applied mechanics, materials science, and engineering -- and thus dealt with various aspects of the modeling of continuous media. The 36 papers are grouped into six parts.

Part 1, "Physics and Thermodynamics," contains seven papers. The topics are the Fokker-Planck description of classical systems; an extension of the Liouville problem of statistical mechanics to random macro-media by definition of an effective operator; approximate statistical averaging, which is called an effective medium theory for nonhomogeneous media; classical thermodynamics of irreversible processes; a theory for relating the microscopic properties of a solid regarded as a system of interacting particles with the macroscopic properties of the continuous media; wave scattering by random distribution of inclusions in a medium and its effective elastic properties; and a continuum theory based on the structure of microcomponents.

Part 2, "Composites," consists of ten topics: Continuum theory of mixtures from a microstructural viewpoint for wave propagation and diffusion in composite materials; variational principles and bounds for the physical properties of homogeneous approximation of composites; effective dielectric properties of materials with planar inclusions; field properties and microstructural parameters of two-phase materials; microstructural models for bounded and unbounded media; dynamic behavior of elastic layered composites by an approximate theory which models the heterogeneous composite as a homogeneous solid; determination of dynamic properties of multiphase materials in terms of constituent properties and volume fractions; magnetoelastic stability of composite structures; interaction of cracks and self-stresses in a composite structure; and continuum modeling of three-dimensional rod-like discrete structures.

"Fracture, Fatigue and Statistical Approaches" is the title of Part 3. The five papers deal with ductile fracture; probabilistic descriptions of microstructural fatigue failure; spectral density of yield limit for structural steel; and random deformation of discrete systems. Five papers of interest to materials scientists have been grouped together in Part 4, "Voids, Dislocations, Lattice Theory and Woven Materials." The papers deal with radiation-induced void swelling, modification of classical lattice theory by the introduction of eigenstrains, theory of elastic constants in lattices, nonlocal theory of dislocations, and bending flexibility of nonwoven fabrics.

Part 5, "Fluids and Polymers," is a collection of four papers on transport and relaxation in polyatomic and chemically reacting fluids; rheology of particulate dispersions; sources of nonlinear relaxation behavior in statistical theories; and the physical significance of non-convergence of integrals in assigning effective properties to inhomogeneous media. The papers in Part 6, "Higher Order Continuum Theories," include the introduction of a generalized function to describe higher order mechanical properties than those exhibited by a stress tensor; micromodels for micropolar continua; and use of the theory of interpenetrating solid continua to describe crystals and composite materials. This book would be useful to those engaged in fundamental research concerning the modeling of continuous media.

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WAVE MOTION IN ELASTIC SOLIDS

K.F. Graff

Ohio State University Press, 1975

This book treats linear elastic waves and vibrations of infinitesimal amplitude in isotropic homogeneous materials at an intermediate level of mathematical difficulty.

The author introduces the topic by considering waves and vibrations in strings. This prototype system allows him to bring out the salient features of the concepts and mathematics with a simple problem.

He displays the governing partial differential equations and then looks for the harmonic solutions. He considers the nature of the initial/boundary value problem. Fourier analysis is applied; normal mode analysis and dispersion curves are worked out. Treatments from the standpoint of energy are introduced, and forced motion and reflections at boundaries are considered. Green functions and contour integration in the complex plane are introduced.

He treats longitudinal and flexural waves in rods. Here, and in the following chapter on waves in membranes, thin plates, and shells, the governing equations are simplified with such assumptions about the kinematics of deformation as neglecting lateral inertia in rods. Laplace and Hankel transform techniques are used extensively. Treatments include the rod theory of Love and the beam theory of Timoshenko.

At this point Graff turns to exact solutions to the full equations in the cases of infinite and semi-infinite media. Navier's equations are introduced and decomposed using scalar and vector potentials. Shear waves and surface waves are manifested. Approximate contour integration along paths of steepest descent through a saddle point is used to get far-field solutions to the case of harmonic wave sources located on the surface of a half-space.

One chapter treats scattering of plane harmonic waves by symmetrical obstacles and the Sommerfeld diffraction problem; i.e., diffraction by a semi-infinite rigid barrier.

The last and longest chapter returns to wave propagation in plates and rods, this time the exact equations of elasticity are used. Considerable effort -- including Rayleigh-Lamb and Pochammer equations -- is expended to obtain frequency spectra for various vibration modes. For more tractable treatment of free and forced vibrations the author works out some of the inexact treatments associated with R.D. Mindlin. More refined kinematic assumptions and approximations to total energy expressions are made.

A valuable set of appendices contains balance and constitutive equations, integral transforms, and experimental methods.

This is quite a good text and reference book. The author does compare theoretical and experimental results and outlines the experimental methods involved. Each chapter has a good bibliography and a challenging set of problems. The book covers a great deal of material with few typographical errors. It is self-contained and quite readable.

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FRACTURE AND FATIGUE CONTROL IN STRUCTURES -- APPLICATION OF FRACTURE MECHANICS

S.T. Rolfe and J.M. Barsom

Prentice-Hall, Inc., Englewood Cliffs, NJ, 1977

Fracture mechanics has become one of the shining lights in controlling fatigue failures and brittle fracture in structures and machinery. Previously, the designer applied factors of safety and ultimate strength and expected the structure he was designing to survive in a dynamic environment. The advent of brittle fracture of bridges, rotor cracks, and merchant ship failures during World War II brought about the development of fracture mechanics.

This book contains 16 chapters. The first three chapters introduce fracture and fatigue in structures and describe the role of stress analysis in members containing cracks. The stress intensity factor (K_I), crack-tip deformation, and crack opening displacement are defined. The determination of and relationship between static (K_{Ic}) and dynamic (K_{Id}) deformation are described.

Chapters IV and V discuss the effects of temperature, loading rate, and plate thickness on fracture toughness. Representative K_{Ic} and K_{Id} values obtained from tests are presented. Applications of fracture mechanics to pressure vessels and rocket engines are considered, as are relationships of K_{Ic} in edge cracks, surface cracks, and "through" cracks.

In Chapter VI the important relationships in fracture mechanics are considered, namely K_{Ic}, K_{Id}, nil-ductility transition temperature, and the Charpy V notch (CVN) input test. The latter two have been used in structural design for years.

The crack initiation phase determines the fatigue life of a specimen. Chapter VIII contains good discussions of the elastic equations in the immediate vicinity of a crack and the role that stress concentrations play in fatigue crack initiation. Threshold fatigue crack initiation is included; it is a fertile area for present day experimentation.

Chapter VIII progresses from crack initiation to crack propagation under constant amplitude loading to the crack growth rate sigmoidal curve. The author discusses the crack growth rate for various types of steels and nonferrous materials. The effects of mean stress, as well as the effects of cyclic frequency and waveform are accounted for in crack growth rates. The chapter concludes with crack growth propagation of steel weldments and composites.

Chapter IX describes constant amplitude and variable amplitude crack propagation; variable amplitude is more representative of service life stresses. Normal distribution loading is explained; experimental results based upon stress input are included. A portion of this chapter is based on one of the author's experimental studies. The reviewer would have preferred to see crack propagation growth described under programmed loading because it is the basis for a number of fracture mechanics tests in the transportation industry. The equations expressing the crack growth rate and stress intensity factor are employed in variable amplitude loading except that rms value is used for ΔK. This phase of fracture mechanics is in its infancy, and more information should be forthcoming.

Stress corrosion cracking becomes important in structures subjected to an aggressive environment. Chapters X through XII deal with experimental means for determining such cracks by wedge opening loads (WOL) and cantilever beam specimens. The material property K_{Iscc} is similar to K_{Ic}. The crack growth rate in a corrosive environment is higher than that in air. The rate of crack growth below K_{Iscc} is apparently highly dependent on the stress wave cycle. The loading rate affects the notch toughness for steels below 140 KSI, and the consequences of failure are vastly different for different types of steel. The fail-safe and safe-fail concepts are discussed as is the relationship of CVN to transition temperature.

Various notch toughness criteria are considered in Chapter XIII. Criteria include CVN, fracture analysis design (FAD), nil-ductility temperature (NDT), and through thickness-yielding criteria. The chapter describes the relationship of CVN to yield stress.

Chapters XIV and XV develop fracture control plans, identify factors contributing to fracture, and establish their relative contributions. Brittle fracture of welded structures and critical fracture control estimates of a large steam turbine rotor frames and rotor are considered, as are jet airplanes, nuclear reactor containment vessels, gas transmission pipe lines, and spacecraft pressure vessels. Recommendations of various committees are given, as are fracture control guidelines for welded ship hulls and floating nuclear power plants.

The concluding chapter considers elastic-plastic mechanics. The J integral, crack opening displacement, and R curve analysis are briefly discussed. This chapter is too short and should be expanded.

The reviewer considers this to be an excellent text; both the novice and experienced engineer can benefit by reading it. The reviewer would have liked a more exhaustive study of heat affected zones, more information on the J integral, and a section on finite element applications of special or isoparametric elements to crack tips. A section on the integral equation approach would also be welcome. The fracture of fastener holes, which is becoming an important design aspect in *aircraft design*, is not discussed.

In summary, this book covers a large amount of material. In any revision, inclusion of the above-mentioned topics should be considered. The reviewer proposes a two-book series on elementary and advanced aspects of fracture mechanics. The authors are to be commended, however.

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SHORT COURSES

JUNE

INSTRUMENTATION FOR MECHANICAL ANALYSIS

Dates: June 25-29, 1979

Place: University of Michigan

Objective: Emphasis is on the use of instruments by non-electrical engineers to analyze systems. Attendees will use a wide range of transducers and associated instrumentation. Lectures are devoted to theory and hands-on laboratory work and demonstrations.

Contact: Engineering Summer Conferences, 200 Chrysler Center, North Campus, The University of Michigan, Ann Arbor, MI 48109.

DYNAMICS OF STRUCTURAL AND MECHANICAL SYSTEMS

Dates: June 25-29, 1979

Place: UCLA

Objective: The course presents the area of structural dynamics at an intermediate to advanced level. The course emphasizes discrete methods, numerical methods and structural modeling for computer-oriented solution of various structural dynamic problems. Some recent developments in the structural dynamic analysis of parametrically excited systems, rotating systems and systems in which fluid-structure dynamic interactions occur are also considered.

Contact: Continuing Education in Engineering and Mathematics, P.O. Box 24902, UCLA Extension, Los Angeles, CA 90024 - (213) 825-3344/825-1295.

MACHINERY VIBRATIONS SEMINAR

Dates: June 26-28, 1979 & October 23-25, 1979

Place: Mechanical Technology Inc., Latham, NY

Objective: To cover the basic aspects of rotor-bearing system dynamics, The course will provide a fundamental understanding of rotating machinery vibrations; an awareness of available tools and techniques for the analysis and diagnosis of rotor vibration problems; and an appreciation of how these techniques are applied to correct vibration problems. Technical personnel who will benefit most from this course are those concerned with the rotor dynamics evaluation of motors, pumps, turbines, compressors, gearing, shafting, couplings, and similar mechanical equipment. The attendee should possess an engineering degree with some understanding of mechanics of materials and vibration theory. Appropriate job functions include machinery designers; and plant, manufacturing, or service engineers.

Contact: Mr. Paul Babson, MTI, 968 Albany-Shaker Rd., Latham, NY 12110 - (518) 785-2371.

JULY

STRUCTURAL DESIGN FOR EARTHQUAKES

Dates: July 9-13, 1979

Place: University of Southern California

Objective: This is an introduction to the characteristics of earthquake ground motions and their influence on the dynamic response of soils and structures. Computer programs used for the seismic analysis of structural systems and soil deposits will be discussed. Techniques for earthquake resistant design of various structural systems will be emphasized.

Contact: J.P. Hutchins, University of Southern California, College of Continuing Education, Los Angeles, CA 90007 - (213) 741-6708.

INDUSTRIAL PRODUCT NOISE CONTROL

Dates: July 9-13, 1979

Place: Union College, Schenectady, New York

Objective: This course is designed for engineers, designers, environmental health specialists and managers concerned with noise and vibration control. A background in theory, measurement and economics of noise reduction is provided. The basic nature of sound and noise control will be discussed, as well as noise criteria, airborne sound distributions, vibration control and noise signature analysis.

Contact: Office of Graduate Studies and Continuing Education, Wells House, 1 Union Ave., Union College, Schenectady, NY 12308 - (518) 370-6288.

FRACTURE MECHANICS I

Dates: July 16-20, 1979

Place: Union College, Schenectady, New York

Objective: This course is designed to illustrate the use of fracture mechanics as a practical tool in engineering design. The institute will benefit those concerned with the application of fracture mechanics to the prevention of fracture in pressure vessels for power generation, for example, or welded structural frameworks for buildings and bridges.

Contact: Office of Graduate Studies and Continuing Education, Wells House, 1 Union Ave., Union College, Schenectady, NY 12308 - (518) 370-6288.

INSTRUMENTATION, MEASUREMENTS ENGINEERING AND APPLICATION

Dates: July 16-20, 1979

Place: Union College, Schenectady, New York

Objective: Major topics will include transducer design, application and limitations, engineering the test program, recording techniques, identifying good and bad data, data reduction and interpretation, and case histories. These will be applied both to static and dynamic measurements.

Contact: Office of Graduate Studies and Continuing Education, Wells House, 1 Union Ave., Union College, Schenectady, NY 12308 - (518) 370-6288.

FRACTURE MECHANICS II WITH INDUSTRIAL APPLICATIONS

Dates: July 23-26, 1979

Place: Union College, Schenectady, New York

Objective: This course is designed for engineers with responsibility and management of fracture analysis and prevention. The course will focus on concepts and methods representing the state-of-the-art as applied in the pressure vessel and piping fields.

Contact: Office of Graduate Studies and Continuing Education, Wells House, 1 Union Ave., Union College, Schenectady, NY 12308 - (518) 370-6288.

WORKSHOP FOR THE ANALYSIS OF ROTOR BEARING SYSTEMS

Dates: July 23-27, 1979

Place: Union College, Schenectady, New York

Objective: A comprehensive survey of the dynamic problems of high speed, flexible rotors will be presented. A full range of rotor-dynamic phenomena will be examined; discussion of theory will be complemented by sample computations of realistic engineering problems.

Contact: Office of Graduate Studies and Continuing Education, Wells House, 1 Union Ave., Union College, Schenectady, NY 12308 - (518) 370-6288.

FINITE ELEMENT METHOD IN MECHANICAL DESIGN

Dates: July 23-27, 1979

Place: University of Michigan

Objectve: Applications of the finite element method to practical problems of stress analysis and design are covered. Also included is the derivation of the method from energy principles. Graphics used for data preparation and interpretation of results will be presented.

Contact: Engineering Summer Conferences, 200 Chrysler Center, North Campus, The University of Michigan, Ann Arbor, MI 48109.

COMPUTER WORKSHOP IN EARTHQUAKE AND STRUCTURAL DYNAMICS

Dates: July 30-August 3, 1979

Place: Union College, Schenectady, New York

Objective: This course will cover structural dynamics techniques for both linear and nonlinear many-degree-of-freedom systems; and random vibration and computer graphics for input generation and output generation. Applications to current technological problems, including earthquake analysis, pipe whip dynamics, shock response of electronic cabinets, and fluid-solid interaction, will be discussed.

Contact: Office of Graduate Studies and Continuing Education, Wells House, 1 Union Ave., Union College, Schenectady, NY 12308 - (518) 370-6288.

AUGUST

THE SCIENTIFIC AND MATHEMATICAL FOUNDATIONS OF ENGINEERING ACOUSTICS

Dates: August 13-24, 1979
Place: Massachusetts Institute of Technology
Objective: The program emphasizes those parts of acoustics -- the vibration of resonators, properties of waves in structures and air -- the generation of sound and its propagation that are important in a variety of fields of application. The mathematical procedures that have been found useful in developing the desired equations and their solutions, and the processing of data are also studied. These include complex notation, fourier analysis, separation of variables, the use of special functions, and spectral and correlation analysis.

Contact: Richard H. Lyon, Massachusetts Institute of Technology, Room 3-366, Dept. of Mech. Engrg., Cambridge, MA 02139.

VIBRATION AND SHOCK SURVIVABILITY

Dates: *August 20-24, 1979*
Place: Tustin Institute of Technology
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.

***FINITE ELEMENT APPLICATIONS IN* MACHINE DESIGN**

Dates: August 27-31, 1979
Place: Tennessee Technological University
Objective: The course will cover basic theories of finite element techniques for force, displacement, and stress-related problems of mechanics and their applications to the solution of problems in the designs of mechanical systems, machines, and their components. Planar and three-dimensional flexural finite line elements; planar triangular, rectangular, quadrilateral and polar finite stress elements; three-dimensional tetrahedron, hexahedron, prism and polar finite stress elements; and rectangular and triangular finite plate elements will be presented.

Contact: Dr. Cemil Bagci, Dept. of Mech. Engrg., Tennessee Technological University, Cookeville, TN 38501 - (615) 528-3265/528-3254.

MACHINERY VIBRATIONS COURSE

Dates: August 28-30, 1979
Place: Anchorage, Alaska
Objective: This course on machinery vibrations will cover physical/mathematical descriptions, calculations, modeling, measuring, and analysis. Machinery vibrations control techniques, balancing, isolation, and damping, will be discussed. Techniques for machine fault diagnosis and correction will be reviewed along with examples and case histories. Torsional vibration measurement and calculation will be covered.

Contact: Dr. Ronald L. Eshleman, Vibration Institute, Suite 206, 101 West 55th Street, Clarendon Hills, IL 60514 - (312) 654-2254/654-2053.

SEPTEMBER

MACHINERY VIBRATION ANALYSIS

Dates: *September 5-7, 1979*
Place: Atlantic City, New Jersey
Dates: December 11-13, 1979
Place: New Orleans, Louisiana
Objective: The topics to be covered during this course are: fundamentals of vibration; transducer concepts; machine protection systems; analyzing vibration to predict failures; balancing; alignment; case histories; improving your analysis capability; managing vibration data by computer; and dynamic analysis.

Contact: Spectral Dynamics Corp. of San Diego, P.O. Box 671, San Diego, CA 92112 - (714) 268-7100.

VIBRATION OF BEAMS, PLATES, AND SHELLS

Dates: September 10-14, 1979
Place: The Ohio State University
Objective: Understanding the natural frequencies and mode shapes of beams, plates and shells as well as their dynamic response to external excitation. A survey of the recent literature and examination of important papers will be included.

Contact: Professor A.W. Leissa, Dept. of Engineering Mechanics, The Ohio State University, 155 West Woodruff Ave., Columbus, OH 43210 - (614) 422-7271.

ROTATING MACHINERY VIBRATIONS SEMINAR

Dates: September 18-20, 1979
Place: Boxborough, Massachusetts
Objective: This seminar will feature lectures on fluid film bearings, torque induced lateral vibration, coupling use on rotating machinery, minicomputer use and self-excited vibrations in rotating machinery. Practical aspects of rotating machines will be emphasized.

Contact: Dr. Ronald L. Eshleman, Vibration Institute, Suite 206, 101 West 55th St., Clarendon Hills, IL 60514 - (312) 654-2254/654-2053.

DIGITAL SIGNAL PROCESSING

Dates: September 18-20, 1979
Place: Washington, D.C.
Objective: This seminar covers theory, operation and applications -- plus additional capabilities such as transient capture, amplitude probability, cross spectrum, cross correlation, convolution coherence, coherent output power, signal averaging and demonstrations.

Contact: Spectral Dynamics Corp. of San Diego, P.O. Box 671, San Diego, CA 92112 - (714) 268-7100.

OCTOBER

VIBRATION CONTROL

Dates: October 8-12, 1979
Place: The Pennsylvania State University
Objective: The seminar will be of interest and value to engineers and scientists in industry, government, and education. Topics include dynamic mechanical properties of viscoelastic materials; structural damping; isolation of machinery vibration from rigid and nonrigid substructures; isolation of impact transients; reduction of vibration in beams, plates, and shells; reduction of the flow-induced vibration of complex structures; case histories in vibration reduction; and characteristics of multi-resonant vibrators.

Contact: Professor John C. Snowdon, Seminar Chairman, Applied Research Lab., The Pennsylvania State University, P.O. Box 30, State College, PA 16801 - (814) 865-6364.

ROTATING MACHINERY VIBRATIONS COURSE

Dates: October 29-November 1, 1979
Place: Cherry Hill, New Jersey
Objective: This advanced course on rotating machinery vibrations will cover physical/mathematical modeling, mathematical computations, physical descriptions of vibration parameters, measuring, and analysis. Machinery vibrations control techniques will be discussed. Torsional vibration measurement, analysis, and control will be reviewed.

Contact: Dr. Ronald L. Eshleman, Vibration Institute, Suite 206, 101 West 55th St., Clarendon Hills, IL 60514 - (312) 654-2254/654-2053.

NOVEMBER

VIBRATION DAMPING

Dates: November 5-8, 1979
Place: University of Dayton Research Institute
Objective: Topics to be covered are: damping behavior of materials, response measurements of damped systems, surface damping treatments on vibrating members, discrete damping devices, special analytical problems, increasing linear viscoelastic material properties, damping of acoustic vibrations, selected case histories, problem solving sessions, and demonstration of digital fast fourier analyses.

Contact: Mrs. Audrey G. Sachs, University of Dayton Research Institute, Dayton, OH 45469 - (513) 229-2919.

NEWS BRIEFS

news on current and Future Shock and Vibration activities and events

SAE MEETING TO FEATURE DYNAMIC SESSIONS

The SAE Technical Committee, G5 Aerospace Shock & Vibration, is organizing two sessions to be presented at the 1979 Aerospace Meeting, December 3-6, 1979, Hyatt House at Airport, Los Angeles, California. The titles of the two sessions are: Advances in Dynamic Analysis & Design and Advances in Dynamic & Modal Analysis/Testing.

Information on the finalized program may be obtained from Roy W. Mustain, Rockwell International Space Systems Group, M.S. AB97, 12214 South Lakewood Boulevard, Downey, California 90241.

INTERNATIONAL CONFERENCE ON ENVIRONMENTAL FORCES ON ENGINEERING STRUCTURES

July 3-6, 1979
Imperial College, London

The conference will focus on Engineering Structures that are subjected to natural environmental forces as the main design requirement. The behavior of structures under earthquake, wind and wave loading are the main topics of the conference. Since common methods are used for the analysis of these structures, the conference will provide a forum for inter-disciplinary discussion.

The conference will focus on the following topics: Wind Loading on Structures; Safety and Structural Integrity; Probabilistic Analysis; Fixed and Floating Offshore Structures; Fatigue and Corrosion Problems; Structures/Fluid Interaction; Mechanical Vibrations; Experimental Behavior of Structures; and Numerical and Computer Techniques.

For information contact: ICEFES, 125 High Street, Southampton SO1 0AA, England.

21st POLISH SOLID MECHANICS CONFERENCE

September 1979

The 21st Polish Solid Mechanics Conference will be held in early September 1979. The Conference will be concerned with all aspects of solid mechanics and related topics. Both theoretical and experimental papers will be presented. All congress languages and Polish are acceptable. The program will contain a number of invited general lectures on topics of particular interest to modern mechanics.

No Proceedings of the Conference are planned, however, the participants are invited to submit their papers for publication in one of the journals edited by IFTR (Archives of Mechanics, Engineering Transactions).

For further information contact: Dr. Marek Elżanowski, Secretary of the 21st Polish Solid Mechanics Conference, Institute of Fundamental Technological Research, Świetokrzyska 21, 00-049 Warsaw, Poland.

ABSTRACT CATEGORIES

ANALYSIS AND DESIGN

- Analogs and Analog Computation
- Analytical Methods
- Dynamic Programming
- Impedance Methods
- Integral Transforms
- Nonlinear Analysis
- Numerical Analysis
- Optimization Techniques
- Perturbation Methods
- Stability Analysis
- Statistical Methods
- Variational Methods
- Finite Element Modeling
- Modeling
- Digital Simulation
- Parameter Identification
- Design Information
- Design Techniques
- Criteria, Standards, and Specifications
- Surveys and Bibliographies
- Tutorial
- Modal Analysis and Synthesis

COMPUTER PROGRAMS

- General
- Natural Frequency
- Random Response
- Stability
- Steady State Response
- Transient Response

ENVIRONMENTS

- Acoustic
- Periodic
- Random
- Seismic
- Shock
- General Weapon
- Transportation

PHENOMENOLOGY

- Composite
- Damping
- Elastic
- Fatigue
- Fluid
- Inelastic
- Soil
- Thermoelastic
- Viscoelastic

EXPERIMENTATION

- Balancing
- Data Reduction
- Diagnostics
- Equipment
- Experiment Design
- Facilities
- Instrumentation
- Procedures
- Scaling and Modeling
- Simulators
- Specifications
- Techniques
- Holography

COMPONENTS

- Absorbers
- Shafts
- Beams, Strings, Rods, Bars
- Bearings
- Blades
- Columns
- Controls
- Cylinders
- Ducts
- Frames, Arches
- Gears
- Isolators
- Linkages
- Mechanical
- Membranes, Films, and Webs
- Panels
- Pipes and Tubes
- Plates and Shells
- Rings
- Springs
- Structural
- Tires

SYSTEMS

- Absorber
- Acoustic Isolation
- Noise Reduction
- Active Isolation
- Aircraft
- Artillery
- Bioengineering
- Bridges
- Building
- Cabinets
- Construction
- Electrical
- Foundations and Earth
- Helicopters
- Human
- Isolation
- Material Handling
- Mechanical
- Metal Working and Forming
- Off-Road Vehicles
- Optical
- Package
- Pressure Vessels
- Pumps, Turbines, Fans, Compressors
- Rail
- Reactors
- Reciprocating Machine
- Road
- Rotors
- Satellite
- Self-Excited
- Ship
- Spacecraft
- Structural
- Transmissions
- Turbomachinery
- Useful Application

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 (UM), 313 N. Fir St., Ann Arbor, MI; U.S. Patents from the Commissioner of Patents, Washington, D.C. 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

ANALYSIS AND DESIGN

Computer applications in dynamic structural analysis and structural design modeling are discussed. For individual titles, see N79-10449 through N79-10465.

ANALOGS AND ANALOG COMPUTATION

79-903

Computerized Symbolic Manipulation in Structural Mechanics -- Progress and Potential

A.K. Noor and C.M. Andersen

George Washington University Ctr., NASA Langley Res. Center, Hampton, VA 23665, Computers Struc., 10 (1-2), pp 95-118 (Apr 1979) 3 figs, 3 tables, 45 refs

Key Words: Computerized symbolic manipulation, Finite element technique, Stiffness coefficients, Mass coefficients, Rayleigh-Ritz method, Plates, Free vibration

Status and recent applications of computerized symbolic manipulation to structural mechanics problems are summarized. The applications discussed include: generation of characteristic arrays of finite elements; evaluation of effective stiffness and mass coefficients of continuum models for repetitive lattice structures; and application of Rayleigh-Ritz technique to free vibration analysis of laminated composite elliptic plates. The major advantages of using computerized symbolic manipulation in each of these applications are outlined. A number of problem areas which limit the realization of the full potential of computerized symbolic manipulation in structural mechanics are examined and some of the means of alleviating them are discussed.

ANALYTICAL METHODS

79-904

Research in Computerized Structural Analysis and Synthesis

H.G. McComb, Jr.

NASA Langley Res. Center, Hampton, VA, Rept. No. NASA-CP-2059; L-12507, 224 pp (Oct 1978) N79-10448

Key Words: Dynamic structural analysis, Dynamic synthesis, Computer aided techniques

79-905

Finite Element Dynamic Analysis on CDC STAR-100 Computer

A.K. Noor and J.J. Lambiotte, Jr.

NASA Langley Res. Center, Hampton, VA 23665, Computers Struc., 10 (1-2), pp 7-19 (Apr 1979) 7 figs, 4 tables, 15 refs

Key Words: Finite element technique, Dynamic structural analysis, Algorithms, Computer aided techniques

Computational algorithms are presented for the finite element dynamic analysis of structures on the CDC STAR-100 computer. The spatial behavior is described using higher-order finite elements. The temporal behavior is approximated by using either the central difference explicit scheme or Newmark's implicit scheme. In each case the analysis is broken up into a number of basic macro-operations. Discussion is focused on the organization of the computation and the mode of storage of different arrays to take advantage of the STAR pipeline capability. The potential of the proposed algorithms is discussed and CPU times are given for performing the different macro-operations for a shell modeled by higher order composite shallow shell elements having 80 degrees of freedom.

79-906

Dynamic Behavior Theory of Elasto-Plastic Bodies (Zur Theorie des dynamischen Verhaltens von elastisch-plastischen Körpern)

K. Groger

Zentralinstitut für Mathematik und Mechanik, Mohrenstrasse 39, German Democratic Republic, 108 Berlin, Z. angew. Math. Mech., 58 (11), pp 483-487 (1978) 4 refs

(In German)

Key Words: Initial value problems, Elastoplastic properties, Dynamic response

This paper shows that under certain assumptions the dynamic behavior of elastic-plastic materials can be described by initial value problems for second order differential inequalities. The unique solution of such problems is proven in the case of a special constitutive relation.

NUMERICAL ANALYSIS

79-907

Theory of Dynamic Systems Which Incorporate Elements with Incomplete Information and Its Relation to the Theory of Discontinuous Systems

M.A. Aizerman and Y.S. Pyatnitskiy

Inst. of Control Sciences, U.S.S.R. Academy of Sciences, 81 Profsoyuznaya, Moscow 117342, USSR, J. Franklin Inst., 306 (6), pp 379-408 (Dec 1978) 4 figs, 21 refs

Key Words: Numerical analysis, Dynamic systems

Dynamic systems which incorporate elements whose description in some regions is incomplete are studied. These represent systems with hysteresis and discontinuous systems (switching systems, discontinuous systems with the Coulomb friction, etc.) when the phenomena in the hysteresis loop and in the vicinity of discontinuity surfaces are little known. Representative equations are obtained for systems which contain discontinuous elements.

79-908

Calculation of Non-Linear Vibrations with Finite Space-Time Elements (Die Berechnung nichtlinearer Schwingungen mit finiten Raum-Zeit-Elementen)

H. Malsch

Ingenieur-Büro Heinrich Malsch, Minsbekkehre 3, D-2000 Hamburg 65, Federal Rep. of Germany, Ing. Arch., 47 (6), pp 349-361 (1978) 14 figs, 6 tables, 6 refs

(In German)

Key Words: Numerical methods, Nonlinear response, Vibration response, Beams

An unconditionally stable method for the computation of large linear dynamic systems is applied to the solution of nonlinear oscillations.

79-909

On a New Algorithm for Time Step Integration of Nonlinear Systems

E. Anderheggen and G. Bazzi

Eidgenoessische Technische Hochschule, Zürich, Switzerland, In: NASA Langley Res. Center, Res. in Computerized Structural Analysis and Syn., pp 141-151 (Oct 1978) (for primary document see N79-10448 01-39)

N79-10459

Key Words: Algorithms, Finite element technique, Dynamic stability

A new implicit algorithm for time step integration of finite element structural dynamic equations is presented. Convergence, stability and numerical damping properties are discussed. Some simple numerical results are presented. A related explicit algorithm is also derived and shortly discussed.

OPTIMIZATION TECHNIQUES

79-910

Implementation of Natural Frequency Analysis and Optimality Criterion Design

R. Levy and K. Chai

Jet Propulsion Lab., Pasadena, CA 91103, Computers Struc., 10 (1-2), pp 277-282 (Apr 1979) 3 figs, 18 refs

Key Words: Natural frequencies, Optimum design, Computer programs, Structural design

A review of methods to compute the lower-frequency modes within a medium- to large-capacity computer design program indicates advantages for the simultaneous iteration method. The optimality criterion design algorithms are summarized for the problem of minimum structural weight with constrained frequency and for the dual problem of constrained weight with maximum frequency. A simple sample application problem shows agreement with a known theoretical result. Another example shows effective results for a structure of practical complexity within reasonable computing times. A summary contains recommendations for continuing research.

79-911

A Generalized Energy Approach to the Optimum Design of Plates and Skeletal Structures

M.A. Oluyomi and B. Tabarrok

Research Div., Ontario Hydro, Toronto, Canada, Computers Struc., 10 (1-2), pp 269-275 (Apr 1979) 6 figs, 15 refs

Key Words: Energy methods, Optimum design, Minimum weight design, Computer programs, Structural design, Plates

The problem of the optimum design of discretized elastic systems is formulated as an energy extremization problem. The approach proposed derives all the pertinent equations of the problem: the governing equations of equilibrium; the optimality criteria; and the constraint equations; from the stationary conditions of a single functional. To accomplish this, the constraints on stresses, deflections, fundamental frequencies and critical buckling loads are posed in the form of equivalent potentials.

STATISTICAL METHODS

79-912

Stochastic Analysis of Oscillators with Non-Linear Damping

P.-T.D. Spanos

Dept. of Aerospace Engrg. and Engrg. Mechanics, The Univ. of Texas at Austin, TX 78712, Intl. J. Nonlin. Mech., 13 (4), pp 249-259 (1978) 18 refs

Key Words: Oscillators, Random excitation, Nonlinear damping, Stochastic processes

The response of a class of oscillators with non-linear damping to stochastic excitation is considered. A partial differential equation which describes approximately the probability density function of the response amplitude is derived. The stationary and non-stationary solutions of this equation are examined. The soundness of the method is tested by comparing the solutions generated by its application to problems with known solutions. The Van der Pol and Rayleigh oscillators are included in the example problems studied.

FINITE ELEMENT MODELING

79-913

Dynamic Photoelastic and Dynamic Finite-Element Analyses of Dynamic-Tear-Test Specimens

S. Mall, A.S. Kobayashi, and Y. Urabe

Dept. of Mech. Engrg., Univ. of Maine, Orono, ME 04473, Exptl. Mech., 18 (12), pp 449-456 (Dec 1978) 13 figs, 1 table, 12 refs

Key Words: Photoelastic analysis, Finite element technique, Fracture properties

The transient response of the dynamic-tear-test specimen of a brittle material, Homalite-100, is investigated by dynamic photoelasticity and dynamic finite-element method. The dynamic stress-intensity factors obtained from dynamic photoelasticity and dynamic finite-element analyses are in reasonable agreement with each other. Dynamic-fracture-toughness vs. crack-velocity relation is also obtained.

PARAMETER IDENTIFICATION

79-914

Identification of Linear Dynamic Systems

Y. Wu

Ph.D. Thesis, Northwestern Univ., 263 pp (1978) UM 7903394

Key Words: System identification technique

The problem of order determination and modeling of multi-input, multi-output, linear, time-invariant, discrete-time systems from the input/output measurements for both the noise-free and the noisy cases is considered. The effect of an input sequence on identification is searched in detail. Sufficient conditions for correct order determination and system identification are also investigated. Procedures for order determination and modeling are developed for the multi-input, single-output, linear, time-invariant, discrete-time systems.

79-915

Parameter Estimation in Linear Discrete System: New Algorithms for Stochastic Approximation Scheme

M.S. Ahmed

Ph.D. Thesis, Univ. of Windsor (Canada) (1978)

Key Words: System identification technique, Parameter identification technique, Algorithms

This work is devoted to the on-line identification of linear discrete-time systems from noise corrupted input and output data, by the method of stochastic approximation. Criteria are established on the gain matrix for the convergence of system identification algorithm by stochastic approximation. By minimizing the estimated error at each stage, expressions for the gain sequence, namely scalar gain, diagonal matrix gain, and square matrix gain, are developed. Finally, the algorithms are extended to multiple input-output systems and time varying systems. The proposed algorithms are applied to the identification of simulated systems. The convergence, storage and computational requirement are compared.

DESIGN INFORMATION

(Also see Nos. 910, 911)

79-916

Natural Frequencies of Structures for Designers

A. Bolton

Dept. of Civil Engrg., Heriot-Watt Univ., The Struc. Engr., 56A (9), pp 245-253 (Sept 1978) 14 figs, 1 table, 5 refs

Key Words: Fundamental frequencies, Natural frequencies, Dynamic structural analysis, Design procedures

This paper discusses a major question in design: what are the natural frequencies of the particular structure, do any of them correspond with a known dynamic load, and if so, how can the structure be altered to change that natural frequency sufficiently? The method is based on the simple formula for the frequency of vibration of a mass hanging on a spring.

CRITERIA, STANDARDS, AND SPECIFICATIONS

79-917

Seismic Design Requirements in a Mexican 1976 Code

E. Rosenblueth

Instituto de Ingenieria, Ciudad Universitoria, DF, Mexico, Intl. J. Earthquake Engr. Struc. Dynam., 7 (1), pp 49-61 (Jan/Feb 1979) 7 figs, 19 refs

Key Words: Seismic design, Standards and codes

In December 1976 the new version of Mexico's Federal District Building Code was officially approved. Design values are based on a probabilistic assessment of seismicity, on a more careful and better substantiated consideration of wave filtering through the peculiar lacustrine soil and on approximate design optimization; ductility receives explicit treatment; and there are significant improvements in the treatment of overturning moments, torques, etc. The paper discusses these matters and contains information on code evolution in Mexico and on the implementation in the Federal District.

SURVEYS AND BIBLIOGRAPHIES

79-918

Aseismic Design of Building Service Systems: The State-of-the-Art

C.W.C. Yancey and A.A. Camacho

Center for Building Technology, National Bureau of Standards, Washington, D.C., Rept. No. NBS-TN-970, 86 pp (Sept 1978)
PB-286 907/1GA

Key Words: Reviews, Seismic design, Hospitals

A search for information is conducted to define the state-of-the-art of aseismic design of building service systems and to identify areas of needed research. The study focuses primarily on service systems essential to the continuous operation of hospital facilities in postearthquake periods. A review of the literature pertaining to seismic performance of nonstructural systems is presented. An evaluation of code and standard regulations applicable to the aseismic design of service system components is also presented. Information obtained from direct contact with several federal agencies, the State of California, and practicing architects and engineers is summarized. The findings from a field visit of two hospitals currently under construction in earthquake-prone areas are reported. Deficiencies in current design/evaluation practice are identified and recommendations for research are presented.

79-919

Automobile Safety: Bumpers (Citations from the NTIS Data Base)

M.E. Young

National Technical Information Service, Springfield, VA, 58 pp (Dec 1978)
NTIS/PS-78/1263/9GA

Key Words: Bibliographies, Collision research (automotive), Bumpers, Energy absorption

Federally-funded reports on bumper tests, design, materials, and crashworthiness are cited in the bibliography. (This updated bibliography contains 51 abstracts, none of which are new entries to the previous edition).

79-920

Automobile Safety: Bumpers (Citations from the Engineering Index Data Base)

M.E. Young

National Technical Information Service, Springfield, VA, 187 pp (Dec 1978)

NTIS/PS-78/1264/7GA

Key Words: Bibliographies, Collision research (automotive), Bumpers, Crashworthiness, Testing techniques

Worldwide research on automobile safety through design and materials for bumpers in included. Articles on testing, crashworthiness, innovative materials; and feasibility studies are cited. (This updated bibliogrpahy contains 181 abstracts, 12 of which are new entries to the previous edition).

COMPUTER PROGRAMS

GENERAL

(Also see No. 1088)

79-921

Mixed Time Integration Schemes

J.P. Wright

Weidlinger Associates, New York, NY 10022, Computers Struc., 10 (1-2), pp 235-238 (Apr 1979) 24 refs

Key Words: Computer programs, Dynamic structural analysis

A current topic of research is the development of structural dynamics codes which permit different time integration methods to be used in different parts of the structure. The primary goal of this effort is the design and implementation of more efficient solution procedures. This paper presents a review of this research and emphasizes some of the factors which are important in this work.

79-922

SPINEQ: A Program for Determining Aircraft Equilibrium Spin Characteristics Including Stability

W.M. Adams, Jr.

NASA Langley Res. Center, Hampton, VA, Rept. No. NASA-TM-78759; L-12328, 86 pp (Nov 1978)

N79-11074

Key Words: Computer programs, Aircraft, Equations of motion

A computer program, SPINEQ, is described which can algebraically solve the nonlinear equations of motion for equilibrium spin conditions. Linear characteristics of the airplane about the equilibrium points are also determined. The theoretical basis of the program is outlined, computational flow is shown, the functions of major subroutines are described, and key parameters directing the computations are identified. Program input and output are described and illustrated by means of a test case.

79-923

Sonic-Box Method Employing Local Mach Number for Oscillating Wings with Thickness

S.Y. Ruo

Lockheed-Georgia Co., Marietta, GA, Rept. No. NASA-CR-158907, 73 pp (Sept 1978)

N79-10999

Key Words: Computer programs, Aircraft wings, Geometric effects, Vibration response

A computer program was developed to account approximately for the effects of finite wing thickness in the transonic potential flow over an oscillating wing of finite span. The program is based on the original sonic-box program for planar wing which was previously extended to include the effects of the swept trailing edge and the thickness of the wing. Account for the nonuniform flow caused by finite thickness is made by application of the local linearization concept. The thickness effect, expressed in terms of the local Mach number, is included in the basic solution. Calculations are made for a delta wing and a rectangular wing performing plunge and pitch oscillations, and the results are compared with those obtained from other methods. An input guide and a complete listing of the computer code are presented.

79-924
Improved Sonic-Box Computer Program for Calculating Transonic Aerodynamic Loads on Oscillating Wings with Thickness
S.Y. Ruo
Lockheed-Georgia Co., Marietta, GA, Rept. No. NASA-CR-158906, 128 pp (Sept 1978)
N79-10998

Key Words: Computer programs, Aircraft wings, Geometric effects, Vibration response

A computer program was developed to account approximately for the effects of finite wing thickness in transonic potential flow over an oscillation wing of finite span. The program is based on the original sonic box computer program for planar wing which was extended to account for the effect of wing thickness. Computational efficiency and accuracy are improved and swept trailing edges are accounted for. Account for the nonuniform flow caused by finite thickness is made by application of the local linearization concept with appropriate coordinate transformation. A brief description of each computer routine and the applications of cubic spline and spline surface data fitting techniques used in the program are given, and the method of input is shown in detail. Sample calculations as well as a complete listing of the computer program listing are presented.

79-925
Coupled Hydrodynamic-Structural Response Analysis of Piping Systems
M.T. A-Moneim
Argonne National Lab., IL, Rept. No. ANL-77-91, 88 pp (Feb 1978)
N79-11358

Key Words: Computer programs, Piping systems, Hydrodynamic excitation

The expansion of the ICEPEL code for the coupled hydrodynamic-structural response analysis of pipe-elbow loops to general piping systems is described. A generalized piping component model, a branching tee junction, and a surge tank model are introduced and coupled with the pipe-elbow loop model so that a general piping system under the effect of internally traveling pressure pulses can be analyzed hydrodynamically, as well as structurally. Optional capabilities are included in the generalized piping component model. The options are nine different axisymmetric exterior wall configurations, elastic-plastic exterior walls, interior rigid-wall simulation, and heat exchanger tube-bundle model. The implicit continuous-fluid Eulerian (ICE) differencing technique is used in the hydrodynamic part of the analysis: the waves in hysteretic arbitrary media finite element scheme are used in the structural response part of the analysis.

ENVIRONMENTS

ACOUSTIC

(Also see No. 975)

79-926
Acoustic Radiation Force on a Sphere in a Quasistationary Wave Field – Theory
T. Hasegawa
Faculty of Science, Ehime Univ., Matsuyama, Ehime 790, Japan, J. Acoust. Soc. Amer., 65 (1), pp 32-40 (Jan 1979) 16 figs, 13 refs

Key Words: Sound waves, Spheres

The acoustic radiation force on a solid sphere in a wave field in an inviscid fluid is investigated theoretically and numerically taking into account the effects of elasticity of the sphere material for the following three cases: the wave field is stationary, the wave field is quasistationary, and the sound absorption in the sphere material is taken into account in each case above.

79-927
Acoustic Radiation Force on a Sphere in a Quasistationary Wave Field – Experiment
T. Hasegawa
Faculty of Science, Ehime Univ., Matsuyama, Ehime 790, Japan, J. Acoust. Soc. Amer., 65 (1), pp 41-44 (Jan 1979) 7 figs, 1 table, 10 refs

Key Words: Sound waves, Spheres

The acoustic radiation force on a sphere in quasistationary waves is investigated experimentally. The radiation forces measured with fused silica spheres are compared with a previous theory by the present author which takes into account the elasticity of the sphere material. Good agreement has been found.

79-928

Acoustic Emission and Transient Waves in an Elastic Plate

Y. Pao, R.R. Gajewski, and A.N. Ceranoglu

Dept. of Theoretical and Appl. Mechanics, Cornell Univ., Ithaca, NY 14853, J. Acoust. Soc. Amer., 65 (1), pp 96-105 (Jan 1979) 10 figs, 3 tables, 18 refs

Key Words: Elastic waves, Wave propagation, Plates

The transient waves which are generated by four kinds of point sources (a single force, double force, and center of dilatation, all inside an infinite plate, and a single force on the surface of the plate) are analyzed. The analysis is based on the generalized ray theory and Cagniard's method.

79-929

Sound Radiation from an Elastically Supported Circular Plate

H. Suzuki and J. Tichy

Consumer Products Research Lab., Mitsubishi Electric Corp., 2-14-40 Ofuna, Kamakura, Kanagawa, Japan, J. Acoust. Soc. Amer., 65 (1), pp 106-111 (Jan 1979) 10 figs, 8 refs

Key Words: Elastic waves, Wave propagation, Circular plates, Elastic foundations

In order to discuss the sound radiation from a direct-radiator loudspeaker in the high-frequency region, an elastically supported circular plate in an infinite baffle is used. The normal modes of this plate is consistently treated from the free boundary to the simply supported boundary, which are the limiting cases of the elastically supported boundary, by defining a dimensionless parameter representing the ratio of the edge stiffness to the bending stiffness of the plate.

79-930

Noise in Weaving Mills – Results of a Survey of Twenty Two Factories. Noise Reduction Possibilities

M.T. Ho and A. Damongeot

I.N.R.S. Research Center, Avenue de Bourgogne/B.P. 27, 54500 Vandoeuvre-les-Nancy, France, 9th Intl. Cong. on Acoustics, Madrid, pp 13-29 (July 1977) Sociedad Espanola de Acustica - 9 I.C.A. C/Serrano, 144 Madrid 6, Spain, 2 figs, 4 refs

Key Words: Textile looms, Noise generation, Noise reduction

The sound pressure levels in the shuttle loom mills ranged between 98 and 104 dB(A) and there were machines in fairly good running condition, and work sites that were not especially reverberant. Continued exposure to such noise environments bears the risk of permanent hearing damage, accentuated by the impulsive nature of the noise. Many cases of deafness have indeed been observed in old weavers, and this hazard is listed in occupational disease tables. Examples are given to demonstrate that the nature of the loom is a determining factor in the noise level attained in mills.

PERIODIC

79-931

On the Dynamic Behavior of Poroelastic Materials

A.M. Wijesinghe and H.B. Kingsbury

Dept. of Mech. Engrg., Massachusetts Inst. of Tech., Cambridge, MA 02139, J. Acoust. Soc. Amer., 65 (1), pp 90-95 (Jan 1979) 4 figs, 16 refs

Key Words: Porous materials, Harmonic excitation, Dynamic response

This paper examines the dynamic response to harmonic loading of a disk or slab of poroelastic material. Biot's dynamic theory for deformable poroelastic media is applied to derive expressions for a complex modulus of the material in terms of poroelastic material coefficients. Both a quasi-static analysis, accounting for dissipation but neglecting inertia, and a dynamic analysis, which neglects dissipation, are presented.

SEISMIC

(Also see Nos. 952, 973, 1043, 1085)

79-932

Evaluating the Seismic Reliability of Electrical Equipment Containing Ceramic Structural Members

A.J. Schiff, R.E. Torres-Cabrejos, and J.T.P. Yao

School of Mech. Engrg., Purdue Univ., West Lafayette, IN, Intl. J. Earthquake Engr. Struc. Dynam., 7 (1), pp 85-98 (Jan/Feb 1979) 11 figs, 11 refs

Key Words: Transmission lines, Ceramics, Earthquake response

A method for evaluating the reliability of ceramic structural members subjected to earthquake-induced vibrations is presented. The method uses the Weibull distribution to represent the probability of failure of the brittle ceramic material and includes the effects of stress concentrations introduced by flaws and the volume of material subjected to stress. The stress concentration introduced by the complex form of insulators and at the mounting interfaces is considered. A numerical example is given to illustrate the application of the method.

SHOCK

(Also see Nos. 920, 1029, 1063, 1087)

79-933

Attenuation of a Plane Compressional Wave by a Random Distribution of Thin Circular Cracks

M. Piau

Institut de Mecanique de Grenoble, B.P. 53 Centre de Tri, 38041, Grenoble Cedex, France, Intl. J. Engr. Sci., 17 (2), pp 151-167 (1979) 3 figs, 14 refs

Key Words: Cracked media, Discontinuity-containing media, Wave diffraction

The problem of the diffraction of obliquely incident plane compressional waves by a thin circular crack located in an infinite isotropic elastic medium is considered. An analytic estimation of the scattering cross-section is obtained for the Rayleigh limit. The attenuation coefficient associated with a random distribution of such cracks is derived for not too closely-spaced cracks, even when weak scattering density conditions are not satisfied. Comparisons are made with known results for spherical cavities and with the attenuation which could be calculated for scalar waves. Conclusions are drawn about attenuation measurements used as a nondestructive test to characterize crack distribution in a sample.

79-934

The Deformation Analysis of a Transversely Struck Glass-Plate by Means of the Moiré Method (Die Verformungsanalyse schlagartig belasteter Glasplatten mit Hilfe des Moiréverfahrens)

H. Schwieger and R. Struebel

Institut f. Mechanik der Ruhr-Universität, Bochum, Federal Republic of Germany, Forsch. Ingenieurw., 44 (6), pp 169-176 (1978) 13 figs, 23 refs

Key Words: Shock wave propagation, Elastic media, Glass, Moiré effects

The dynamic deflection of an impact loaded plate is investigated by means of the Moiré method and the single flash technique. Using a grating and a beam splitter, the image of this grating corresponding to the mirrored glass-plate and this one corresponding to the reference mirror are frozen by moment photography. The Moiré effect caused by the distorted grating image of the plate is visualized by spatial filtering. The obtained Moiré fringes represent loci of equal deflection gradient. The central deflections and the impact forces are measured.

TRANSPORTATION

79-935

Effects of Jerk Limiting on the Stability of Automated Transit Vehicles

W.L. Garrard

Dept. of Aerospace Engrg. and Mech., Univ. of Minnesota, Minneapolis, MN 55455, J. Dyn. Syst., Meas. and Control., Trans. ASME, 100 (4), pp 298-301 (Dec 1978) 5 figs, 10 refs

Key Words: Transportation vehicles, Automatic control, Dynamic response

In this paper a method is presented for estimating the effects of jerk limiting on the stability of the longitudinal dynamic response of automated transit vehicles.

PHENOMENOLOGY

COMPOSITE

(Also see No. 942)

79-936

Dynamics of Composite Materials

S. Nemat-Nasser

Northwestern Univ., Evanston, IL, Rept. No. ARO-

10578.7-E, 8 pp (July 1978)
AD-A060 006/4GA

Key Words: Composite materials, Fiber composites, Plates, Beams, Boundary value problems

In this project attention is focused on: the accurate calculation of the dispersive properties of laminated and two- and three-dimensional fiber-reinforced elastic composites; the accurate determination of natural frequencies of composite plates and beams, or plates and beams with variable dimensions or with inclusions; calculation of upper and lower bounds for the eigenfrequencies in the first two areas; and the assessment of the effect of fiber geometry on the dynamic properties of the fiber-reinforced composite.

79-937
Dynamic Inelastic Behavior of Materials
S.R. Bodner
Material Mechanics Lab., Technion-Israel Inst. of Tech., Haifa, Israel, Rept. No. AFOSR-TR-78-1290, 23 pp (July 1978)
AD-A059 514/0GA

Key Words: Constitutive equations, Composite materials, Elastic properties, Viscoplastic properties

The main subject of the research program is the further development of elastic-viscoplastic constitutive equations to represent a wide range of material behavior and loading conditions and application of the equations to static and dynamic structural problems. Associated investigations include generalization of the constitutive equations to multiaxial stress states and studies on anelastic materials. Other topics in the program are investigations of ballistic penetration single target plates under oblique impact and of multi-layered targets subject to normal impact, impact strength of composites, and acoustic emission of composites. The accomplishments of the program are discussed and proposed directions of future research are indicated.

79-938
Dynamic Strength Testing of Adhesive and Piezoceramics
P. Aproian and R.S. Woollett
Navy Underwater Sound Lab., New London, CT, Rept. No. USL-TM-1150-34-60, 19 pp
AD-A060 197/1GA

Key Words: Sandwich structures, Adhesives, Dynamic tests

The present investigation is aimed at determining the inherent strength exhibited by barium titanate metal structures which are executing extensional vibrations. The present tests employ alternating stress.

DAMPING

(Also see Nos. 964, 971, 972)

79-939
Using Materials to Muffle Noise
Product Engr. (NY), 50 (2), pp 47-51 (Feb 1979) 7 figs

Key Words: Noise reduction, Material damping, Aircraft, Diesel engines

Materials used for suppressing noise generated by aircraft, diesel cars and trucks, business machines, and many other products, are described.

ELASTIC

79-940
Approximate Methods to Describe the Reflections from Cylinders and Spheres with Complex Impedance
J. George and H. Überall
Physics Dept., Catholic Univ. of America, Washington, D.C. 20064, J. Acoust. Soc. Amer., 65 (1), pp 15-24 (Jan 1979) 11 figs, 24 refs

Key Words: Wave reflection, Cylinders, Spheres

The scattering of plane waves from cylinders and spheres with complex impedance boundary conditions using the Kirchhoff method and the Luneburg-Kline method is studied. A stationary phase approximation is made in the Kirchhoff derivation to eliminate spurious contributions from the boundary of the insonified region. Dependence of the cross section on the complex impedance, the incident wave frequency, as well as on the azimuthal angle is illustrated.

79-941
The Propagation and Reflection of Cylindrically Symmetric Waves in Inhomogeneous Anisotropic Elastic Materials
T.B. Moodie, D.W. Barclay, and J.B. Haddow
Dept. of Mathematics, Univ. of Alberta, Edmonton, Canada, Intl. J. Engr. Sci., 17 (1), pp 95-105 (1979) 6 figs, 1 table, 4 refs

Key Words: Cylinders, Wave propagation, Wave reflection, Elastic media

The effectiveness of an approximate method of inverting the Laplace transforms, which arise in a study of cylindrically symmetric waves produced by a step function application of pressure at the inner surface of a cylindrically anisotropic inhomogeneous cylinder, is explored. The method is based on approximating modified Bessel functions by the product of the first term of the asymptotic expansion and a rational function. Results obtained using both linear and quadratic polynomials for the rational function are compared with those obtained from the method of characteristics.

79-942
Harmonic Generation at an Unbonded Interface – I. Planar Interface Between Semi-Infinite Elastic Media
J.M. Richardson
Science Center, Rockwell International, Thousand Oaks, CA 91360, Intl. J. Engr. Sci., 17 (1), pp 73-85 (1979) 6 figs, 4 refs

Key Words: Elastic media, Discontinuity-containing media, Nonlinear theories, Continuum mechanics, Layered materials

An analysis is made of the nonlinear dynamics of a system composed of an unbonded planar interface separating two semi-infinite linear elastic media.

FLUID

(Also see No. 1040)

79-943
On Transient Analysis of Fluid-Structure Systems
K.J. Bathe and W.F. Hahn
Dept. of Mech. Engrg., Massachusetts Inst. of Tech., Cambridge, MA 02139, Computers Struc., 10 (1-2), pp 383-391 (Apr 1979) 10 figs, 14 refs

Key Words: Interaction: fluid-structure, Transient response, Computer programs, Pipes (tubes)

Finite element procedures for the dynamic analysis of fluid-structure systems are presented and evaluated. The fluid is assumed to be inviscid and compressible and is described using an updated Lagrangian formulation. Variable-number-nodes isoparametric two- and three-dimensional elements with lumped or consistent mass idealization are employed in the finite element discretization, and the incremental dynamic equilibrium equations are solved using explicit or implicit time integration. The solution procedures are applied to the analysis of a number of fluid-structure problems including the nonlinear transient analysis of a pipe test.

79-944
A Laboratory Study of the Fluid-Structure Interaction of Submerged Tanks and Caissons in Earthquakes
R.C. Byrd
Ph.D. Thesis, Univ. of California, Berkeley, 157 pp (1978)
UM 7904395

Key Words: Interaction: fluid-structure, Submerged structures, Storage tanks, Earthquake response

An experimental study comparing the results of measurements of forces on a submerged tank model due to earthquake excitation is presented. The experimental results are compared with analytical solutions for the case where the model is submerged in water of depth *equal to 2.5 times* the tank height and for the case where the depth exactly equals the height. Details are presented for the design of a 1 to 100 scale model of a circular cylindrical structure which is 34 meters in height with a mass of approximately 250,000 tons. The model includes a foundation system which simulates elastic half-space soil stiffness in three degrees of freedom. The experimental results are presented in the form of inertia coefficients measured in harmonic motion at varying amplitudes and over a frequency range of 0.3 Hz to 2 Hz in prototype scale. Coefficients are presented for horizontal, vertical, rotational, and horizontal-rotational coupling. The relationship between these coefficients and the physics of the fluid-structure interaction are discussed in detail.

79-945
Supersonic Unstalled Flutter
J.J. Adamczyk, M.E. Goldstein, and M.J. Hartmann
NASA Lewis Res. Center, Cleveland, OH, Rept. No.

NASA-TM-79001; E-9785, 24 pp (1978)
N79-11000

Key Words: Airfoils, Flutter, Aerodynamic loads, Fluid-induced excitation

Flutter analyses are developed to predict the onset of supersonic unstalled flutter of a cascade of two-dimensional airfoils. The first of these analyzes the onset of supersonic flutter at low levels of aerodynamic loading (i.e., backpressure), while the second examines the occurrence of supersonic flutter at moderate levels of aerodynamic loading. Both of these analyses are based on the linearized unsteady inviscid equations of gas dynamics to model the flow field surrounding the cascade. These analyses are utilized in a parametric study to show the effects of cascade geometry, inlet Mach number, and backpressure on the onset of single and multidegree of freedom unstalled supersonic flutter. Several of the results are correlated against experimental qualitative observation to validate the models.

79-946
Axisymmetric Free Vibration Analysis of a Floating Roof in a Cylindrical Tank
H. Kondo
Ishikawajima-Harima Heavy Industries Co., Ltd., Tokyo, Japan, Bull. JSME, 21 (162), pp 1710-1716 (Dec 1978) 3 figs, 4 tables, 6 refs

Key Words: Floating structures, Coupled response, Free vibration, Tanks (containers), Storage tanks

Coupled oscillations of a liquid and a floating roof in a circular cylindrical tank are studied for small motions. The liquid is assumed as a perfect fluid, both floating roof and bottom plate of the tank are treated as thin plates, and the side wall is assumed rigid. The Fourier-Bessel expansion is used to obtain frequency equations. Numerical examples for the axisymmetric case are given to illustrate the effect of coupling.

79-947
Wind and Seismic Effects – Proceedings of the Joint Panel Conference of the U.S.-Japan Cooperative Program in Natural Resources (9th), Held at Tokyo, Japan in May 24-27, 1977
H.S. Lew
Center for Building Tech., National Bureau of Standards, Washington, D.C., Rept. No. NBS-SP-523, 522 pp (Sept 1978)
PB-286 993/1GA

Key Words: Wind-induced excitation, Seismic excitation, Proceedings

The proceedings of the Joint Meeting include the program, the formal resolutions, and the technical papers. The subjects covered in the paper include: characteristics of strong winds; wind loads on structures and design criteria; earthquake prediction; earthquake ground motions and soil failures; seismic loads on structures and design criteria; design of special structures; earthquake hazard reduction program; and quantitative evaluation of damages caused by winds and earthquakes. (Portions of this document are not fully legible).

SOIL

79-948
Dynamic Response of Layered Cohesive Soil
F. Oka
Mem. Fac. Engr. Kyoto Univ., 40 (3), pp 136-151 (July 1978) 12 figs, 2 tables, 6 refs

Key Words: Soils, Dynamic response, Constitutive equations

The realistic stress-strain relation of cohesive soil is applied to analyze the dynamic response of layered cohesive soil system during shear wave propagation. The cohesive soil is treated as a saturated elastic-viscoplastic body. The characteristics method is used for this analysis, and the stress, strain and velocity under the ground are determined from the surface motion.

79-949
A Preliminary Survey of Seismic Velocities Through In-Situ Rock Salt
R.L. Thoms, R.I. Eidemiller, and R.K. Hilding
Louisiana State Univ., Baton Rouge, LA, ASME Paper No. 78-Pet-79

Key Words: Rocks, Seismic waves

Results are presented for a survey of seismic velocity through rock salt in-situ in a south Louisiana salt mine. Implications for cavern stability studies and further research are discussed.

79-950
Nonlinear Stiffness of Foundations
M. Jakub and J.M. Roesset
Constructed Facilities Div., Massachusetts Inst. of Tech., Cambridge, MA, Rept. No. MIT-CE-R77-35
57 pp (Sept 1977)
PB-286 653/1GA

Key Words: Foundations, Dynamic stiffness

The effects of nonlinear soil behavior on the dynamic stiffness of foundations are evaluated through a series of parametric studies. Approximate formulae for use in preliminary analyses are developed. A two-dimensional plane-strain model, corresponding to a strip footing resting on the surface of a layer of finite depth, and an equivalent linearization technique are used. The dynamic excitation of a machine foundation and a building subjected to seismic motion are investigated.

79-951
Random Response Analysis of a Non-Linear Soil-Suspension Bridge Pier
Y. Yamada, H. Takemiya, and K. Kawano
Dept. of Civil Engrg., Kyoto Univ., Kyoto, Japan,
Intl. J. Earthquake Engr. Struc. Dynam., 7 (1), pp 31-47 (Jan/Feb 1979) 10 figs, 36 refs

Key Words: Piers, Towers, Suspension bridges, Random response, Interaction: soil-structure, Linear theories, Modal analysis

The structure analyzed is a tower and pier system of long-span suspension bridge. The tower shaft is modeled to allow classical normal modes decomposition in order to reduce higher modes. The pier is assumed to be rigid body free to translation as well as to rocking motion, being reacted by the surrounding soil compliance that is derived from a continuum mechanics approach. Linear and non-linear soil and structural dynamic interaction is dealt with by random vibration theory with use of the linearization technique and complex modal analysis. Primary interest is placed on the investigation of the dynamic characteristics of the total interaction system and the rms response with change of the soil condition and input excitation level. Also discussed is the approximate response analysis, using classical normal modes for the interaction system, for purposes of practical design.

79-952
Vertical Soil Structure Interaction Effects
R.R. Little and D.D. Raftopoulos
Dept. of Mech. Engrg., Univ. of Toledo, Toledo, OH 43606,
Bull. Seismol. Soc. Amer., 69 (1), pp 221-236 (Feb 1979) 8 figs, 19 refs

Key Words: Interaction: soil-structure, Transformation techniques, Laplace transformation, Hankel transformation, Nuclear power plants, Seismic excitation

An analytical expression describing the three-dimensional vertical soil-structure interaction effects is developed using Laplace and Hankel transformation techniques. Utilizing these transformation techniques and normal mode theory of vibration, an N-mass structural model is coupled to an elastic half-space representing the earth. The resulting interaction equation is solved by numerical iteration techniques for a model of a nuclear power plant subjected to actual earthquake ground excitation. The effects of the soil-structure interaction are evaluated by comparing free-field acceleration spectrum response curves with similar curves determined from the foundation motion.

79-953
The Longitudinal Harmonic Excitation of a Circular Bar Embedded in an Elastic Half-Space
G.F. Fowler and G.B. Sinclair
California Inst. of Tech., Pasadena, CA 91125,
Intl. J. Solids Struc., 14 (12), pp 999-1012 (1978) 6 figs, 11 refs

Key Words: Bars, Elastic properties, Half-space, Harmonic excitation, Mathematical models, Energy dissipation, Interaction: soil-structure, Seismic excitation

This investigation is concerned with the dynamic response of a circular elastic bar of finite length partially embedded in a half-space of distinct elastic properties. The bar is perpendicular to the free surface of the embedding medium and supports a mass which is harmonically excited in the direction of the bar's longitudinal axis. Two bonding conditions are considered: fully bonded wherein the bar completely adheres to the embedding medium throughout the surface of contact, and loosely bonded wherein the bar is secured through its terminal cross section alone.

EXPERIMENTATION

DIAGNOSTICS

(Also see No. 1031)

79-954

Evaluation of Aircraft Equipment Monitoring Devices, Procedures and Techniques

J.E. Marsh

Cobro Corp., Silver Spring, MD, Rept. No. TR-11-3, USARTL-TR-78-31, 110 pp (July 1978)
AD-A059 846/6GA

Key Words: Diagnostic instrumentation, Diagnostic techniques, Helicopters

This report presents the results of a study of current diagnostic techniques and procedures used at the aviation unit maintenance level for Army helicopters. A projection is provided to show the potential improvement which could be attained in reliability, availability, and direct support costs for selected helicopter components through improved diagnostic methods. The validity of current diagnostic monitoring devices, techniques and procedures is presented. A relationship of primary fault indicators to the degree of aircraft damage or loss of mission effectiveness is also presented.

79-955

Analysis of Roller/Ball Bearing Vibrations

S. Braun and B. Datner

Technion-Israel Inst. of Tech., Haifa, Israel, J. Mech. Des., Trans. ASME, 101 (1), pp 118-125 (Jan 1979)
15 figs, 1 table, 17 refs

Key Words: Diagnostic techniques, Roller bearings, Ball bearings

A vibration based diagnostic method aimed at detecting localized defects developing in roller/ball bearings is described. The signature is decomposed into generalized periodic functions and a search strategy for the various components developed and implemented.

79-956

Ambient Vibration Monitoring for Assessing the Structural Health of Production Platforms

A.E. Stevenson and S. Rubin

The Aerospace Corp., El Segundo, CA, ASME Paper No. 78-Pet-71

Key Words: Off-shore structures, Diagnostic techniques, Vibration measurement

This paper reports a study on the capability provided by monitoring the vibration induced by the typical ambient environment to infer overall structural health. The basis for the assessment is the inferred frequencies and shapes of the lower modes of vibration. The study includes the acquisition of data on an eight-leg steel platform using accelerometers located above sea level. Vertical and angular accelerations are measured.

79-957

Noise Analysis for Early Failure Detection in Fixed Installation Turbomachines as a Problem of Pattern Recognition

D. Barschdorff, W. Hensle, and B. Stuehlen

Royal Aircraft Establishment, Farnborough, UK, RAE Lib. Transl. 1984; BR64848 (1978) (Engl. transl. from Tech. Messen, 44 (5) (1977))
N79-12444

Key Words: Turbomachinery, Diagnostic techniques

Condition monitoring of turbomachines is maintained by observing mechanical and thermodynamic parameters. The adapted methods of pattern recognition are able to supply additional information on machine performance and to support preventive failure detection. Some new methods of adapted techniques of measurement and signal analysis are discussed. The application on turbines in power plants is investigated.

79-958

Incipient Failure Detection

R.J. Drago

Power Transm. Des., 21 (2), pp 40-45 (Feb 1979)
13 figs

Key Words: Diagnostic techniques, High frequency resonance technique, Rotating structures

Incipient Failure Detection (IFD), a new technique for detecting the presence and monitoring the progression of faults in rotating machinery, is discussed. IFD uses inexpensive sensors and does not require custom baseline data. Its operation is explained and some typical test results are presented.

79-959
Listen to Structural Differences
L.W. Kessler and D.E. Yuhas
Sonoscan, Inc., Indus. Res., 20 (4), pp 101-106 (Apr 1978) 5 figs, 3 refs

Key Words: Diagnostic instrumentation, Acoustic measuring instruments

The value of acoustic microscopy, using the Scanning Laser Acoustic Microscope (SLAM), for flaw detection in materials is demonstrated. Three unclassified examples of the analysis of ceramics are selected.

79-960
Low-Speed Dynamics Diagnose Large-Diameter Cooling-Fan Failures
J. Sylvester
Power, 123 (2), pp 71-73 (Feb 1979) 5 figs, 4 refs

Key Words: Fans, Cooling towers, Dynamic balancing, Diagnostic techniques

The importance of careful consideration of cooling-tower-fan dynamic characteristics during selection, along with a regular maintenance program including dynamic balancing, is discussed.

EQUIPMENT

(See No. 1097)

INSTRUMENTATION

79-961
Automatic Resonant-Bar Apparatus for Plotting of Internal Friction Against Strain Amplitude
G. Bergamasco, L. Passari, and G. Zini
Istituto di Fisica, Universita di Ferrara, Via Paradiso 12, 44100 Ferrara, Italy, J. Phys. E. (Sci. Instr.), 11 (12), pp 1159-1161 (Dec 1978) 4 figs, 9 refs

Key Words: Measuring instruments, Resonant bar technique, Internal friction

An automatic apparatus for plotting internal friction and sample resonant frequency as functions of strain amplitude is described.

79-962
Effective Application of Various Types of Test Force Signals for the Investigation of the Dynamic Behaviour of Mechanical Systems
K.A. Ramsey
VDI-Z., 120 (19), pp 873-880 (1978) 10 figs, 1 table

Key Words: Frequency analyzers, Fourier analysis, Mechanical systems

A brief introduction into the mathematical description of the dynamic behavior of mechanical systems is given. The various methods for the measurement of the transfer functions by means of the fourier analyzer are discussed.

79-963
Instrumentation for Measuring the Dynamic Pressure on Rotating Compressor Blades. Final Report
H.P. Grant and G.A. Lanati
Commercial Products Div., Pratt & Whitney Aircraft, East Hartford, CT, Rept. No. NASA-CR-159466, 182 pp (Sept 1978)
N79-12418

Key Words: Measuring instruments, Vibration measurement, Compressor blades

To establish the capability for measurement of oscillatory pressure on rotating blades, miniature fast response semiconductor strain gage pressure transducers (2mm x 0.33 mm) are mounted in several configurations on thin titanium and steel compressor blades and subjected to pressure cycles from 1 to 310 kPa during static tests and spin tests.

79-964

Calibration of Instrumentation for Vibration and Damping Tests

H.N. Phelps, Jr. and M.F. Borg

Navy Underwater Sound Lab., New London, CT, Rept. No. USL-TM-933-236-63, 8 pp

AD-A060 278/9GA

Key Words: Electronic instrumentation, Calibrating, Measuring instruments, Vibration tests, Vibration damping, Test facilities

A High Frequency Vibration Laboratory was established for conducting vibration and damping tests pertinent to the design and development of sonar domes. Electronic equipment necessary for the studies has been installed. This memorandum discusses the calibration of the electronic equipment that will be used in conducting vibration and damping tests of plates, materials and dome structures.

79-965

Composite Transducer for Longitudinal Strain Modulation

J. Wosik, K. Nesteruk, W. Zbieranowski, and A. Sienkiewicz

Inst. of Physics, Polish Academy of Sciences, Warsaw, Poland, J. Phys. E. (Sci. Instr.), 11 (12), pp 1200-1202 (Dec 1978) 6 figs, 7 refs

Key Words: Transducers, Measuring instruments

A longitudinal strain modulation system, consisting of a composite transducer, amplitude transformer and a resonator with the sample under investigation is designed for use in ESR and optical spectroscopy. The method of strain calibration is described. Some applications of such a modulator are mentioned.

79-966

Report on the Acoustic Transmission and Vibration Damping Characteristics of Materials for Use on Acoustic Windows of Sonar Domes

Naval Appl. Science Lab., Brooklyn, NY, Rept. No. NASL-IED-11-TM-1, 17 pp

AD-A060 190/6GA

Key Words: Sonar transducers, Vibration damping, Material damping

This paper discusses one of the methods currently used to reduce the vibrations in the AN/SQS-23 sonar dome: to fill its lower section, below the acoustic 'window' with approximately 5-6 inches of Ottawa sand and to blanket this sand with foamed-in-place, high density polyurethane foam. This water penetration, coupled with movement of the sand, resulted in both corrosion and erosion degradation of the dome and decreased damping efficiency.

79-967

Investigation of Korfund Damping Materials for Sonar Dome Windows

H.N. Phelps, Jr.

Navy Underwater Sound Lab., New London, CT, Rept. No. USL-TM-2133-257-69, 24 pp

AD-A060 198/9GA

Key Words: Sonar equipment, Vibration damping, Material damping

This technical memorandum presents the progress made in investigating certain vibration damping materials manufactured by the Korfund Dynamics Corporation, Westbury, Long Island, New York. The purpose of the investigation is to find an acoustically-transparent damping material for windows of sonar domes in general, and for the AN/SQS-26 steel sonar dome in particular.

79-968

Results of Acceleration Measurements Made on a Modified AN/SQS-26 Sonar Dome Section

H.N. Phelps, Jr. and P.E. Seaman

Navy Underwater Sound Lab., New London, CT, Rept. No. USL-TM-933-11-66, 15 pp

AD-A060 241/7GA

Key Words: Sonar transducers, Vibration reduction

This memorandum presents the results of USL measurements taken on an AN/SQS-26 sonar dome section to determine if a particular modification reduces vibrations when the dome section is excited by sonar transmissions. The purpose of the experiment is to determine how an additional reinforcement in one panel of the dome section would affect the reverberant build-up of waves experienced by the dome window.

79-969

Longitudinal Circumferential Vibrations of Magnetostrictive Rings

S.L. Ehrlich and H. Sussman

Navy Underwater Sound Lab., New London, CT, Rept. No. USL-141, 13 pp

AD-A060 243/3GA

Key Words: Sonar transducers, Vibration excitation, Rings, Magnetic properties

An experimental investigation of the longitudinal circumferential vibrations of magnetostrictive rings is the subject of this report. Two methods of exciting several orders of these modes of vibration by means of magnetostriction are described. Sensitivity curves and radiation patterns of experimental transducers operating in these modes are presented.

79-970

Computer Graphics and the Finite Element Method as Applied to Sonar Transducer Analysis

L.E. McCleary, J.T. Hunt, R.R. Smith, D. Barach, and H.N. Christiansen

Naval Undersea Center, San Diego, CA, Rept. No. NUC-TN-1055, 6 pp

AD-A060 283/9GA

Key Words: Sonar transducers, Finite element technique, Data display

In order to understand the vibratory characteristics of electromechanical sonar transducers, two sophisticated techniques, the finite element method and state-of-the-art computer graphics, have been successfully combined. This process has demonstrated the normal mode behavior of a Navy sonar transducer. This paper briefly describes the actual transducer being analyzed as well as the method used, gives results for the first three constant voltage drive resonant frequencies, and shows how computer graphics plays a key role in any such endeavor.

79-971

Damping Characteristics of Panels Treated by Acushnet Process Company

H.N. Phelps, Jr.

Navy Underwater Sound Lab., New London, CT, Rept. No. USL-TM-933-178-64, 8 pp

AD-A060 279/7GA

Key Words: Sonar equipment, Vibration dampers, Polyurethane resins, Testing technique, Experimental data

This technical memorandum presents the results of vibration damping tests that were made on five panels on which three different polyurethanes were sprayed by the Acushnet Process Company, New Bedford, Massachusetts.

79-972

Damping Characteristics of Three Untreated Steel Plates

H.N. Phelps, Jr.

Navy Underwater Sound Lab., New London, CT, Rept. No. USL-TM-933-54-64, 17 pp

AD-A060 277/1GA

Key Words: Sonar equipment, Electronic instrumentation, Measuring instruments, Vibration damping, Plates, Steel

This memorandum presents the damping characteristics of three untreated steel plates that will be used as references for damping evaluations to be made on treated panels of the same size.

SCALING AND MODELING

79-973

Preliminary Empirical Model for Scaling Fourier Amplitude Spectra of Strong Ground Acceleration in Terms of Modified Mercalli Intensity and Recording Site Conditions

M.D. Trifunac

Dept. of Civil Engrg., Univ. of Southern California, Intl. J. Earthquake Engr. Struc. Dynam., 7 (1), pp 63-74 (Jan/Feb 1979) 9 figs, 13 refs

Key Words: Scaling, Seismic excitation, Ground motion

This paper presents an empirical model for scaling Fourier amplitude spectra of ground acceleration during strong earthquake shaking in terms of the reported Modified Mercalli Intensity (MMI) and the simplified characteristics of the geologic environment at the recording station.

TECHNIQUES

(Also see Nos. 1071, 1097)

79-974

A Fourier Transform Approach to the Measurement of the Elastic Constants and Internal Friction of Small Specimens

J.M. Anderson and P. Tollin

Dept. of Physics, The University, Dundee DD1 4HN, UK, J. Phys. E. (Sci. Instr.), 11 (12), pp 1157-1158 (Dec 1978) 4 figs, 1 ref

Key Words: Measurement techniques, Elastic properties, Internal friction, Fourier transformation

A method is described which uses the data gathered in measuring the elastic constants and internal friction of small samples undergoing free decay. A Fourier transform approach is employed which first determines accurately the period and starting phase of the free decay and checks the purity of the signal. This information is then used along with the original data to determine the internal friction of the sample.

79-975

Simple Measurements of Sound Level of Noise Sources

O.J. Pedersen

The Acoustics Lab., Technical Univ. of Denmark, DK-2800, Lyngby, Denmark, 9th Intl. Cong. on Acoustics, Madrid, pp 1-12 (July 1977), Sociedad Espanola de Acustica - 9 I.C.A. C/Serrano, 144-Madrid 6, Spain, 4 figs, 4 tables, 10 refs

Key Words: Machinery noise, Noise measurement, Measurement techniques

The interest in providing and obtaining exact information of noise emitted by machines and appliances ranging from huge earth moving machines to tiny fan heaters for use in the household is developed. Exchange of such information and establishing and enforcing limits for noise require the existence of unified measurement methods.

COMPONENTS

SHAFTS

79-976

Asymptotic Stability of a Viscoelastic Elliptic Shaft

H.L. Arora

Dept. of Mathematics, College of Science, Mosul Univ., Mosul-Iraq, J. Franklin Inst., 307 (1), pp 31-38 (Jan 1979) 2 figs, 5 refs

Key Words: Shafts, Viscoelastic properties, Stability, Geometric effects

A finite viscoelastic shaft whose model is based on the spring and dash-pot (Kelvin element) is asymptotically stable as long as its angular speed is less than or equal to the square root of the least eigenvalue of the system. The least eigenvalue is constructed numerically by using an iteration method where a definite integral is evaluated by the GAUSQZ method.

79-977

Flexible Shafts Take on More Jobs

Product Engr. (NY), 50 (1), pp 57-59 (Jan 1979) 7 figs

Key Words: Shafts (machine elements), Design techniques

The characteristics, couplings, and fittings, as well as applications of a flexible shaft are described.

79-978

Effects of Shaft Misalignment on Machinery Vibration

R. Hagler, H. Schwerdlin, and R. Eshleman

Lovejoy, Inc., Downers Grove, IL, Des. News., 35 (2), pp 38-41 (Jan 22, 1979) 10 figs

Key Words: Shafts (machine elements), Alignment, Machinery vibration, Flexible couplings

The trade-off between the shaft misalignment and vibration when flexible couplings are present in a shafting system is investigated.

BEAMS, STRINGS, RODS, BARS

(Also see No. 1005)

79-979

Improved Method of Free Vibration Analysis of Frame Structures

M.I. Basci, T.G. Toridis, and K. Khozeimeh
School of Engrg. and Appl. Sciences, The George Washington Univ., Washington, D.C. 20052, Computers Struc., 10 (1-2), pp 255-265 (Apr 1979) 2 figs, 8 tables, 13 refs

Key Words: Natural frequencies, Mode shapes, Frames, Beams, Finite element technique

The objective of this paper is to develop more accurate procedures in the generation of consistent 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 obtained from the solution of the differential equations governing the free vibration behavior of structural components. Two types of elements are considered: straight beam and curved (circular arc) beam elements, both of which have a uniform cross section. A computer program is developed for the free vibration analysis of frame type structures. Results are obtained for various type of structures, including free-free, clamped-free (cantilever) and continuous beams, and simple portal frames.

79-980

A Numerical Procedure for the Dynamic Plastic Response of Beams with Rotatory Inertia and Transverse Shear Effects

J. Gomes de Oliveira and N. Jones
Dept. of Ocean Engrg., Massachusetts Inst. of Tech., Cambridge, MA, Rept. No. 78-2, 64 pp (Aug 1978) AD-A060 302/7GA

Key Words: Beams, Dynamic plasticity, Rotatory inertia effects, Transverse shear deformation effects, Numerical analysis

A numerical procedure is used to examine the influence of transverse shear forces in the yield criterion and rotatory inertia on the dynamic plastic response of beams. Various results are presented for a long beam impacted by a mass and a simply supported beam loaded impulsively, both of which are made from a rigid perfectly plastic material with yielding controlled by the Ilyushin-Shapiro yield criterion.

79-981

Large Viscoplastic Deflections of Impulsively Loaded Plane Frames

P.S. Symonds and C.T. Chon
Div. of Engrg., Brown Univ., Providence, RI 02912, Intl. J. Solids Struc., 15 (1), pp 15-34 (1979) 11 figs, 17 refs

Key Words: Frames, Beams, Viscoplastic properties, Mode approximation technique, Deflection bound technique

Applications are described of two estimation techniques to obtain final deflections and response times of plane rectangular frames subjected to impulsive loading on the transverse (beam) member. Deflections up to roughly one third the span (thirty thicknesses) are estimated by the mode approximation and deflection bounds techniques, treating the plastic rate dependence by means of homogeneous viscous constitutive equations. Comparisons are made with recent test results, and the degree of agreement is discussed in terms of the known error sources of the two techniques.

79-982

Dynamic Stability of Elastic Mechanisms

M. Badlani and W. Kleinhenz
Basic Technology, Inc., Pittsburgh, PA, J. Mech. Des., Trans. ASME, 101 (1), pp 149-153 (Jan 1979) 1 fig, 14 refs

Key Words: Beams, Dynamic stability, Timoshenko theory, Bernoulli-Euler method, Rotatory inertia effects, Transverse shear deformation effects

A study of the dynamic stability of a slider-crank mechanism with an undamped elastic connecting rod is presented using the Euler-Bernoulli and Timoshenko beam theories.

79-983

Vibrations of Curved Bars Perpendicular to Their Planes

K. Suzuki, H. Aida, and S. Takahashi
Faculty of Engrg., Yamagata Univ., Yonezawa, Japan, Bull. JSME, 21 (162), pp 1685-1695 (Dec 1978) 15 figs, 3 tables, 4 refs

Key Words: Curved bars

Out-of-plane vibrations of curved bars with uniform cross section are described. Two general methods for solving the problems are presented: one is to use a variable, of which the relation to arc length represents the curvature and the other is to use the curvature expressed by arc length. As numerical examples, the frequencies and the mode shapes are shown in graphs for symmetric arc bars with clamped ends having the center lines in the form of ellipses, sines, catenaries, hyperbolas, parabolas and cycloids.

79-984

Effect of a Small Tip Mass on the Vibrations of a Rapidly Rotating Flexible Rod

W.D. Lakin
Dept. of Mathematics, Univ. of Toronto, Toronto, Canada M5S 1A1, Quart. J. Mech. Appl. Math., 31 (4), pp 497-506 (Nov 1978) 6 refs

Key Words: Rods, Rotating structures, Boundary value problems

A boundary-value problem associated with the vibrations of a rapidly rotating flexible rod with a small tip mass at its free end is considered. The governing fourth-order differential equation involves two small parameters and has a turning point close to one of the endpoints. Uniformly valid approximations are used to derive a consistent approximation to the eigenvalue relation.

79-985

On a Variational Principle for the Clamped-Free Rod Subjected to Tangential Follower Forces

H.H.E. Leipholz
Dept. of Civil Engrg., Solid Mechanics Div., Univ. of Waterloo, Waterloo, Ontario, Canada N2L 3G1, Mech. Res. Comm., 5 (6), pp 335-339 (1978) 4 figs, 4 refs

Key Words: Rods, Follower forces

In a previous paper, a variational principle for Beck's rod using the concept of generalized self-adjointness together with the convolution property was derived. In this paper, a similar technique is applied.

79-986

Vibrations of a String with Time-Variable Length

T. Yamamoto, K. Yasuda, and M. Kato
Nagoya Univ., Chikusa-ku, Nagoya, Japan, Bull. JSME, 21 (162), pp 1677-1684 (Dec 1978) 8 figs, 3 refs

Key Words: Strings, Time-dependent parameters, Free vibration, Forced vibration

Free and forced vibrations of a string with time-variable length are treated theoretically under the assumption that the variation rate of the length is small. The solutions are obtained in the form of a power series of a small parameter which prescribes the variation rate of the length. An experimental analysis is performed for the forced vibration. The comparison of the results of the theoretical analysis with those of the experimental analysis shows a fairly good agreement.

79-987

Finite Element Study of the Free Vibration of 3-D Cable Networks

M.L. Gambhir and B.DeV. Batchelor
Thapar Engrg. College, Patiala, Punjab, India, Intl. J. Solids Struc., 15 (2), pp 127-136 (1979) 8 figs, 1 table, 15 refs

Key Words: Cables, Finite element technique, Natural frequencies, Normal modes

This paper briefly describes a finite element model previously developed for studying the free vibration characteristics of a single sagged cable hanging freely from two supports. This element, which allows elastic deformations, is used to determine the natural frequencies and normal modes of vibration of 3-D cable networks. A parametric study is made to predict the influence of various parameters, such as rise/span ratio of cables, initial pretension, cable rigidity, linear dimensions and surface curvature, on the natural frequencies and normal modes of vibration of 3-D cable nets. The results for various configurations are presented in the form of non-dimensional plots.

BEARINGS

(Also see No. 955)

79-988

Technology Transfer in the Determination of Torque Characteristics of Instrument Ball Bearings at High Speeds with Radial and Axial Loads

H.H. Mabie

Virginia Polytechnic Inst. and State Univ., Blacksburg, VA 24061, J. Mech. Des., Trans. ASME, 101 (1), pp 126-132 (Jan 1979) 20 figs, 1 table, 9 refs

Key Words: Ball bearings, Torsional response

Torque-speed curves are presented for ball bearings with various combinations of radial and axial loads with oil and with grease lubrication.

BLADES

(Also see Nos. 963, 1056, 1072)

79-989

Wind Tunnel Tests of a Blade Subjected to Midchord Torsional Oscillation at High Subsonic Stall Flutter *Conditions*

D.R. Boldman and A.E. Buggele

NASA Lewis Res. Center, Cleveland, OH, Rept. No. NASA-TM-78998; E-9782, 33 pp (Oct 1978) N79-12016

Key Words: Blades, Torsional vibration, Flutter, Wind tunnel tests

A mechanical drive system for oscillating blades in a wind tunnel at frequencies up to 767 Hz and amplitudes of + or - 1.2 deg is described.

79-990

Effect of Structural Parameters on the Flap-Lag Response of a Rotor Blade in Forward Flight

D.A. Peters and D.P. Schrage

Dept. of Mech. Engrg., Washington Univ., St. Louis, MO, Rept. No. ARO-14585.1-E, 107 pp (July 1978) AD-A060 331/6GA

Key Words: Helicopter rotors, Rotor blades, Eigenvalue problems, Modal analysis

A study is made of the effect of structural coupling on the vibrations of rigid, centrally hinged rotor blades. In order to determine the *stability* and *vibrations simultaneously*, a new analytical method, based on eigenvalue and modal decoupling, is developed to solve for the eigenvalues and forced response of systems of equations with periodic coefficients. This method is then applied to the linearized equations of motion for rotor flap-lag in forward flight. This analysis retains the nonlinear terms as added forcing functions.

79-991

Local Momentum Theory and Its Application to the Rotary Wing

A. Azuma and K. Kawachi

Univ. of Tokyo, Tokyo, Japan, J. Aircraft, 16 (1), pp 6-14 (Jan 1979) 15 figs, 18 refs

Key Words: Helicopter rotors, Rotor blades (rotary wings), Aerodynamic loads

A new momentum theory, named the local momentum theory, is developed and applied to study rotary wing aerodynamics. The theory is based on the instantaneous momentum balance of the fluid with the blade elemental lift at a local station in the rotor rotational plane. A rotor blade is considered to be decomposed into a series of wings, each of which has an *elliptical circulation distribution. The elliptical* wings are so arranged that a tip of each wing is aligned to the blade tip. Applying the proposed theory to both steady and unsteady aerodynamic problems leads to results with less computational time than that required in the vortex theory.

COLUMNS

79-992

Harmonic Non-Linear Response of Beck's Column to a Lateral Excitation

M.R.M.C. Da Silva

Dept. of Engrg. Science, Univ. of Cincinnati, Cincinnati, OH 45221, Intl. J. Solids Struc., 14 (12), pp 987-997 (1978) 7 figs, 31 refs

Key Words: Columns (supports), Follower forces, Periodic excitation

The non-linear response of a column with a follower force (Beck's column) subjected to a distributed periodic lateral excitation, or to a support excitation, is determined. An analytical solution for the response amplitude in terms of the loading and system parameters is obtained by a perturbation analysis of the differential equations of motion. Non-linear inertia and non-linear curvature terms are taken into account in the formulation of the differential equations.

79-993
Lower Bounds to Fundamental Frequencies and Buckling Loads of Columns and Plates
P. Shih and H.L. Schreyer
Civil Engrg. Res. Facility, Univ. of New Mexico, Albuquerque, NM 87131, Intl. J. Solids Struc., 14 (12), pp 1013-1026 (1978) 3 figs, 3 tables, 29 refs

Key Words: Columns (supports), Plates, Fundamental frequencies, Buckling, Boundary value problems

A general derivation of expressions for lower bounds to fundamental frequencies and buckling loads is given for the class of structures governed by linear elastic theory in the prebuckling state. These expressions involve two Rayleigh quotients both of which are upper bounds for the fundamental frequency under a prescribed load. The finite element procedure can be used to systematically narrow the difference between the upper and lower bounds. The theory is illustrated with several column and plate problems. The finite element method is applied to uniform and nonuniform columns with a representative set of boundary conditions.

79-994
Influence of an Elastic End Support on the Stability of Viscoelastic (Voigt) Column
V.P. Madan
Dept. of Appl. Math., Red Deer College, Red Deer, Alberta, Canada, Mecanique Apliquee, 23 (6), pp 847-852 (Nov/Dec 1978) 4 refs

Key Words: Columns (supports), Viscoelastic properties, Elastic foundations, Follower forces

The influence of an elastic end support on the vibration and stability of a nonconservatively loaded (follower force) viscoelastic Voigt column is examined by deriving equations for the lateral deflection and frequency. The results for corresponding elastic and viscoelastic columns with and without end supports are deduced.

CONTROLS

79-995
Radial Forces in a Misaligned Radial Face Seal
I. Etsion
Dept. of Mech. Engrg., Technion-Israel Inst. of Tech., Haifa, Israel, J. Lubric. Tech., Trans. ASME, 101 (1), pp 81-85 (Jan 1979) 5 figs, 10 refs

Key Words: Seals (stoppers), Alignment

Radial forces on the primary seal ring of a flat misaligned seal are analyzed, taking into account the radial variation in seal clearance. An analytical solution for both hydrostatic and hydrodynamic effects is presented that covers the whole range from zero to full angular misalignment. The net radial force on the primary seal ring is directed to produce a radial eccentricity which generates inward pumping.

79-996
Stability of a Hydraulic Circuit with a Counter-Balance Valve
S. Miyakawa
Ebara Corp., Central Research Lab. 4720, Fujisawa, Fujisawa-shi, Kanagawa-ken Japan, Bull. JSME, 21 (162), pp 1750-1756 (Dec 1978) 15 figs, 8 refs

Key Words: Hydraulic valves, Valves, Self-excited vibrations

The stability of a hydraulic circuit is studied in the most fundamental circuit consisting of a hydraulic motor and a counter-balance valve. By using linearized equations of the system, the effects of the flow rate of the hydraulic pump, spring constant and taper angle of the spool valve, and cylindrical choke in the pilot line on the stability of the system and the characteristics of self-excited vibration are clarified. Fundamental data for preventing unstable phenomena are obtained.

CYLINDERS
(See No. 941)

DUCTS

79-997
Nonlinear Propagation of a Wave Packet in a Two-Dimensional Lined Duct
M.S. Tsai
Boeing Commercial Airplane Co., Seattle, WA, AIAA J., 17 (2), pp 129-130 (Feb 1979) 4 figs, 5 refs

Key Words: Ducts, Acoustic linings, Wave propagation, Wave attenuation

The method of multiple scales is used to analyze the nonlinear effects of the gas motion and the acoustic lining material on the propagation and attenuation of a wave packet in a two-dimensional lined duct of a uniform cross section. The partial differential equations describing the space and time variations of amplitude and phase are obtained.

79-998
Duct Wall Impedance Control as an Advanced Concept for Acoustic Suppression Enhancement
P.D. Dean
Lockheed-Georgia Co., Marietta, GA, Rept. No. NASA-CR-159425, 115 pp (Oct 1978)
N79-10842

Key Words: Ducts, Acoustic linings

A systems concept procedure is described for the optimization of acoustic duct liner design for both uniform and multisegment types. The concept is implemented by the use of a double reverberant chamber flow duct facility coupled with sophisticated computer control and acoustic analysis systems. The optimization procedure for liner insertion loss is based on the concept of variable liner impedance produced by bias air flow through a multilayer, resonant cavity liner. A multiple microphone technique for in situ wall impedance measurements is used and successfully adapted to produce automated measurements for all liner configurations tested.

79-999
Production and Propagation of Sound in a Duct
J.J. Keller
Brown Boveri Res. Center, CH-5405 Baden, Switzerland, J. Acoust. Soc. Amer., 65 (1), pp 25-31 (Jan 1979) 9 refs

Key Words: Ducts, Sound propagation

The problem of sound propagation in a duct is investigated. Several results for isentropic duct flow are extended to the case where entropy convection is included. For this more general case, a concept is developed to guide the solution of wave-propagation problems in an optimal manner. The stability of waves behind a shock wave is considered.

FRAMES, ARCHES

(Also see No. 979)

79-1000
Experiments on Dynamic Plastic Loading of Frames
S.R. Bodner and P.S. Symonds
Div. of Engrg., Brown Univ., Providence, RI 02912, Intl. J. Solids Struc., 15 (1), pp 1-13 (1979) 18 figs, 2 tables, 11 refs

Key Words: Frames, Dynamic plasticity

Tests are described on plane frames of mild steel and titanium (commercial purity) in which high intensity short duration pressure pulses are applied transversely to the beam member either uniformly over this member or concentrated at its center. The objective is to examine applications of two estimation techniques (upper bounds on deflections and the mode approximation technique) for major response features of pulse loaded structures at large deflections, taking account of strong plastic strain rate sensitivity.

LINKAGES

79-1001
A Computationally Efficient Numerical Algorithm for the Transient Response of High-Speed Elastic Linkages
A. Midha, A.G. Erdman, and D.A. Frohrib
Dept. of Mech. Engrg., The Pennsylvania State Univ., University Park, PA 16802, J. Mech. Des., Trans. ASME, 101 (1), pp 138-148 (Jan 1979) 10 figs, 2 tables, 14 refs

Key Words: Linkages, Computerized simulation, Transient response

A new numerical algorithm, easily adaptable for computer simulation, is developed to approximate the transient response of a single degree-of-freedom vibrating system; governing differential equation is linear and second order with time-dependent and periodic coefficients. The classical linear single degree-of-freedom problem with constant coefficients is solved. The system is excited by a periodic forcing function possessing a certain degree of smoothness. The integration terms in the solution are systematically expanded into two groups of terms: one consists of non-integral terms while the other contains only integral terms. The final integral terms are bounded.

79-1002

A Closed-Form Numerical Algorithm for the Periodic Response of High-Speed Elastic Linkages

A. Midha, A.G. Erdman, and D.A. Frohrib

Dept. of Mech. Engrg., The Pennsylvania State Univ., University Park, PA 16802, J. Mech. Des., Trans. ASME, 101 (1), pp 154-162 (Jan 1979) 9 figs, 12 refs

Key Words: Linkages, Computerized simulation, Periodic response

A numerical closed-form algorithm, easily adaptable for computer simulation, is developed to solve for the periodic solutions of vibrating systems, and in particular, the high-speed elastic linkage. The algorithm is introduced to solve the single degree-of-freedom mass-dashpot-spring system, the governing differential equation of which is a linear, second-order equation with constant coefficients. This algorithm is utilized as a basic tool and extended to solve a single degree-of-freedom mass-dashpot-spring system whose governing differential equation of motion is a linear, second-order equation with time-dependent and periodic coefficients. The system is excited by a periodic forcing function and solution is made possible by discretizing the forcing time period into a number of time intervals.

79-1003

The Elastic-Dynamic Behavior of a Counterweighted Rocker Link with an Overhanging Endmass in a Four-Bar Linkage. Part I: Theory

W.G. Jandrasits and G.G. Lowen

Westinghouse Electric Corp., Bettis Atomic Power Lab., West Mifflin, PA, J. Mech. Des., Trans. ASME, 101 (1), pp 77-88 (Jan 1979) 5 figs, 34 refs

Key Words: Linkages, Elastic analysis, Free vibration, Floquet theory

The theoretical part of an investigation of the elastic-dynamic behavior of a counterweighted four-bar linkage rocker link, which in addition carries an overhanging mass, is given. The linearized equations of motion are derived by way of Hamilton's integral, a novel elastic mechanism constraint equation, and the method of Kantorovich. The normal modes of the free vibration of the complex link provide the space portions of the solution, while the time portions are furnished by the resulting Hill's equations. Floquet theory is adapted for stability considerations and a method for obtaining steady-state solutions is given. Part II applies the solution techniques to a specific mechanism and reports on confirming experimentation.

79-1004

The Elastic-Dynamic Behavior of a Counterweighted Rocker Link with an Overhanging Endmass in a Four-Bar Linkage. Part II: Application and Experiment

W.G. Jandrasits and G.G. Lowen

Westinghouse Electric Corp., Bettis Atomic Power Lab., West Mifflin, PA, J. Mech. Des., Trans. ASME, 101 (1), pp 89-98 (Jan 1979) 15 figs, 4 refs

Key Words: Linkages, Elastic analysis, Free vibration

This paper presents Part II of a two-part investigation dealing with the damped elastic behavior of the counterweighted rocker link of a four-bar linkage which also carries an overhanging mass. The analytical techniques developed in Part I are applied to an example mechanism and the results are compared to those of an associated experiment. Three mode solutions of decoupled Hill's equations furnish a stability analysis as well as steady state solutions for strain responses at off- and on-resonance locations over a range of speeds from 100 to 200 rpm. In general, good qualitative as well as quantitative agreement between analytical and experimental results was found.

79-1005

Finite Element Approach to Mathematical Modeling of High-Speed Elastic Linkages

A. Midha, A.G. Erdman, and D.A. Frohrib

Dept. of Mech. Engrg., The Pennsylvania State Univ., University Park, PA 16802, Mech. Mach. Theory, 13 (6), pp 603-618 (1978) 6 figs, 19 refs

Key Words: Linkages, Finite element technique, Mathematical models, Beams

A general approach is described for deriving the equations of motion of planar linkages in high-speed machinery. Well-known displacement finite element method is used to develop the mass and stiffness properties of an elastic linkage. To demonstrate the various steps in the analysis, a 4-bar linkage is utilized; however the method is readily extendible to other planar multi-loop linkages. Starting with a typical elastic planar beam element, the nodal displacement and acceleration expressions are derived including the terms coupling the elastic and rigid-body motions. The linkage is modeled as beam elements and its equations of motion are stated in matrix form. Methods are described for systematic assembly of all elements. Conventional forms of structural damping are reviewed and appended to this paper for inclusion in the equations of motion. This paper also includes assumptions made in order to simplify the analyses here as well as facilitate numerical solutions.

79-1006

Study of Force Effects on Selected Materials Used in Cargo to Vehicle Restraint Systems for Rail Transport. Volume 2. Laboratory Dynamic Tests on Wood-Nail Assemblies

E. Jackson and J. Kenna

Military Traffic Management Command Transportation Engrg. Agency, Newport News, VA, Rept. No. MTMC-TR-73-14-2, 346 pp (Apr 1978)

AD-A059 331/9GA

Key Words: Fasteners, Dynamic tests, Cargo transportation, Rail transportation

This report presents the results from laboratory tests that simulated field dynamic conditions of forces on wood-nail assemblies. Between April 1973 and May 1977, 336 laboratory test specimens, three samples per specimen, were tested on a modified conbur type inclined ramp.

79-1007

Study of Force Effects on Selected Materials Used in Cargo to Vehicle Restraint Systems for Rail Transport. Volume 3. Rail Impact Tests on Wood-Nail Assemblies

E. Jackson and J. Kenna

Military Traffic Management Command Transportation Engrg. Agency, Newport News, VA, Rept. No. MTMC-TR-73-14-3, 49 pp (Jan 1978)

AD-A059 332/7GA

Key Words: Fasteners, Dynamic tests, Cargo transportation, Rail transportation

This report is Volume 3 of six volumes that document a series of tests that were conducted by the US Army Materiel Development and Readiness Command (DARCOM) Ammunition Center and the Military Traffic Management Command (MTMC) Transportation Engineering Agency (TEA). The tests were performed in order to develop a technological base for selecting various materials to be used in cargo to vehicle restraint systems. This report presents results of rail impact tests that were performed on thirteen wood-nail combinations of full-scale blocking. These tests were conducted between July and October 1977, inclusive, to determine if the laboratory data could be applied to full-scale blocking and bracing design.

79-1008

Study of Force Effects on Selected Materials Used in Cargo to Vehicle Restraint Systems for Rail Transport. Volume 4. Study of the Effects of Nail Coating

E. Jackson and J. Kenna

Military Traffic Management Command Transportation Engrg. Agency, Newport News, VA, Rept. No. MTMC-TR-73-14-4, 41 pp (May 1977)

AD-A059 333/5GA

Key Words: Fasteners, Dynamic tests, Cargo transportation, Rail transportation

A number of laboratory tests were conducted in the past four years to establish physical criteria for and characteristics of cargo restraint systems. This report presents results of further tests, which seek to explain some of the results of the previous laboratory tests.

79-1009

Study of Force Effects on Selected Materials Used in Cargo to Vehicle Restraint Systems for Rail Transport. Volume 5. Effectiveness of Wheel Chocks in the Chain Restraint System on DODX 80 Ton Flatcar

E. Jackson and J. Kenna

Military Traffic Management Command Transportation Engrg. Agency, Newport News, VA, Rept. No. MTMC-TR-73-14-5, 37 pp (Nov 1977)

AD-A059 334/3GA

Key Words: Cargo restraint systems, Chains, Impact tests, Cargo transportation, Rail transportation

This report presents results of tests that were conducted during September 1977 to measure the effectiveness of wheel chocks when a vehicle is secured to a flatcar equipped with a chain restraint system.

79-1010

Study of Force Effects on Selected Materials Used in Cargo to Vehicle Restraint Systems for Rail Transport. Volume 6. Effectiveness of Wheel Chocks in a Restraint System Using 3/8-Inch, 1/2-Inch, or 5/8-Inch Wire Rope

E. Jackson and J. Kenna

Military Traffic Management Command Transportation Engrg. Agency, Newport News, VA, Rept. No. MTMC-TR-73-14-6, 66 pp (Feb 1978)

AD-A059 335/0GA

Key Words: Wire, Cables (ropes), Impact tests, Cargo transportation, Rail transportation

This report presents results of tests that were conducted during October and November 1977 to measure the effectiveness of wheel chocks when a wire rope restraint system is used to secure a vehicle to a flatcar.

MECHANICAL

79-1011

A New Interpretation for the Dynamic Phenomena Associated with Geneva Mechanisms

M. Taat and D. Tesar

College of Engrg., Iran College of Science and Tech., Tehran, Iran, J. Mech. Des., Trans. ASME, 101 (1), pp 63-76 (Jan 1979) 40 figs, 6 tables, 13 refs

Key Words: Mechanisms, Dynamic properties

The classification of the dynamic characteristics of the Geneva Mechanism (an intermittent motion mechanism) is established in this paper to make feasible, meaningful comparisons with all other available mechanisms for the same task. The coupling in series of two Genevas or another mechanism and a Geneva is considered and recommendations are made in terms of several dynamic criteria. A large collection of reference charts and a tabulation of numerical classification data are provided.

PIPES AND TUBES

(Also see No. 925)

79-1012

The Effect of Internal-Flow on the Dynamic Responses of a Cantilever Pipe

R.B. Shilling, III and Y.K. Lou

Atlantic Richfield Co., College Station, TX, ASME Paper No. 78-Pet-57

Key Words: Pipes (tubes), Cantilever beams, Heat exchangers, Fluid-filled containers, Fluid-induced excitation

An experimental study is conducted to investigate the effects of internal flow rate and the depth of immersion on the dynamic response of a cantilever pipe discharging a fluid.

79-1013

Dynamic Characteristics of an Underwater Pipeline

A.R. Desai

Dow Engrg. & Construction Services, Houston, TX, ASME Paper No. 78-Pet-50

Key Words: Pipelines, Underwater pipelines, Random excitation

This study represents an effort to put the pragmatic design practices on a firmer scientific footing. The experimental study represents a novel approach with wide band random excitation being applied to the pipe model through inertial coupling. This represents an improvement over the conventional harmonic excitation applied at reduced Reynolds numbers.

PLATES AND SHELLS

(Also see Nos. 911, 993)

79-1014

Static and Dynamic Analysis of Kirchhoff Shells Based on a Mixed Finite Element Formulation

D. Talaslidis and W. Wunderlich

Ruhr-Universität Bochum, Institut f. konstruktiven Ingenieurbau, Lehrstuhl IV, D-4630 Bochum, West Germany, Computers Struc., 10 (1-2), pp 239-249 (Apr 1979) 8 figs, 3 tables, 22 refs

Key Words: Shells of revolution, Finite element technique

Mixed curved shell elements are presented for the static and free vibration analysis of arbitrary Kirchhoff shells. Following derivation of the appropriate generalized linear element matrix and the consistent mass matrix, the properties of mixed models when applied to static and dynamic analysis of Kirchhoff shells are discussed. An outline of solution algorithms which take the special properties of generalized variational principles into consideration is given. Several numerical plate and shell examples demonstrate the applicability of the method.

79-1015

Condensation for Mixed Dynamic FE Analysis of Rotational Shells

P.L. Gould

Dept. of Civil Engrg., School of Engrg. & Appl. Science, Washington Univ., St. Louis, MO 63130, Computers Struc., 10 (1-2), pp 251-253 (Apr 1979) 2 figs, 9 refs

Key Words: Shells of revolution, Finite element technique, Dynamic structural analysis

Mixed method finite elements are characterized by a set of explicit nodal variables which are composed of both stress and displacement terms. It is shown that for the mixed method formulation, the overall condensation may be decomposed into kinematic and static components thereby separating the approximate and exact operations and maintaining the parallel with the static procedure.

79-1016

Dynamic Behaviour of Thin Cylindrical Shells Subjected to Transient Inner Pressures – Effects of Shearing Force and Rotatory Inertia

S. Suzuki

Dept. of Aeronautics, Nagoya Univ., Chikusa-ku, Nagoya 464, Japan, Nucl. Engr. Des., 51 (3), pp 423-429 (Feb 1979) 4 figs, 11 refs

Key Words: Cylindrical shells, Internal pressure, Transverse shear deformation effects, Rotatory inertia effects

Stress analysis is carried out for a horizontal thin cylindrical shell subjected to transient inner hydraulic pressures resulting from closure of a terminal valve and the effects of shearing force and rotatory inertia to the maximum values of dynamic hoop stresses are investigated. The relationship between hydraulic pressure and time is obtained and the fundamental equation of motion of a cylinder is analyzed, using Laplace transformation method.

79-1017

Flexural Vibrations of Rotating Electromagnetic Shields

G.J. Shevchuk and P. Thullen

Bell Labs., Holmdel, NJ, J. Mech. Des., Trans. ASME, 101 (1), pp 133-137 (Jan 1979) 7 figs, 6 refs

Key Words: Flexural vibration, Electromagnetic shielding, Cylindrical shells

A simple theoretical analysis of the effects of rotation on the vibrations of long cylinders is presented. These effects are verified over a significant speed range by two experiments as well as data from tests on the experimental alternator. Results are related to the design of electromagnetic shields for superconducting alternators.

79-1018

Thermally Induced Vibration of Circular Plate

T. Irie and G. Yamada

Faculty of Engrg., Hokkaido Univ., Sapporo, Japan, Bull. JSME, 21 (162), pp 1703-1709 (Dec 1978) 6 figs, 9 refs

Key Words: Circular plates, Thermal excitation

The thermally induced vibration of a circular plate and an annular plate are investigated. The plate is subjected to a sinusoidally varying heat flux on one surface, while the other surface is thermally insulated. The temperature distribution due to the heat input is analyzed by the Fourier heat conduction equation. The thermal moment due to the temperature is calculated and the stationary deflection and stresses of the plate induced by the thermal moment are analyzed theoretically.

79-1019

Nonlinear Vibrations of Tapered Circular Plates Elastically Restrained Against Rotation at the Edges

K.K. Raju and G.V. Rao

Structural Engrg. Div., Vikram Sarabhai Space Centre, Trivandrum-69500, India, Nucl. Engr. Des., 51 (3), pp 417-421 (Feb 1979) 6 tables, 9 refs

Key Words: Circular plates, Nonlinear response, Finite element technique

Large amplitude free vibration characteristics of tapered circular plates elastically restrained against rotation is studied in this paper using the finite element method. Linear frequency parameter and ratios of nonlinear to linear periods are obtained for various values of rotational spring parameter and taper parameter and are presented in the form of tables.

79-1020

On the Axially Symmetric Vibration of Thick Circular Plates

Z. Celep

Faculty of Engrg. and Architecture, Technical Univ., Istanbul, Turkey, Ing. Arch., 47 (6), pp 411-420 (1978) 5 figs, 14 refs

Key Words: Circular plates, Method of initial functions, Natural frequencies

The method of initial functions is developed in cylindrical coordinates for axially symmetric elastodynamic deformation of the circular plate. The governing equations are derived from the three dimensional elastodynamic equations. Using a suitable transformation the difficulty in the application of the method of initial functions is removed. The method is used to obtain the free vibration frequencies of thick circular plates. Numerical results are given for the circular plate with clamped edges and compared with those of the known solutions.

79-1021

An Asymptotic Theory for Vibrating Plates

F.I. Niordson

Dept. of Solid Mechanics, The Technical Univ. of Denmark, Lyngby, Denmark, Intl. J. Solids Struc., 15 (2), pp 167-181 (1979) 2 figs, 5 refs

Key Words: Plates, Flexural vibration, Harmonic response

The two-dimensional equations of motion for a vibrating plate are derived by means of an asymptotic expansion of the three-dimensional elastic state. The assumptions involved are of mathematical character only and concern the continuity, differentiability and convergence of the series used. The three-dimensional problem is reduced to a two-dimensional eigenvalue problem consisting of a linear fourth order partial differential equation for the deflection of the middle-surface and a proper set of boundary conditions. The solution of this problem is discussed and the frequency of stationary plane waves in an infinite plate is computed as an example. The result is compared with the exact solution.

79-1022

Free Vibration of Clamped Polygonal Plates

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

Faculty of Engrg., Hokkaido Univ., Sapporo, Japan, Bull. JSME, 21 (162), pp 1696-1702 (Dec 1978) 3 figs, 7 tables, 9 refs

Key Words: Plates, Free vibration

An analytical method to study free vibration of polygonal plates clamped at the edges is presented. The force and moment distributed along the edges are expanded into a Fourier sine series with unknown coefficients, and homogeneous linear equations are derived with use of restraint conditions at the edges. The natural frequencies and the mode shapes of the polygonal plate are determined by calculating the eigenvalues and eigenvectors of the equations.

79-1023

The Horizontal Plate Filter as a Torsional Vibration System with Vibration Absorption

R. Habeck

Technische Universität, München, Germany, J. Mech. Des., Trans. ASME, 101 (1), pp 163-168 (Jan 1979) 11 figs, 6 refs

Key Words: Plates, Torsional vibration, Vibration absorption (equipment)

Filter cake is removed from the plates of a horizontal plate filter by means of torsional vibrations of the plates. For good vibration isolation from the surrounding objects the application of a new vibration absorber technique is suggested for the vibrational design of the apparatus. The design includes the consideration of damping forces between cake and plates. The theoretical results are confirmed by experiments with a simplified model.

79-1024

Impulsive Loading of Fibre-Reinforced Rigid-Plastic Plates

A.J.M. Spencer

Dept. of Theoretical Mechanics, Univ. of Nottingham, UK, Intl. J. Engr. Sci., 17 (1), pp 35-47 (1979) 3 figs, 7 refs

Key Words: Plates, Fiber composites, Reinforced plates

A theory for the dynamic deformations of ideal fibre-reinforced rigid-plastic plates is formulated. This theory is applied to the problems of loading of circular and rectangular plates by uniformly distributed impulsive loads. The resulting permanent deflections are compared with the corresponding deflections which are predicted by the theory for unreinforced plates.

79-1025

Three-Dimensional Finite Strip Analysis of Elastic Solids

M.S. Cheung

NASA Langley Res. Center, Hampton, VA, In: NASA Langley Res. Ctr. Res. in Computerized Structural Analysis and Syn., pp 153-164 (Oct 1978)

N79-10460

Key Words: Finite strip method, Free vibration, Plates

Finite element shape functions are combined with beam eigenfunctions to formulate three-dimensional finite strips. Because of the orthogonality of the beam functions, three-dimensional problems are reduced to a series of two-dimensional problems, often with stiffness matrices of very narrow bandwidth. Isoparametric and high order finite element shape functions are used in the formulation of the 3-D finite strips. Numerical examples such as the static and free vibration analyses of simply supported thick plates are presented. Results are compared with existing solutions and good agreement is obtained in all cases.

STRUCTURAL

79-1026

A Note on Fracture and Deformation in Cubical Box Structures Due to Impulsive Loading

A.G. Mamalis and S.R. Reid

Dept. of Engrg., Univ. of Cambridge, Cambridge CB2 IPZ, UK, Intl. J. Mech. Sci., 21 (1), pp 53-61 (1979) 7 figs, 1 table, 16 refs

Key Words: Structural members, Impact response (mechanical), Fracture properties

The purpose of the investigation is to examine and contrast the patterns of fracture and deformation of cubical box-like structures open on one side, when impulsively loaded. Part 1: Brittle cubical boxes of plaster of Paris, open on one side, are subjected to intense impulsive point loading. The resulting terminal fracture patterns are shown and discussed. Part 2: A small number of thin metal boxes are point loaded by the impact of a heavy slow moving mass. The resulting plastic deformation patterns are described and discussed. In the Appendix, energy absorption due to bending is estimated and related to the results of Part 2.

79-1027

Importance of Reinforcement Details in Earthquake-Resistant Structural Walls

A.E. Fiorato and R.G. Oesterle

Construction Tech. Labs., Portland Cement Assn., Skokie, IL, Rept. No. NSF/RA-770626, 28 pp (July 1977)

PB-287 351/1GA

Key Words: Walls, Reinforced concrete, Earthquake resistant structures

Examples of detailing practices related to design and construction of reinforced concrete structural walls are discussed. Areas covered are confinement reinforcement in vertical boundary elements, and anchorage of horizontal wall reinforcement. The functions of confinement reinforcement are illustrated using results from laboratory tests of structural walls. The four primary functions discussed are the increase in limiting strain capacity of concrete, the support of vertical reinforcement against inelastic buckling, the containment of concrete, and the improvement of shear capacity and stiffness. Recommendations for details of hoop and supplementary cross-tie reinforcement are made. Details for proper anchorage of horizontal wall shear reinforcement are suggested. Several areas of needed research are outlined.

79-1028

Structural Walls in Earthquake-Resistant Buildings. Dynamic Analysis of Isolated Structural Walls - Representative Loading History

A.T. Derecho, M. Iqbal, S.K. Ghosh, M. Fintel, and W.G. Corley
Construction Technology Labs., Portland Cement Assn., Skokie, IL, Rept. No. NSF/RA-780255, 139 pp (Aug 1978)
PB-287 323/0GA

Key Words: Walls, Earthquake resistant structures, Experimental data

An analytical investigation attempts to estimate the maximum forces and deformations that can reasonably be expected in critical regions of structural walls subjected to strong ground motion. This document deals with the qualitative description of 'a representative loading history' which can be used in testing isolated structural wall specimens under slowly reversing loads. One hundred and seventy rotational response histories, representing a broad range of parameter values, are examined. The representative loading history is described in terms of the magnitude of the largest rotational deformation that can reasonably be expected in the hinging region of isolated walls, the total number of cycles of such large-amplitude deformations, and the sequence in which these large-amplitude deformations occur relative to deformations of lesser amplitude. Also considered are the forces (moments and shears) that can accompany these deformations.

79-1029
Blast Capacity Evaluation of Glass Windows and Aluminum Window Frames
S. Weissman, N. Dobbs, W. Stea, and P. Price
Ammann and Whitney, NY, Rept. No. ARLCD-CR-78016, 104 pp (June 1978)
AD-A060 027/9GA

Key Words: Windows, Blast resistant structures, Experimental data

A series of static and dynamic tests are performed to evaluate the blast-resistant capacity of tempered and regular glass windows and aluminum window frames used in buildings at Army ammunition plants. Design criteria developed based in the test results are presented and recommendations are made for testing of thinner glass windows.

79-1030
Non-Linear Analysis of Coupled Wall Systems
T. Takayanagi and W.C. Schnobrich
Taisei Corp., Tokyo, Japan, Intl. J. Earthquake Engr. Struc. Dynam., 7 (1), pp 1-22 (Jan/Feb 1979) 16 figs, 6 refs

Key Words: Walls, Beams, Structural members, Multistory buildings, Mathematical models, Seismic excitation

The nonlinear response history and failure mechanism of coupled wall systems under dynamic loads and static loads are investigated through an analytical model. The walls and coupling beams are replaced by flexural elements. Axial and shear stiffnesses are included for the wall members. The stiffness characteristics of each member are determined by inelastic properties. The suitable hysteresis loops to each constituent member are established to include the specific characteristics of coupled wall systems. The computed results are compared with results obtained from tests using model structures statically and dynamically tested on the Illinois Earthquake Simulator.

TIRES

(Also see No. 1093)

79-1031
Passenger Vehicle Tire Inspection Equipment Development. Volume 1: Summary Report
J.E. Johnson, S.B. Hugg, E.C. Schroeder, and R.E. Thomas
Southwest Research Inst., San Antonio, TX, Rept. No. DOT-HS-803 578, 25 pp (Mar 1978)
PB-287 143/2GA

Key Words: Tires, Diagnostic techniques, Nondestructive tests

Nondestructive tire testing techniques are developed and the resultant technology enhancement is incorporated into a prototype machine capable of performing on-vehicle tests of passenger vehicle tires with respect to three parameters: carcass integrity, inflation pressure, and tread depth.

SYSTEMS

ABSORBER
(Also see No. 1055)

79-1032
Energy Absorber
N.S. Phillips and W.B. Walcott
Dept. of the Navy, Washington, D.C., Rept. No. AD-D005 226/6, 19 pp (Apr 25, 1978)
PAT-APPL-899 956/GA

Key Words: Energy absorption, Crash research (aircraft), Shock absorbers

This patent application is on a notched-energy absorber for attenuating high level accelerations such as would occur during aircraft crashes, thereby avoiding injury to a user. The energy absorber force-displacement curve has a large initial spike, followed by a valley or 'notch' and then by a constant force level intermediate the spike and valley levels.

NOISE REDUCTION

79-1033
Traffic Noise Attenuation by a Masonry Subdivision Perimeter Fence
R.G. Thurman
Arizona Dept. of Transportation, Phoenix, AZ, S/V, Sound Vib., 12 (12), pp 16-18 (Dec 1978) 1 fig, 4 refs

Key Words: Traffic noise, Noise barriers, Masonry, Noise reduction

This article sets forth a simple practical procedure for measuring the effective attenuation attributable to an existing barrier in the field. Sound level measurements are made for a masonry subdivision perimeter fence along an arterial street in Phoenix, Arizona. The field data is analyzed for comparison with predicted barrier attenuation values, giving consideration to real-world sound transmission effects.

AIRCRAFT
(Also see Nos. 923, 924, 1099)

79-1034
Load and Dynamic Assessment of B-52B-008 Carrier Aircraft for Finned Configuration 1 Space Shuttle Solid Rocket Booster Decelerator Subsystem Drop Test Vehicle. Volume 1: Summary
D.A. Quade
Boeing Co., Wichita, KS, Rept. No. NASA-CR-150-833, 68 pp (June 9, 1978)
N79-10048

Key Words: Aircraft, Drop tests (impact tests), Flutter, Space shuttles

The B-52B airplane is identified for use in solid rocket booster (RSB) parachute drop flight testing. The purpose of this study is to determine by theoretical analysis methods the compatability and structural capability of B-52B drop test vehicle configuration (with fins) to accomplish the drop test mission. This document consists of four volumes. This volume presents a summary of airplane flutter and load strength evaluation analysis results and a comparative study of the pylon loading resulting from drop test vehicle inertia and aerodynamic considerations.

79-1035
Load and Dynamic Assessment of B-52B-008 Carrier Aircraft for Finned Configuration 1 Space Shuttle Solid Rocket Booster Decelerator Subsystem Drop Test Vehicle. Volume 2: Airplane Flutter and Load Analysis Results
D.A. Quade
Boeing Co., Wichita, KS, Rept. No. NASA-CR-150-834, 72 pp (June 9, 1978)
N79-10049

Key Words: Aircraft, Drop tests (impact tests), Flutter, Space shuttles

The airplane flutter and maneuver-gust load analysis results obtained during B-52B drop test vehicle configuration (with fins) evaluation are presented. These data are presented as supplementary data to that given in Volume 1 of this document. A brief mathematical description of airspeed notation and gust load factor criteria are provided as a help to the user. References are defined which provide mathematical description of the airplane flutter and load analysis techniques.

79-1036

Load and Dynamic Assessment of B-52B-008 Carrier Aircraft for Finned Configuration 1 Space Shuttle Solid Rocket Booster Decelerator Subsystem Drop Test Vehicle. Volume 3: Pylon Load Data Method 1

D.A. Quade

Boeing Co., Wichita, KS, Rept. No. NASA-CR-150-835, 135 pp (June 9, 1978)

N79-10050

Key Words: Aircraft, Drop tests (impact tests), Flutter, Space shuttles

The pylon loading at the drop test vehicle and wing interface attach points is presented. The loads shown are determined using a stiffness method, which assumes the side stiffness of the foreward hook guide to be one-fourth of the fore and aft stiffness of each drag pin. For a comparison of these loads to previous X-15 analysis design loadings, see Volume 1 of this document.

79-1037

Load and Dynamic Assessment of B-52B-008 Carrier Aircraft for Finned Configuration 1 Space Shuttle Solid Rocket Booster Deceleration Subsystem Drop Test Vehicle. Volume 4: Pylon Load Data

D.A. Quade

Boeing Co., Wichita, KS, Rept. No. NASA-CR-150-836, 135 pp (June 9, 1978)

N79-10051

Key Words: Aircraft, Drop tests (impact tests), Flutter, Space shuttles

The pylon loading at the drop test vehicle and wing interface attack points is presented. The loads shown are determined using a stiffness method, which assumes the side stiffness of the forward hook guide and the fore and aft stiffness of each drag pin to be equal. For a comparison of these loads to previous X-15 analysis design loadings, see Volume 1 of this document.

79-1038

Dynamic Response of Aircraft to Unloaded and Loaded Pavement Profiles

W.H. Highter and M.R. Snyder

Detachment 1 (ADTC), Civil and Environmental Engrg. Development Office, Tyndall AFB, FL, Rept. No. CEEDO-TR-77-42, 63 pp (Aug 1978)

AD-A059 787/2GA

Key Words: Aircraft, Taxiing effects, Pavement roughness, Computer programs

The objective of this study is to determine whether or not there exists a significant difference in the simulated dynamic response of an F-4C aircraft traversing either an unloaded (undeflected) or loaded (deflected) pavement profile. The Air Force computer code, TAXI, was adapted for use on the Clarkson College IBM 360 Model 65 computer from the CDC 6600 computer used by the Air Force Civil Engineering Center. The TAXI code calculates the vertical accelerations at three points on an aircraft traverses a pavement profile.

79-1039

Ride Technology Applications to Large Passenger Aircraft

S.H. Brumaghm and J.R. McKenzie

Boeing Co., Wichita, KS, Passenger Vibration in Transportation Vehicles, Presented at the Des. Engr. Tech. Conf., Sept 1977, AMD - Vol. 24, A. Berman and A.J. Hannibal, eds., ASME, 1977, 11 figs, 18 refs

Key Words: Aircraft, Vibration control, Human response

The needs for appropriate passenger aircraft ride technology are: what are the best means for designing acceptable passenger ride and what are the criteria for satisfactory passenger ride. This paper presents the status of aircraft ride technology in terms of these twofold needs and cites current weaknesses for use in achieving a goal of cost effective passenger ride.

BRIDGES

(Also see No. 951)

79-1040

Dynamic Distribution of Lift on Suspension Bridges

R. Sofronie

Inst. of Civil Engrg., Bucharest, Mecanique Appliquee, 23 (6), pp 925-938 (Nov/Dec 1978) 10 figs, 10 refs

Key Words: Suspension bridges, Wind-induced excitation, Fluid-induced excitation

The paper presents a method for comparing different structural systems of suspension bridges according to their dynamic loading by wind. In this analysis the wind is assumed to be an incompressible horizontal fluid in steady state flow, while the suspension bridges are assumed to be rigid lifting surfaces, elastically clamped at ends and submitted to an initial torsional motion of arbitrary but small amplitudes. The ratio of the aerodynamic lift of these elastic bridges to that of the same bridges assumed to be rigidly clamped is defined as dynamic loading factor. It represents a function of the wind dynamic pressure and differs for each structural system of suspension bridges.

79-1041

A Method of Computing Railway Bridge Impact

C.L. Dhar

Ph.D. Thesis, Illinois Inst. of Tech., 71 pp (1978)
UM 7902993

Key Words: Bridges, Railroad trains, Moving loads, Interaction: vehicle-structure

It is the purpose of this study to improve the present impact formula and to provide a rational basis for it. A method has been proposed to analyze the dynamic response of a girder or a truss bridge during the passage of one or a series of railway vehicles.

BUILDING

(Also see No. 1059)

79-1042

Optimum Deisgn of Plane Tall Steel Structures for Simultaneous Multicomponent Static, Dynamic and Seismic Inputs

D. Srifuengfung

Ph.D. Thesis, Univ. of Missouri-Rolla, 287 pp (1978)
UM 7904336

Key Words: Structural design, Optimum design, Multistory buildings, Steel, Seismic excitation, Computer programs

This report presents the optimum design for various plane steel structures subjected to the multicomponent input of static loads, dynamic forces, and seismic excitations for the purpose of: examining the effect of the interaction of ground motions on their relative stiffness requirements, overall stiffness distribution at critical regions, and on the entire system; selecting suitable structural systems for certain types of loads; and providing member properties for detailed design. The structural systems that are studied are trusses, unbraced, single-braced, double-braced, and K-braced frameworks in which the constituent members are bar elements for bracings and truss-members and beam-column elements for columns and girders.

79-1043

Earthquake-Simulation Tests of a Ten-Story Reinforced Concrete Frame with a Discontinued First-Level Beam

J.P. Moehle and M.A. Sozen

Dept. of Civil Engrg., Illinois Univ. at Urbana-Champaign, IL, Rept. No. STRUCTURAL RESEARCH SER-451, 174 pp (Aug 1978)
PB-287 807/2GA

Key Words: Multistory buildings, Reinforced concrete, Model testing, Seismic response, Experimental data

A small-scale, ten-story, reinforced concrete frame structure with relatively flexible lower stories is subjected successively to simulated earthquakes of increasing intensity on the University of Illinois Earthquake Simulator. The test structure comprised two frames situated opposite one another with strong axes parallel to a horizontal base motion and with story-masses spanning between. The frames had relatively 'tall' first and last stories and a discontinued first floor-level, exterior-span beam. Earthquake simulation tests were complemented by free-vibration tests and steady-state sinusoidal tests at a series of frequencies bounding the fundamental frequency. This report documents the experimental work, presents data (including time-response histories), and discusses the observed dynamic response in relation to stiffness, strength, and energy-dissipative capacity.

ELECTRICAL

79-1044

Apply Large High-Speed Synchronous Motors. Part I

H.E. Albright

Fluor Engineers & Constructors, Inc., Houston, TX, Hydrocarbon Processing, 58 (1), pp 181-186 (Jan 1979) 6 figs, 19 refs

Key Words: Machinery vibration, Torsional vibration, Motors

More HPI plants are turning to larger synchronous motors to drive machinery. Motor design, starting considerations and torsional vibrations are discussed.

representing seismic excitation, the values of the masses, natural frequencies, and distance between foundations are varied in the investigation.

FOUNDATIONS AND EARTH

79-1045

Response of Embedded Foundations to Travelling Waves

J. Dominguez and J.M. Roesset

Dept. of Civil Engrg., Massachusetts Inst. of Tech., Cambridge, MA, Rept. No. MIT-CE-R78-24, 300 pp (Aug 1978)

PB-287 130/9GA

Key Words: Foundations, Seismic excitation

The motion of a rigid massless square foundation under various types of seismic waves is studied. Surface foundations are investigated using the Boundary Element Method and a comparison is made with other published results. Embedded foundations subjected to vertically travelling shear waves are studied and the results are compared to circular foundations. Finally the case of embedded foundations under a combination of SV and P waves that will produce a free-field motion compatible with the Newmark-Blume-Kapur spectra is investigated.

79-1046

Dynamic Interaction Between Adjacent Structures

J.J. Gonzalez and J.M. Roesset

Constructed Facilities Div., Massachusetts Inst. of Tech., Cambridge, MA, Rept. No. MIT-CE-R77-30, 45 pp (Sept 1977)

PB-287 079/8GA

Key Words: Interaction: soil-structure, Finite element technique, Foundations, Seismic excitation

A finite element formulation for the solution of a three-dimensional soil-structure interaction problem is developed, based upon the use of the consistent lateral boundary. The method is applied to the determination of the dynamic stiffness of a square foundation and the results are compared to an equivalent circular footing to check the validity. The underlying soil interaction between two rigid masses is then investigated for the case of a harmonic force applied at the base of one mass, and for the case of a base motion

79-1047

Dynamic Stiffness of Rectangular Foundations

J. Dominguez and J.M. Roesset

Dept. of Civil Engrg., Massachusetts Inst. of Tech., Cambridge, MA, Rept. No. MIT-CE-R78-20, 64 pp (Aug 1978)

PB-287 131/7GA

Key Words: Foundations, Dynamic stiffness, Stiffness coefficients

The Boundary Element Method is used to determine the dynamic stiffnesses of rectangular foundations resting upon or embedded within an elastic half-space. The effects of mesh size and relaxed versus nonrelaxed boundary conditions are investigated for square surface foundations. The static stiffnesses and the frequency dependent stiffness coefficients are then obtained as a function of the aspect ratio for rectangular foundations. Solutions for embedded foundations are obtained and results showing the effects of the embedment ratio are presented.

79-1048

The Consequences of Partially Grouted Joints Upon the Arch Dam Seismic Behaviour

R. Priscu, A. Popovici, and C. Stere

Civil Engrg. Inst. of Bucharest, Mecanique Appliquee, 23 (5), pp 779-788 (Sept/Oct 1978) 8 figs, 1 table, 9 refs

Key Words: Dams, Joints, Seismic response, Finite element technique

In this paper, a numerical study of the seismic behavior of a large arch dam in Romania is carried out, through the finite element method, following the hypotheses of a monolithic-continuous structure and of different dam joints grouting schemes. Some remarks related to the seismic behavior of this large dam during the recent Vrancea earthquake of March 4, 1977 are also included.

79-1049
Cyclic Loading Behavior of Masonry Piers
S.J. Chen
Ph.D. Thesis, Univ. of California, Berkeley, 236 pp (1978)
UM 7904405

Key Words: Piers, Masonry, Seismic excitation

The objective of the masonry single-pier research program conducted at Berkeley is to investigate the hysteretic characteristics of masonry piers under earthquake-like excitation. Specifically, hysteretic characteristics such as structural stiffness, ultimate strength, ductility ratio as well as energy absorption and energy dissipation capacity are of primary interest in the study. Conclusions are drawn from data analysis of the hysteretic characteristics of comparable specimen groups. Analytical models are formulated to determine the theoretical stiffness and strength properties at various key stages. These properties are used to determine the hysteretic envelope and mode of failure.

HELICOPTERS

(Also see Nos. 954, 991, 1058, 1064)

79-1050
Rating Helicopter Noise
J.W. Leverton, B.J. Southwood, and A.C. Pike
Westland Helicopters Ltd., Yeovil, UK, In: NASA Langley Res. Ctr., Helicopter Acoustics, Pt. 2, pp 419-438 (Aug 1978)
N79-10845

Key Words: Helicopter noise, Noise measurement

The effectiveness of the EPNL procedure in quantifying helicopter blade slap and tail rotor noise heard on approach some distance from the flyover position is addressed. Alternative methods of rating helicopter noise are reviewed including correction procedures to the EPNL concept which account for blade slap and tail rotor noise. The impact of the use of such corrections is examined.

79-1051
Subjective Evaluation of Helicopter Blade Slap Noise
W.J. Galloway
Bolt Beranek and Newman, Inc., Cambridge, MA, In: NASA Langley Res. Ctr., Helicopter Acoustics, Pt. 2, pp 403-418 (Aug 1978)
N79-10844

Key Words: Helicopter noise, Helicopter rotors

Several methods for adjusting EPNL to account for its underestimate of judged annoyance are applied to eight helicopter flyover noise signatures having various degrees of blade slap. A proposal for an impulsive noise correlation procedure based on a digital analysis of the flyover signal is investigated.

79-1052
The Effect of Operations on the Ground Noise Footprints Associated with a Large Multi-Bladed, Nonbanging Helicopter
D.A. Hilton, H.R. Henderson, D.J. Maglieri, and W.B. Bigler
NASA Langley Res. Center, Hampton, VA, In: NASA Langley Res. Ctr., Helicopter Acoustics, Pt. 2, pp 519-533 (Aug 1978)
N79-10851

Key Words: Helicopter noise, Noise measurement

In order to expand the data base of helicopter external noise characteristics, a flyover noise measurement program was conducted utilizing the NASA Civil Helicopter Research Aircraft. The remotely operated multiple array acoustics range (ROMAAR) and a 2560-m linear microphone array are utilized for the purpose of documenting the noise characteristics of the test helicopter during flyby and landing operations. By utilizing both ROMAAR concept and the linear array, the data necessary to plot the ground noise footprints and noise radiation patterns are obtained. Examples of the measured noise signature of the test helicopter, the ground noise footprint or contours, and the directivity patterns measured during level flyby and landing operations of a large, multibladed, nonbanging helicopter, the CH-53, are presented.

79-1053
Theoretical Modeling of High-Speed Helicopter Impulsive Noise
F.H. Schmitz and Y.H. Yu
Aeromechanics Lab., U.S. Army Aviation R&D Command, Ames Res. Center, Moffett Field, CA, J. Amer.

Helicopter Soc., 24 (1), pp 10-19 (Jan 1979) 15 figs, 19 refs

Key Words: Helicopter noise, Noise source identification, Mathematical models

A simple theoretical model of high-speed helicopter impulsive noise, based on the Ffowcs Williams and Hawkings theoretical formulation, is developed. The model depends primarily on the large scale features of the rotor's aerodynamic flow field.

79-1054

Helicopter Acoustics. Part 2

NASA Langley Res. Center, Hampton, VA, Rept. No. NASA-CP-2052-Pt-2, L-12339-Pt-2, 438 pp (Aug 1978)

N79-10843

Key Words: Helicopter noise

Exterior and interior helicopter noise problems are addressed from the physics and engineering as well as the human factors point of view. Noise regulation concepts, human factors and criteria, rotor noise generation and control, design, operations and testing for noise control, helicopter noise prediction, and research tools and measurements are covered.

79-1055

Vibration in Helicopters

R. Gabel

Boeing Vertol Co., Philadelphia, PA, Passenger Vibration in Transportation Vehicles. Presented at the Des. Engr. Tech. Conf., Sept 1977, AMD - Vol. 24, A. Berman and A.J. Hannibal, eds., ASME 1977, 35 figs, 6 refs

Key Words: Helicopter vibration effects, Vibration control, Vibration isolation, Vibration absorption (equipment)

Low frequency vibration in helicopters is an annoyance to the passengers and crew. The primary disturbing vibration is at the frequency of the number of rotor blades times rotor speed or b/rev. This is generally in the range from 10 to 30 Hz. The elimination of these vibrations through the use of anti-vibration devices including isolation, pendulum absorbers, fixed and variable tune absorbers and airframe response detuning is discussed.

79-1056

A Calculation of Rotor Impedance for Hovering Articulated-Rotor Helicopters

K. Kato and T. Yamane

Univ. of Tokyo, Tokyo, Japan, J. Aircraft, 16 (1), pp 15-22 (Jan 1979) 10 figs, 1 table, 11 refs

Key Words: Helicopter rotors, Helicopters, Rotor-induced vibration, Rotor blades (rotary wings), Mechanical impedance

A procedure is presented to calculate the loads transferred from an articulated rotor to the fuselage when the rotor hub is forced to oscillate sinusoidally in hover. The blade is considered as a rotating elastic beam and the inertial load expressions are given for the case where the hub is in motion. Basis assumptions include: quasisteady aerodynamic loads; integration with strip theory; and neglect of the effects of preceding and returning wakes. Sample calculations reveal the manner in which the typical articulated rotor impedances are influenced by blade elastic deformations, inertial loads, aerodynamic loads, and hub frequencies.

79-1057

Comprehensive Helicopter Analysis: A State of the Art Review

W. Johnson

NASA Ames Res. Center, Moffett Field, CA, Rept. No. NASA-TM-78539; AVRADCOM-78-56(AM), 18 pp (Nov 1978)

N79-12019

Key Words: Helicopters, Design techniques, Computer-aided techniques

An assessment of the status of helicopter theory and analysis is presented. The technology level embodied in available design tools (computer programs) is examined, considering the problem areas of performance, loads and vibration, handling qualities and simulation, and aeroelastic stability. The effectiveness of the present analyses is discussed. The characteristics of the technology in the analyses are reviewed, including the aerodynamics technology, induced velocity and wake geometry, dynamics technology, and machine limitations.

HUMAN

(Also see Nos. 1039, 1091)

79-1058

Effects of Vibration and Noise on Some Indices of Efficiency of Mi-4 Helicopter Crews

Y.N. Kamenskiy and Y.A. Sokolova

Joint Publications Res. Service, Arlington, VA, In: its Space Biol. and Aerospace Med., 12 (5), pp 76-81 (Oct 26, 1978) (Engl. transl. from Kosm. Biol. i Aviakosm. Med. (Moscow), No. 5, pp 56-59 (1978) N79-10711

Key Words: Helicopter noise, Helicopter vibration effects, Human response

The majority of Mi-4 pilots assessed noise and vibration as strong and unpleasant during the flight. Many reported intensification of these factors during take-offs, landings and hovering. There was a feeling of fatigue, buzzing in the ears and occasional headache. In the course of the work day, there was an appreciable change in visual function of Mi-4 pilots, with impairment of muscoloarticular sensibility, and deterioration of conditioned reflex activity and capacity for fine coordination of movements.

79-1059

Human Response to Aircraft-Noise-Induced Building Vibration

J.M. Cawthorn, T.K. Dempsey, and R. DeLoach
NASA Langley Res. Center, Hampton, VA, In: NASA Langley Res. Ctr., Helicopter Acoustics, Pt. 2, pp 479-491 (Aug 1978)
N79-10848

Key Words: Buildings, Aircraft noise, Vibration response, Human response

The effects of noise induced building structure vibration and the rattle of objects on human response to aircraft flyover noise are investigated in a series of studies conducted in both the field and the laboratory. The subjective detection thresholds for vibration and rattle are determined as well as the effect of vibration and rattle upon aircraft noise annoyance.

79-1060

Exploratory Laboratory Studies of the Relative Aversiveness of Traffic Sounds

G.W. Cermak
Societal Analysis Dept., General Motors Res. Labs., Warren, MI 48090, J. Acoust. Soc. Amer., 65 (1), pp 112-123 (Jan 1979) 6 figs, 3 tables, 40 refs

Key Words: Traffic noise, Human response, Experimental data

Two experiments examined the acoustical correlates of traffic sound aversiveness. In experiment I, all pairs of 13 45-s traffic sound recordings are presented; subjects chose the sound of each pair to which they would rather be exposed and judged the relative similarity of the sounds. The energy equivalent sound level, L_{eq}, accounted for choice and similarity judgments better than any other noise index, and there is no substantial improvement in ability to account for subjective judgments when other indices are used in conjunction with L_{eq}. In experiment II, subjects judged the same sounds which had been made equal in L_{eq} level.

79-1061

Development of Noise and Vibration Ride Comfort Criteria

T.K. Dempsey, J.D. Leatherwood, and S.A. Clevenson
NASA Langley Res. Center, Hampton, VA 23665, J. Acoust. Soc. Amer., 65 (1), pp 124-132 (Jan 1979) 7 figs, 23 refs

Key Words: Traffic noise, Vehicles, Noise generation, Vibration excitation, Human response

A laboratory investigation was directed at the development of criteria for the prediction of ride quality in a noise-vibration environment. The stimuli for the study consisted of octave bands of noise centered at 500 and 2000 Hz and vertical floor vibrations composed of either 5 Hz sinusoidal vibration, or random vibrations centered at 5 Hz and with a 5 Hz bandwidth. Based on the experimental results, a model of subjective discomfort that accounted for the interdependence of noise and vibration was developed. The model was then used to develop a set of criteria (constant discomfort) curves that illustrate the basic design tradeoffs available between noise and vibration.

79-1062

Comparative Vibration Environments of Transportation Vehicles

D.G. Stephens
NASA Langley Res. Center, Hampton, VA, Passenger Vibration in Transportation Vehicles, Presented at the Des. Engr. Tech. Conf., Sept 1977, AMD-Vol 24, A. Berman and A.J. Hannibal, eds., ASME 1977, 9 figs, 1 table, 17 refs

Key Words: Transportation vehicles, Aircraft, Vibration generation, Human response

Measured vibration data are presented for a number of air and surface vehicles. Consideration is given to the importance of direction effects; of vehicle operating modes such as takeoff, cruise, and landing; and of measurement location on the level and frequency of the measurements. Various physical measurement units or descriptors are used to quantify and compare the data. The results form a data base useful in assessing the ride of existing or future systems relative to vehicles in current operation. Subjective response data obtained from vibration simulator studies are presented to illustrate human response characteristics as well as to indicate a laboratory approach for the development of ride-quality criteria.

79-1063

Rotational Acceleration Tolerance by Human Head (Zur Erträglichkeit von Rotationsbeschleunigungen des menschlichen Kopfes)

G. Rüter, H. Hontschik, and E. Müller

Pfingstbrunnenstrasse 38, 6231 Schwalbach, Automobiltech. Z., 81 (1), pp 25-27 (Jan 1979) 6 figs, 7 refs

(In German)

Key Words: Collision research (automotive), Head (anatomy), Seat belts, Anthropomorphic dummies

The significance of rotational acceleration of the head as a cause of injuries in impact accidents of belted car occupants is investigated by comparing published threshold levels with the results of sledge tests with dummies.

ISOLATION

(Also see No. 1055)

79-1064

Flight Evaluation of Helicopter Rotor Isolation System

R. Jones

Kaman Aerospace Corp., Bloomfield, CT, Passenger Vibration in Transportation Vehicles, Presented at the Des. Engr. Tech. Conf., Sept 1977, AMD-Vol 24, A. Berman and A.J. Hannibal, eds., ASME 1977, 14 figs

Key Words: Dynamic Antiresonant Vibration Isolators (DAVI), Helicopter rotors, Rotor-induced vibration

Analytical and experimental programs were conducted on the Dynamic Antiresonant Vibration Isolator (DAVI), an inertially coupled isolation device which permits a high degree of isolation at discrete low frequencies without sacrifice of elastic stiffness. The principles upon which the DAVI is based and laboratory test results are presented to show the independence of DAVI isolation from the weight of the isolated item. A summary of the analytical, shake test and full helicopter scale rotor isolation programs are discussed.

79-1065

Magnetic Suspension for Low-Speed Vehicles

P.K. Sinha

Dept. of Engrg. Science, Univ. of Warwick, Coventry, UK, J. Dyn. Syst., Meas. and Control, Trans. ASME, 100 (4), pp 333-342 (Dec 1978) 11 figs, 17 refs

Key Words: Suspension systems (vehicles), Electromagnetic properties

Several forms of novel suspension systems for passenger-carrying vehicles are currently being investigated. The possibility of using controlled direct-current electromagnets for low-speed (up to 70 kph) vehicle suspension is explored in this paper. This system, also known as ferromagnetic or attraction suspension system, offers a combination of design simplicity, low operating and maintenance costs, high reliability and virtually silent operation. This system is also considered to have capital costs comparable with alternative forms of urban-transport systems and could be designed to fit into the existing fabric of cities and towns. The feasibility of the d-c system is illustrated here through analytical and experimental results of the ride and track-clearance characteristics for a single degree of freedom suspension system. These results are used to formulate a procedure for designing a multimagnet vehicle suspension system. Main design and performance criteria for maglev vehicles are discussed in the context of experimental results obtained from test vehicles.

79-1066

An Improved Suspension System for a Wheel Rolling on a Flat Track

H.D. McGinness

NASA, Pasadena, CA, Rept. No. NASA-Case-NPO-14395-1; US-Patent-Appl-SN-961833, 25 pp (Nov 1978)

N79-12446

Key Words: Suspension systems (vehicles), Antennas

A suspension system is described which has particular utility as an azimuth bearing for large track-mounted antennas. The system comprises a wheel frame assembly including at least one uncrowned wheel connected in supporting relation with the assembly and adapted to be seated in rolling engagement with a flat truck, a load supporting bed, and a number of flexural struts interconnecting the bed and the assembly. Each of the struts is disposed in an inclined plane passing through the center of the uncrowned wheel surface along the line, substantially bisecting the line of contact established between the wheel surface and the track surface, and is characterized by a modulus of elasticity sufficient for maintaining the axis of rotation for the wheel in substantial parallelism with the line of contact.

METAL WORKING AND FORMING

79-1067

Dynamic Accuracy of Hybrid Profiling Mechanisms in Cam Manufacturing

S. Sankar and M.O.M. Osman

Dept. of Mech. Engrg., Concordia Univ., Montreal, Canada, J. Mech. Des., Trans. ASME, 101 (1), pp 108-117 (Jan 1979) 13 figs, 11 refs

Key Words: Cams, Cutting, Machining, Metal working

Dynamic accuracy in cam production using hybrid profiling mechanisms in turning with a single point cutting tool is investigated. A profiling mechanism consisting of a four-way, critical-centered spool valve and a symmetrical volume power cylinder with a fixed piston is mathematically modeled and simulated on a hybrid computer to study its dynamic behavior. The model includes the dynamic cutting forces and their interaction with the velocity response of the mechanism, the nonlinear dry friction in the copying slide, and the dynamic behavior of the copying slide, control valve, and the stylus.

OFF-ROAD VEHICLES

79-1068

A Development of a Dynamic Analysis Technique for Vehicle Frames of Vibratory Plows and Trenchers

D.L. Turney

Ph.D. Thesis, Oklahoma State Univ., 114 pp (1978) UM 7903754

Key Words: Agricultural machinery, Vibratory techniques

The basic vehicle including the frame assembly, cab, and front axle is modeled. Both the vibratory plow and digging chain are attached to the frame assembly. Two formulations are made: one for two-dimensional motion having six degrees of freedom, and one for three-dimensional motion having fifteen degrees of freedom. The equations of motion are written for both cases using a Lagrangian approach. These equations are numerically integrated to yield the rigid body motion of the model. Having this motion the tire, plow, and cab-mount forces are evaluated and these forces are applied to the frame and the three frame stress resultants calculated for the case of plane motion. Studies are made to determine the frame stresses due to the vibratory plow and digging chain.

PUMPS, TURBINES, FANS, COMPRESSORS

(Also see No. 960)

79-1069

Aerodynamic and Acoustic Effects of Eliminating Core Swirl from a Full Scale 1.6 Stage Pressure Ratio Fan (QF-5A)

R.P. Woodward, L.W. Acker, and E.G. Stakolich

NASA Lewis Res. Center, Cleveland, OH, Rept. No. NASA-TM-78991; E-9774, 35 pp (Sept 1978) N79-11001

Key Words: Fans, Noise reduction, Design techniques

Fan QF-5A is a modification of fan QF-5 which has an additional core stator and adjusted support struts to turn the core exit flow from a 30 deg swirl to the axial direction. This modification is necessary to eliminate the impingement of the swirling core flow on the axial support pylon of the NASA-Lewis Quiet Fan Facility that cause aerodynamic, acoustic and structural problems with the original fan stage at fan speeds greater than 85 percent of design.

79-1070

An Experimental Study on Noise Reduction of Axial Flow Fans (1st Report. Effects of Some Parameters on Blade Elements)

S. Suzuki
Noise Control Engrg. Center, Central Research Inst., Ebara Corp., 4720 Fujisawa, Fujisawa-shi, Japan, Bull. JSME, 21 (162), pp 1733-1740 (Dec 1978) 25 figs, 5 refs

Key Words: Fans, Noise reduction

Studies on the noise reduction of the axial-flow fans are carried out. Varying principals assumed parameters such as the chord length of the blade, the camber of the airfoil, the position of maximum camber, and the surface pressure distribution of the airfoil. A separated flow on the surface of the two-dimensional airfoil is observed with use of the Schlieren device, and measurements are made of the strength of turbulence with the use of a hot wire probe to determine their correlation with fan noise. The airfoil profile is determined by calculating an optimum pressure distribution.

79-1071

Dynamic Response Testing of Gas Turbines

R.V. Cottington and C.B. Pease
National Gas Turbine Establishment, Pyestock, Farnborough, Hampshire, UK, J. Engr. Power, Trans. ASME, 101 (1), pp 95-100 (Jan 1979) 14 figs, 7 refs

Key Words: Gas turbine engines, Testing techniques

A technique, based on an improved and generalized version of the pseudo-random binary noise (PRBN) method, is described which shows significant improvements compared to other methods of dynamic response testing. The technique involves the injection of a small PRBN or other random disturbance into the fuel flow or variable geometry actuator, the recording of the response of other engine parameters to that disturbance and the subsequent use of a computer to derive the frequency response. The requirements necessary for successful dynamic response testing are discussed and a comparison made between the improved PRBN technique and conventional sinewave testing from actual engine tests. A number of engines have been analyzed using the new method and some of the results are presented.

79-1072

Modern Diagnostic Techniques Improve Steam-Turbine Reliability

R.L. Bannister, R.L. Osborne, and S.J. Jennings
Westinghouse Electric Corp., Power, 123 (1), pp 46-50 (Jan 1979) 12 figs

Key Words: Blades, Steam turbines, Diagnostic techniques

This article reviews some basic turbine problems and explores new experimental diagnostic techniques which provide accurate data for planning preventive-maintenance programs, and thus improve unit reliability and availability.

79-1073

Nonlinear Dynamic Modeling of a Once-Through Steam Generator

M. Lee
Ph.D. Thesis, The Univ. of Tennessee, 206 pp (1978) UM 7903438

Key Words: Mathematical models, Boilers, Transient response

A detailed, nonlinear, many lump, moving boundary dynamic model for a helical coiled once-through steam generator with nonuniform tube cross section is developed. The steady state calculation for generating the state variable distributions along the tube coordinate is developed. Nonlinearity of the steam generator responses is studied.

79-1074

Experimental Investigation of Unsteady Phenomena in Vaneless Radial Diffusers

A.N. Abdelhamid, W.H. Colwill, and J.F. Barrows
Research Div., Carrier Corp., Syracuse, NY, J. Engr. Power, Trans. ASME, 101 (1), pp 52-60 (Jan 1979) 17 figs, 10 refs

Key Words: Compressors, Fluid-induced excitation

Pressure fluctuations at various locations on the flow path of two centrifugal compressor stages are recorded and analyzed in the time and frequency domains. Two distinct types of unsteady phenomena are measured: a rotating pressure pattern in the diffuser and compressor system surge.

79-1075

Growth of a Perturbation in an Axial Flow Compressor

J. Fabri
Chef de Division, ONERA, Chatillon-sous-Bagneaux,

France, J. Engr. Power, Trans. ASME, 101 (1), pp 87-94 (Jan 1979) 5 figs, 3 tables, 13 refs

Key Words: Compressors, Perturbation theory, Fluid-induced excitation

A time-dependent linearized approach is used to predict the amplification or the decay of an initial perturbation in the multistage axial compressor of high hub-to-tip ratio.

79-1076

Propagation of Inlet Flow Distortions Through an Axial Compressor Stage

J. Colpin

Von Karman Inst. for Fluid Dynamics, Rhode-St-Genese, Belgium, J. Engr. Power, Trans. ASME, 101 (1), pp 116-124 (Jan 1979) 7 figs, 1 table, 10 refs

Key Words: Compressors, Finite difference theory, Fluid-induced excitation

A calculation method for predicting the development of an inlet flow distortion through a compressor stage is presented. A finite difference technique is used to treat the flow equations outside the blade rows. A set of experimental data, measured on a one stage axial compressor, submitted to a rectangular inlet total pressure distortion is discussed and serves as a basis for comparison between theory and experiments.

RAIL

(Also see Nos. 1006, 1007, 1008, 1009, 1010)

79-1077

Theoretical and Experimental Investigation of Rail Overturning

Y.S. Wang

Ph.D. Thesis, Illinois Inst. of Tech., 97 pp (1978) UM 7903008

Key Words: Interaction: rail-wheel, Rails, Beams, Timoshenko theory, Finite element technique

A unified theory applicable to the investigation of rail overturning problems is presented. The proposed theory takes into account the effects of nonlinear (piecewise) vertical, lateral and torsional spring resistance. The technique of solving the equations and removing the unbalanced forces is described. Data from past research of vertical, lateral and torsional resistance are reviewed. Methods of treating the initial and permanent deformations are described.

79-1078

The Simulation of Vehicle and Structure Interaction with Nonlinear Constraint Conditions

T.E. Blejwas

Ph.D. Thesis, Univ. of Colorado at Boulder, 208 pp (1978)
UM 7903025

Key Words: Interaction: vehicle-structure, Interaction: rail-wheel, Noise generation

A method of analysis is presented for the simulation of vehicle and structure interaction with nonlinear constraint conditions. Vehicle modeling that includes inertial forces at discrete points of contact is considered. The motion of the surface over which the vehicle traverses is represented in terms of continuous mode shapes. The interaction forces between the vehicle and surface are represented by Lagrange multipliers. Numerical examples that illustrate the application of the methodology are presented. The method of solution is utilized to analyze wheel-rail impact noise due to wheel flats.

79-1079

Track Maintenance/Railcar Suspension Trade-Offs to Obtain Acceptable Ride Quality

M.W. Sayers and J.K. Hedrich

Dept. of Mech. Engrg., Massachusetts Inst. of Tech., Cambridge, MA, Passenger Vibration in Transportation Vehicles, Presented at the Des. Engr. Tech. Conf., Sept 1977, AMD-Vol 24, A. Berman and A.J. Hannibal, eds., ASME 1977, 17 figs, 20 refs

Key Words: Railroad tracks, Suspension systems (vehicles), Railroad cars, Ride dynamics, Human response

A methodology for combining vehicle suspension design with track maintenance requirements to provide an acceptable level of ride quality is presented in this paper. The emphasis is on minimizing the combined vehicle/track costs to maintain a specified ride quality. A general methodology is formulated that uses dynamic railcar computer models, models that relate maintenance/construction tolerances to track

irregularity descriptions, available cost data that identify the cost of maintaining specified maintenance/construction tolerances, and ride quality specifications that relate the railcar vibration environment to passenger comfort. The methodology is illustrated by an example that analyzes the lateral dynamic response of a conventional passenger car to rail alignment irregularities. A preliminary track maintenance cost model is developed from available data.

79-1080

A Survey of Rail Vehicle Testing for Validation of Theoretical Dynamic Analyses

N.K. Cooperrider and E.H. Law

Arizona State Univ., Tempe, AZ, J. Dyn. Syst., Meas. and Control, Trans. ASME, 100 (4), pp 238-251 (Dec 1978) 15 figs, 1 table, 69 refs

Key Words: Railroad cars, Railroad trains, Vibration tests

This paper discusses experience in rail vehicle testing for validation of theoretical rail vehicle dynamic analyses. Laboratory and field testing are covered including shaker, roller rig, freight car rock and roll, vehicle stability, vehicle forced response, and rail vehicle curving tests. The specific vehicle and roadbed characterization requirements for validation tests are described. Some of the shortcomings of previous testing efforts are outlined and recommendations for future validation testing made.

79-1081

Optimization of Rail Vehicle Operating Speed with Practical Constraints

J.J. Cox, J.K. Hedrick, and N.K. Cooperrider

Dept. of Civil Engrg., Engrg. Mechanics and Materials, USAF Academy, CO, J. Dyn. Syst., Meas. and Control, Trans. ASME, 100 (4), pp 260-269 (Dec 1978) 6 figs, 17 refs

Key Words: Railroad cars, Hunting motion

A constrained optimization algorithm to maximize the operating speed of a fifteen degree-of-freedom lateral dynamic model for a passenger railcar subject to random alignment irregularities is presented in this paper.

79-1082

Rail Passenger Vehicle Lateral Dynamic Performance Improvement Through Active Control

P.K. Sinha, D.N. Wormley, and J.K. Hedrick

Intermetrics, Inc., Cambridge, MA 02138, J. Dyn. Syst., Meas. and Control, Trans. ASME, 100 (4), pp 270-283 (Dec 1978) 14 figs, 3 tables, 22 refs

Key Words: Railroad cars, Ride dynamics, Hunting motion, Active control

High speed operation of conventional rail vehicles is limited by a number of dynamic problems including ride quality, curve negotiation, and hunting. Active control is investigated as a technique for improving rail vehicle performance at high speeds. Two controller case studies are examined to demonstrate the effectiveness of controller configuration on rail vehicle performance in terms of ride quality and tracking errors on tangent track while allowing specified curve negotiation requirements to be met.

79-1083

A Parametric Study to Relate Railcar Speed to Permissible Combinations of Track Geometry Deviations

F. Dimasi and H. Weinstock

U.S. Dept. of Transportation, Research and Special Programs Administration, Cambridge, MA, J. Dyn. Syst., Meas. and Control, Trans. ASME, 100 (4), pp 252-259 (Dec 1978) 10 figs, 2 tables, 15 refs

Key Words: Railroad cars, Computerized simulation, Interaction: vehicle-guideway, Computerized simulation

A passenger railcar is modeled using quasi-linear, frequency domain computer simulation models to compute lateral and vertical rms wheelset forces and relative displacements over a range of speeds, in response to power spectra representations of track geometry deviations in surface, alignment, and crosslevel. A simplified wheel-climb criterion (Lateral to Vertical Force Ratio, L/V) is used to estimate the margin of safety for wheel-climb and to impose limits on combined track geometry deviations. "Constant performance" contours of speed versus combined track geometry deviations are developed for selected L/V threshold values and exceedance probabilities.

REACTORS

79-1084

The Swedish Underground Containment Studies: State of Art

T. Lindbo
Statens Vattenfallsverk, Byggnadsteknik, Varmekraft-sektionen S-16287 Vallingby, Sweden, Nucl. Engr. Des., 50 (3), pp 431-442 (Nov 1978) 10 figs, 2 tables, 3 refs

Key Words: Nuclear power plants, Underground structures

Studies of underground siting for nuclear power plants in Sweden are surveyed. The first containment study has led to siting in rock or in a pit. The second study was aimed at surveying the advantages and disadvantages of a rock sited 1000 MW BWA nuclear power plant from a reactor safety standpoint, compared to a plant above ground. The third study consisted of two parts: one part discusses such questions as safety, operation, maintenance, sabotage, war protection, cost and decommissioning. The other part aims to a broader view of risks and consequences in peace and war and also advantages and disadvantages of nuclear power plants for district heating.

79-1085
Analysis of Seismic Testing Motions with Instantaneous Response Spectra
A. Morrone
Advanced Reactors Div., Westinghouse Electric Corp., Madison, PA 15663, Nucl. Engr. Des., 51 (3), pp 445-451 (Feb 1979) 8 figs, 2 refs

Key Words: Nuclear power plants, Nuclear reactor components, Seismic response spectra

Synthetic multiple-frequency and single-frequency motions are analyzed for their adequacy to simulate a calculated seismic motion for seismic testing of nuclear power plant equipment. The analysis is performed by first comparing their time-independent response spectra and then comparing response spectra derived at an instant of time: instantaneous response spectra. Recommendations are given on practical test methods and type of test motions.

79-1086
Collapse of Chimney Caused by Earthquake or by Aircraft Impingement with Subsequent Impact on Reactor Building
J.P. Wolf and P.E. Skrikerud
Electrowatt Engrg. Services, Ltd., CH-8022, Zürich, Switzerland, Nucl. Engr. Des., 51 (3), pp 453-472 (Feb 1979) 30 figs, 2 tables, 9 refs

Key Words: Chimneys, Nuclear power plants, Seismic excitation, Impact response, Aircraft

The behavior of a typical chimney stack of a nuclear-power plant subjected to earthquake and impact loads is examined. The explicit integration procedure using convected coordinates is adopted to perform the transient analyses with large displacements and material nonlinearities of the concrete stack, of the impinging aircraft and of the soil. Force-time relationships of the aircraft impinging on the chimney are developed.

ROAD

(Also see Nos. 920, 1063)

79-1087
Seatbelt Preload Devices (Untersuchungen mit Sicherheitsgurtstraffern)
H. Grittner
Steintor 18, 5067 Kurten-Durscheid, Automobiltech. Z., 81 (1), pp 17-23 (Jan 1979) 6 figs
(In German)

Key Words: Automobile seat belts, Collision research (automotive)

The forward displacement during a crash is caused by a certain amount of unavoidable slack, packing of the occupant's clothes, packing the webbing of the reel and webbing elongation, and can be avoided by a pre-loaded seatbelt. The belt is tightened by means of a pyrotechnic device which starts operating at the moment of impact. This article discusses the effectiveness and best position of seatbelt pre-load devices during development work.

79-1088
Refinement of Finite Element Analysis of Automobile Structures Under Crash Loading. Volume 1. Summary Report
K.S. Yeung and R.E. Welch
IIT Research Inst., Chicago, IL, Rept. No. J6384, DOT-HS-803 465, 28 pp (Oct 1977)
PB-287 300/8GA

Key Words: Collision research (automotive), Computer programs, Finite element technique

A finite element computer program for use in the static and dynamic analyses of vehicle structure, including sheet metal, in a crash environment was developed in this research project. The computer program consists of the following features: large displacement, nonlinear static and dynamic, and elastic and plastic including strain-rate effect; with plate, three-dimensional beam and spring elements, and rigid links and a variety of three-dimensional beam and conditions; options of using either the explicit or implicit time integration procedures; and options of specifying stress, mass and center of gravity, and energy output.

79-1089

Highway Accident Report - Kohler Company Tractor-Semitrailer/Pickup Truck Collision, N.C. Route 226, Near Marion, North Carolina, January 25, 1978

Bureau of Accident Investigation, National Transportation Safety Board, Washington, D.C., Rept. No. NTSB-HAR-78-6, 24 pp (Sept 21, 1978)
PB-287 116/8GA

Key Words: Collision research (automotive), Semitrailers, Trucks

This report discusses the probable causes of the title accident.

79-1090

Digital Processing of Measured Vibration Data for Automobile Ride Evaluation

A.J. Healey
Dept. of Mech. Engrg., The Univ. of Texas at Austin, Austin, TX, Passenger Vibration in Transportation Vehicles, Presented at the Des. Engr. Tech. Conf., Sept 1977, AMD-Vol 24, A. Berman and A.J. Hannibal, eds., ASME 1977, 13 figs, 7 refs

Key Words: Automobiles, Vibration measurement, Data processing, Digital techniques, Ride dynamics

This paper is concerned with the measurement and processing of motor vehicle ride vibration data so that comfort can be assessed. Typical vibrations experienced are random, with some periodic components sometimes included. Measures include r.m.s. (root mean square) acceleration in the three linear directions relative to the passengers' orientations, spectral density and one-third octave band r.m.s. acceleration levels. Procedures are described using digital analysis techniques. The effects of detrending and windowing are considered. Special consideration is given to the coverage of the low frequency range 0.1 to 40 cycles per second. Typical results are shown for automobiles riding over highways having a wide range of roughness.

79-1091

Ride Comfort in Medium and Heavy Duty Trucks

R.W. Glotzbach, R.A. Wentz, and N.C. Mehta
Vehicle Dynamics Group, International Harvester Co., Fort Wayne, IN, Passenger Vibration in Transportation Vehicles, Presented at the Des. Engr. Tech. Conf., Sept 1977, AMD-Vol 24, A. Berman and A.J. Hannibal, eds., ASME 1977, 5 figs, 11 refs

Key Words: Trucks, Ride dynamics, Human response

This paper discusses the causes, effects and possible solutions to the major ride problems in medium and heavy duty trucks. Means of achieving the desired comfort levels and the limitations of ride improvements from economical and physical viewpoints are examined.

79-1092

Coupled Vertical-Lateral Dynamics of a Pneumatic Tired Vehicle: Part I -- A Mathematical Model

N.S. Nathoo and A.J. Healey
Shell Development Co., Houston, TX, J. Dyn. Syst., Meas. and Control, Trans. ASME, 100 (4), pp 311-318 (Dec 1978) 5 figs, 18 refs
Sponsored by the U.S. Dept. of Transportation

Key Words: Automobiles, Pneumatic tires, Ride dynamics, Surface roughness, Mathematical models

A method is presented which permits the simulation of the coupled vertical and lateral rigid body vibration response of an automobile to roadway roughness inputs. A set of equations in matrix form is obtained for an assumed ten degree-of-freedom mathematical model of the vehicle-tire system using generalized linear and Euler angle coordinates.

79-1093

Coupled Vertical-Lateral Dynamics of a Pneumatic Tired Vehicle: Part II -- Simulated Versus Experimental Data

N.S. Nathoo and A.J. Healey

Shell Development Co., Houston, TX, J. Dyn. Syst., Meas. and Control, Trans. ASME, 100 (4), pp 319-325 (Dec 1978) 17 figs, 11 refs

Key Words: Automobiles, Pneumatic tires, Ride dynamics, Surface roughness, Mathematical models

The vertical and lateral acceleration response of an automobile to roadway roughness inputs is simulated using a ten degree-of-freedom mathematical model. The simulated response compares favorably with that obtained experimentally in terms of their power spectral density functions and root mean squared values in the 0.1 - 10 Hz frequency range. A sensitivity study was conducted to determine the effect of variations in the suspension damping ratio, antiroll bar stiffness and lateral "pneumatic" stiffness on vehicle response variables.

ROTORS

79-1094

Designing Mechanical Face Seals for Improved Performance. Part 1 - Basic Configurations

L.P. Ludwig and H.F. Greiner

NASA Lewis Res. Center, Cleveland, OH, Mech. Engr., 100 (11), pp 38-46 (Nov 1978) 15 figs, 2 tables, 8 refs

Key Words: Seals (stoppers), Rotory seals, Lubrication, Rotors

Fluids which must be sealed range from water (automobiles, reactors, submarines) and oils, to liquid oxygen and toxic chemicals. Mechanical face seals developed for these applications have many diverse forms, from the low-cost automotive water pump seals to the sophisticated seals for liquid oxygen turbopumps such as are used on the space shuttle. Seals can have a significant cost impact in regard to maintenance and downtime. Exposure to even low levels of some substances can have serious health consequences.

79-1095

Dynamic Analysis of Flexible Rotor-Bearing Systems Using a Modal Approach. Final Report. 1 Sept 1976 - 31 Aug 1977

K.C. Choy, E.J. Gunter, and L.E. Barrett

Dept. of Mech. and Aerospace Engrg., Virginia Univ., Charlottesville, VA. Rept. No. NASA-CR-157781, 371 pp (Oct 1978)

N79-10446

Key Words: Rotor-bearing systems, Stiffness methods, Modal analysis

The generalized dynamic equations of motion are obtained by the direct stiffness method for multimass flexible rotor-bearing systems. The direct solution of the equations of motion is illustrated on a simple 3-mass system. The use of undamped and damped system mode shapes in the transformation is discussed. A rapid procedure for computing stability, steady state unbalance response, and transient response of the rotor-bearing system is presented. Examples of the application of this modal approach are presented. The dynamics of the system is further investigated with frequency spectrum analysis of the transient response.

79-1096

Nonlinear Dynamic Response of Wind Turbine Rotors, Ph.D. Thesis - MIT

I. Chopra

NASA Ames Res. Center, Moffett Field, CA, Rept. No. NASA-TM-78324, 233 pp (Feb 1977)

N79-12542

Key Words: Rotors, Wind turbines, Flexible foundations, Springs (elastic)

The nonlinear equations of motion for a rigid rotor restrained by three flexible springs representing the flapping, lagging and feathering motions are derived using Lagrange's equations for arbitrary angular rotations. These are reduced to a consistent set of nonlinear equations using nonlinear terms up to third order.

SHIP

(See No. 956)

SPACECRAFT

79-1097

Study of Hydraulic Generators for Vibration Testing of Large Space Modules

Merlet and Lemonde

European Space Agency, Paris, France, Rept. No. ESA-TT-492, 117 pp (Aug 1978) (Engl. transl. of 'Etudes des Generateurs Hydraulique pour les Essais aux Vibrations d'Objets Spatiaux de Grandes Dimensions', SOPEMEA, Toulouse Rept. ESA-CR(P)-1044, (Nov 24, 1977))
N79-11092

Key Words: Spacecraft, Testing equipment, Testing techniques, Hydraulic equipment

The state of the art of vibration simulation techniques using hydraulic exciters is presented. Phase 1 of the study deals with the search for high power installations. In phase 2 the available facilities and their limitations are discussed. Phase 3 is concerned with safety systems and with the studies to be undertaken in order to improve existing installations.

79-1098
Some Results from 1/8-Scale Shuttle Model Vibration Studies
L.D. Pinson and S.A. Leadbetter
NASA Langley Res. Center, Hampton, VA, J. Spacecraft Rockets, 16 (1), pp 48-55 (Jan-Feb 1979) 13 figs, 28 refs

Key Words: Space shuttles, Test models, Experimental data

Highlights of experimental and analytical vibration studies of a 1/8-scale structural dynamic model of the space shuttle are presented. The space shuttle is a launch vehicle with elements assembled in an asymmetric manner. Responses of the assembled vehicle are characterized by directional coupling and high modal density at low frequencies.

STRUCTURAL

79-1099
Human Response to Dynamic Motion of Structures
A.W. Irwin
Dept. of Civil Engrg., Heriot-Watt Univ., The Struc. Engr., 56A (9), pp 237-244 (Sept 1978) 4 figs, 3 tables, 39 refs

Key Words: Buildings, Bridges, Vibration response, Human response

In this paper human reactions to such vibrations as perceptible motions of buildings, bridges, offshore and other fixed structures are discussed. Magnitudes of motion caused by a variety of environmental and other forces which should prove acceptable to the majority of people are suggested.

TRANSMISSIONS

79-1100
Mechanics of Multi-Pulley Flexible Drive Systems
F.Y. Chen
Dept. of Mech. Engrg., Ohio Univ., Athens, OH 45701, Mech. Mach. Theory, 13 (6), pp 643-648 (1978) 3 figs, 3 refs

Key Words: Transmission systems, Pulleys, Belt drives

This paper presents a basic treatment of the mechanics of multi-pulley flexible drive systems. In order to keep the model simple, it is assumed that the initial pressure between the contacting surfaces of belt and pulley is sufficient so that no slipping will occur, that the belt is lightweight and non-stretchable, thus the elastic creep is discounted and that the belt is flexible enough not to include the flexural bending and shear effects in the analysis.

TURBOMACHINERY

(See No. 957)

USEFUL APPLICATION

79-1101
Transactions of Machine Elements Division on Vibrating Hammers
A. Wallin
Machine Elements Div., Lund Inst. of Tech., Sweden, 134 pp (1978)
PB-286 804/0GA

Key Words: *Vibrators (machinery), Mathematical models*

Different models for vibrating hammers intended for use as impact machines are investigated with regard to their dynamic qualities. One-dimensional vibrating systems consisting of one or two masses and linear spring elements as well as systems with fully distributed mass are considered.

AUTHOR INDEX

PERIODICALS SCANNED

PUBLICATION AND ADDRESS	ABBREVIATION
ACTA MECHANICA Springer-Verlag New York, Inc. 175 Fifth Ave. New York, NY 10010	Acta Mech.
ACUSTICA S. Hirzel Verlag, Postfach 347 D-700 Stuttgart 1 W. Germany	Acustica
AERONAUTICAL JOURNAL Royal Aeronautical Society 4 Hamilton Place London W1V 0BQ, UK	Aeronaut. J.
AERONAUTICAL QUARTERLY Royal Aeronautical Society 4 Hamilton Place London W1V 0BQ, UK	Aeronaut. Quart.
AIAA JOURNAL American Institute of Aeronautics and Astronautics 1290 Avenue of the Americas New York, NY 10019	AIAA J.
AMERICAN SOCIETY OF CIVIL ENGINEERS, PROCEEDINGS Publications Office, ASCE United Engineering Center 345 East 47th St. New York, NY 10017	
JOURNAL OF ENGINEERING MECHANICS DIVISION	ASCE J. Engr. Mech. Div.
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JOURNAL OF STRUCTURAL DIVISION	ASCE J. Struc. Div.
JOURNAL OF TRANSPORTATION ENGINEERING DIVISION	ASCE J. Transport. Engr. Div.
AMERICAN SOCIETY OF LUBRICATING ENGINEERS, TRANSACTIONS Academic Press 111 Fifth Ave. New York, NY 10019	ASLE, Trans.

PUBLICATION AND ADDRESS	ABBREVIATION
AMERICAN SOCIETY OF MECHANICAL ENGINEERS, TRANSACTIONS United Engineering Center 345 East 47th St. New York, NY 10017	
JOURNAL OF APPLIED MECHANICS	J. Appl. Mech., Trans. ASME
JOURNAL OF DYNAMIC SYSTEMS, MEASUREMENT AND CONTROL	J. Dyn. Syst., Meas. and Control, Trans. ASME
JOURNAL OF ENGINEERING FOR INDUSTRY	J. Engr. Indus., Trans. ASME
JOURNAL OF ENGINEERING FOR POWER	J. Engr. Power, Trans. ASME
JOURNAL OF LUBRICATION TECHNOLOGY	J. Lubric. Tech., Trans. ASME
JOURNAL OF MECHANICAL DESIGN	J. Mech. Des., Trans. ASME
JOURNAL OF PRESSURE VESSEL TECHNOLOGY	J. Pressure Vessel Tech., Trans. ASME
APPLIED ACOUSTICS Applied Science Publishers, Ltd. Ripple Road, Barking Essex, UK	Appl. Acoust.
APPLIED MATHEMATICAL MODELING IPC House 32 High St., Guildford Surrey GU1 3EW, UK	Appl. Math. Modeling
ARCHIVES OF ACOUSTICS Polish Academy of Sciences Committee on Acoustics Polish Acoustical Society	Arch. Acoust.
ARCHIVES OF MECHANICS (ARCHIWUM MECHANIKI STOSOWANEJ) Export and Import Enterprise Ruch UL, Wronia 23, Warsaw, Poland	Arch. Mech.
ASTRONAUTICS AND AERONAUTICS AIAA EDP 1290 Avenue of the Americas New York, NY 10019	Astronaut. & Aeronaut.
AUTOMOBILTECHNISCHE ZEITSCHRIFT Franckh'sche Verlagshandlung Abteilung Technik 7000 Stuttgart 1, Pfizerstrasse 5-7 W. Germany	Automobiltech. Z.

PUBLICATION AND ADDRESS	ABBREVIATION
AUTOMOTIVE ENGINEER (SAE) Society of Automotive Engineers, Inc. 400 Commonwealth Drive Warrendale, PA 15096	Auto. Engr. (SAE)
AUTOMOTIVE ENGINEER (UK) P.O. Box 24, Northgate Ave. Bury St., Edmunds Suffolk IP21 GBW, UK	Auto. Engr. (UK)
BALL BEARING JOURNAL (English Edition) SKF (U.K.) Ltd. Luton, Bedfordshire LU3 1JF, UK	Ball Bearing J.
BROWN BOVERI REVIEW Brown Boveri and Co., Ltd. CH-5401, Baden, Switzerland	Brown Boveri Rev.
BULLETIN DE L'ACADEMIE POLONAISE DES SCIENCES, SERIES DES SCIENCES TECHNIQUES Ars Polona-Ruch 7 Krokowskie Przedmiescie, Poland	Bull. Acad. Polon. Sci., Ser. Sci. Tech.
BULLETIN OF JAPAN SOCIETY OF MECHANICAL ENGINEERS Japan Society of Mechanical Engineers Sanshin Hokusei Bldg. H-9 Yoyogi 2-chome Shibuya-ku Tokyo 151, Japan	Bull. JSME
BULLETIN OF SEISMOLOGICAL SOCIETY OF AMERICA Bruce A. Bolt Box 826 Berkeley, CA 94705	Bull. Seismol. Soc. Amer.
CIVIL ENGINEERING (NEW YORK) ASCE Publications Office 345 E. 47th St. New York, NY 10017	Civ. Engr. (N.Y.)
COMPUTERS AND STRUCTURES Pergamon Press Inc. Maxwell House, Fairview Park Elmsford, NY 10523	Computers Struc.
DESIGN NEWS Cahners Publishing Co., Inc. 221 Columbus Ave. Boston, MA 02116	Des. News
DIESEL AND GAS TURBINE PROGRESS Diesel Engines, Inc. P.O. Box 7406 Milwaukee, WI 53213	Diesel Gas Turbine Prog.
ENGINEERING MATERIALS AND DESIGN IPC Industrial Press Ltd. 33-40 Bowling Green Lane London EC1R, UK	Engr. Matl. Des.
EXPERIMENTAL MECHANICS Society for Experimental Stress Analysis 21 Bridge Sq., P.O. Box 277 Westport, CT 06880	Exptl. Mech.
FORSCHUNG IM INGENIEURWESEN Verein Deutscher Ingenieur, GmbH Postfach 1139, Graf-Recke Str. 84 4 Duesseldorf 1 W. Germany	Forsch. Ingenieurw.
HEATING/PIPING/AIR CONDITIONING Circulation Dept. 614 Superior Ave. West Cleveland, OH 44113	Heating/ Piping/ Air Cond.
HYDRAULICS AND PNEUMATICS Penton/IPC, Inc. 614 Superior Ave., West Cleveland, OH 44113	Hydraulics & Pneumatics
HYDROCARBON PROCESSING Gulf Publishing Co. Box 2608 Houston, TX 77001	Hydrocarbon Processing
IBM JOURNAL OF RESEARCH AND DEVELOPMENT International Business Machines Corp. Armonk, NY 10504	IBM J. Res. Dev.
INDUSTRIAL RESEARCH Dun-Donnelley Publishing Corp. 222 S. Riverside Plaza Chicago, IL 60606	Indus. Res.
INGENIEUR-ARCHIV Springer-Verlag New York, Inc. 175 Fifth Ave. New York, NY 10010	Ing. Arch.
INSTITUTE OF MARINE ENGINEERS, TECHNICAL REPORTS The Memorial Building 76 Mark Lane London EC3R 7IN, UK	Inst. Mar. Engr., T.R.
INSTITUTION OF ENGINEERS, AUSTRALIA, CIVIL ENGINEERING TRANSACTIONS 11 National Circuit Barton, A.C.T. 2600 Australia	Instn. Engr., Austral., C.E. Trans.
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INSTITUTION OF MECHANICAL ENGINEERS, (LONDON), PROCEEDINGS Institution of Mechanical Engineers 1 Birdcage Walk, Westminster, London SW1, UK	Instn. Mech. Engr. Proc.
INSTRUMENT SOCIETY OF AMERICA, TRANSACTIONS Instrument Society of America 400 Stanwix St. Pittsburgh, PA 15222	ISA Trans.
INTERNATIONAL JOURNAL OF CONTROL Taylor and Francis Ltd. 10-14 Macklin St. London WC2B 5NF, UK	Intl. J. Control

PUBLICATION AND ADDRESS	ABBREVIATION
INTERNATIONAL JOURNAL OF EARTHQUAKE ENGINEERING AND STRUCTURAL DYNAMICS John Wiley and Sons, Ltd. 650 Third Ave. New York, NY 10016	Intl. J. Earthquake Engr. Struc. Dynam.
INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES Pergamon Press Inc. Maxwell House, Fairview Park Elmsford, NY 10523	Intl. J. Engr. Sci.
INTERNATIONAL JOURNAL OF MACHINE TOOL DESIGN AND RESEARCH Pergamon Press, Inc. Maxwell House, Fairview Park Elmsford, NY 10523	Intl. J. Mach. Tool Des. Res.
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ISRAEL JOURNAL OF TECHNOLOGY Weizmann Science Press of Israel Box 801 Jerusalem, Israel	Israel J. Tech.
JOURNAL DE MECANIQUE Gauthier-Villars 55 Quai des Grands Augustines, Paris 6, France	J. de Mécanique
JOURNAL OF THE ACOUSTICAL SOCIETY OF AMERICA American Institute of Physics 335 E. 45th St. New York, NY 10010	J. Acoust. Soc. Amer.
JOURNAL OF AIRCRAFT American Institute of Aeronautics and Astronautics 1290 Avenue of the Americas New York, NY 10019	J. Aircraft

PUBLICATION AND ADDRESS	ABBREVIATION
JOURNAL OF THE AMERICAN HELICOPTER SOCIETY American Helicopter Society, Inc. 30 E. 42nd St. New York, NY 10017	J. Amer. Helicopter Soc.
JOURNAL OF ENGINEERING MATHEMATICS Academic Press 198 Ash Street Reading, MA 01867	J. Engr. Math.
JOURNAL OF ENVIRONMENTAL SCIENCES Institute of Environmental Sciences 940 E. Northwest Highway Mt. Prospect, IL 60056	J. Environ. Sci.
JOURNAL OF FLUID MECHANICS Cambridge University Press 32 East 57th St. New York, NY 10022	J. Fluid Mech.
JOURNAL OF THE FRANKLIN INSTITUTE Pergamon Press, Inc. Maxwell House, Fairview Park Elmsford, NY 10523	J. Franklin Inst.
JOURNAL OF HYDRONAUTICS American Institute of Aeronautics and Astronautics 1290 Avenue of the Americas New York, NY 10019	J. Hydronautics
JOURNAL OF THE INSTITUTE OF ENGINEERS, AUSTRALIA Science House, 157 Gloucter Sydney, Australia 2000	J. Inst. Engr., Austral.
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JOURNAL OF PHYSICS E. (SCIENTIFIC INSTRUMENTS) American Institute of Physics 335 East 45th St. New York, NY 10017	J. Phys. E. (Sci. Instr.)
JOURNAL OF SHIP RESEARCH Society of Naval Architects and Marine Engineers 20th and Northhampton Sts. Easton, PA 18042	J. Ship Res.
JOURNAL OF SOUND AND VIBRATION Academic Press 111 Fifth Ave. New York, NY 10019	J. Sound Vib.

PUBLICATION AND ADDRESS	ABBREVIATION
JOURNAL OF SPACECRAFT AND ROCKETS American Institute of Aeronautics and Astronautics 1290 Avenue of the Americas New York, NY 10019	J. Spacecraft Rockets
JOURNAL OF TESTING AND EVALUATION (ASTM) American Society for Testing and Materials 1916 Race St. Philadelphia, PA 19103	J. Test Eval. (ASTM)
KONSTRUKTION Springer Verlag 3133 Connecticut Ave., N.W. Suite 712 Washington, D.C. 20008	Konstruktion
LUBRICATION ENGINEERING American Society of Lubrication Engineers 838 Busse Highway Park Ridge, IL 60068	Lubric. Engr.
MACHINE DESIGN Penton Publishing Co. Penton Bldg. Cleveland, OH 44113	Mach. Des.
MASCHINENBAUTECHNIK VEB Verlag Technik Oranienburger Str. 13/14 102 Berlin, E. Germany	Maschinenbautechnik
MECCANICA Pergamon Press, Inc. Maxwell House, Fairview Park Elmsford, NY 10523	Meccanica
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NAVAL ENGINEERS JOURNAL American Society of Naval Engineers, Inc. Suite 507, Continental Bldg. 1012 - 14th St., N.W. Washington, D.C. 20005	Naval Engr. J.
NOISE CONTROL VIBRATION ISOLATION Trade and Technical Press Ltd. Crown House, Morden Surrey SM4 5EW, UK	Noise Control Vib. Isolation
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QUARTERLY JOURNAL OF MECHANICS AND APPLIED MATHEMATICS Wm. Dawson & Sons, Ltd. Cannon House Folkestone, Kent, UK	Quart. J. Mech. Appl. Math.
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REVIEW OF SCIENTIFIC INSTRUMENTS American Institute of Physics 335 East 45th St. New York, NY 10017	Rev. Scientific Instr.
SAE PREPRINTS Society of Automotive Engineers Two Pennsylvania Plaza New York, NY 10001	SAE Prepr.

PUBLICATION AND ADDRESS	ABBREVIATION
SIAM JOURNAL ON APPLIED MATHEMATICS Society for Industrial and Applied Mathematics 33 S. 17th St. Philadelphia, PA 19103	SIAM J. Appl. Math.
SIAM JOURNAL ON NUMERICAL ANALYSIS Society for Industrial and Applied Mathematics 33 S. 17th St. Philadelphia, PA 19103	SIAM J. Numer. Anal.
S/V, SOUND AND VIBRATION Acoustic Publications, Inc. 27101 E. Oviat Rd. Bay Village, OH 44140	S/V, Sound Vib.
TECHNISCHES MESSEN - ATM R. Oldenburg Verlag GmbH Rosenheimer Str. 145 8 München 80, W. Germany	Techn. Messen-ATM
TURBOMACHINERY INTERNATIONAL Turbomachinery Publications, Inc. 22 South Smith St. Norwalk, CT 06855	Turbomach. Intl.
VDI ZEITSCHRIFT Verein Deutscher Ingenieur GmbH Postfach 1139, Graf-Recke Str. 84 4 Duesseldorf 1, Germany	VDI Z.
VDI FORSCHUNGSHEFT Verein Deutscher Ingenieur GmbH Postfach 1139, Graf-Recke Str. 84 4 Duesseldorf 1, Germany	VDI Forsch.
VEHICLE SYSTEMS DYNAMICS Swets and Zeitlinger N.V. 347 B. Herreweg Lisse, The Netherlands	Vehicle Syst. Dyn.
WAVE MOTION North Holland Publishing Co. P.O. Box 211 1000 AE Amsterdam The Netherlands	Wave Motion
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ZEITSCHRIFT FÜR ANGEWANDTE MATHEMATIK UND MECHANIK Akademie Verlag GmbH Liepziger Str. 3-4 108 Berlin, Germany	Z. angew. Math. Mech.
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GOVERNMENT REPORTS ANNOUNCEMENTS & INDEX NTIS U.S. Dept. of Commerce Springfield, VA 22161	GRA
SCIENTIFIC AND TECHNICAL AEROSPACE REPORTS Superintendent of Documents U.S. Government Printing Office Washington, D.C. 20402	STAR
DISSERTATION ABSTRACTS INTERNATIONAL University Microfilms Ann Arbor, MI 48106	DA

ANNUAL PROCEEDINGS SCANNED

PUBLICATION AND ADDRESS	ABBREVIATION
INSTITUTE OF ENVIRONMENTAL SCIENCES, ANNUAL PROCEEDINGS Institute of Environmental Sciences 940 E. Northwest Highway Mt. Prospect, IL 60056	Inst. Environ.
INTERNATIONAL CONGRESS ON ACOUSTICS, ANNUAL PROCEEDINGS	Intl. Cong. Acoust., Proc.
THE SHOCK AND VIBRATION BULLETIN, UNITED STATES NAVAL RESEARCH LABORATORIES, ANNUAL PROCEEDINGS Shock and Vibration Information Center Naval Research Lab., Code 8404 Washington, D.C. 20375	Shock Vib. Bull., U.S. Naval Res. Lab., Proc.

CALENDAR

JUNE 1979

12-16 **Acoustical Society of America, Spring Meeting,** [ASA] Cambridge, MA *(ASA Hq.)*

18-20 **Applied Mechanics, Fluid Engineering and Bio-engineering Conference,** [ASME-CSME] Niagra Hilton Hotel, Niagra Falls, NY *(ASME Hq.)*

JULY 1979

9-13 **5th World Congress on the Theory of Machines and Mechanisms,** [ASME] Montreal, Quebec, Canada *(ASME Hq.)*

SEPTEMBER 1979

9-14 **Petroleum Mechanical Engineering Conference** [ASME] Hyatt Regency, New Orleans, LA *(ASME Hq.)*

10-12 **ASME Vibrations Conference,** [ASME] St. Louis, MO *(ASME Hq.)*

10-13 **Off-Highway Meeting and Exposition** [SAE] MECCA, Milwaukee, WI *(SAE Meeting Dept., 400 Commonwealth Dr., Warrendale, PA 15096)*

11-14 **INTER-NOISE 79,** [INCE] Warsaw, Poland *(INTER-NOISE 79, IPPT PAN, ul. Swietokrzyska 21, 00-049 Warsaw, Poland)*

OCTOBER 1979

7-11 **Fall Meeting and Workshops,** [SESA] Mason, OH *(SESA, 21 Bridge Square, P.O. Box 277, Saugatuck Sta., Westport, CT 06880 - Tel. (203) 227-0829)*

16-18 **50th Shock and Vibration Symposium,** Colorado Springs, CO *(H.C. Pusey, Director, The Shock and Vibration Information Center, Code 8404, Naval Research Lab., Washington, D.C. 20375 - Tel (202) 767-3306)*

16-18 **Joint Lubrication Conference,** [ASLE-ASME] Dayton, OH *(ASME Hq.)*

17-19 **Stapp Car Crash Conference** [SAE] Hotel del Coronado, San Diego, CA *(SAE Meeting Dept., 400 Commonwealth Dr., Warrendale, PA 15096)*

NOVEMBER 1979

4-6 **Diesel and Gas Engine Power Technical Conference,** San Antonio, TX *(ASME Hq.)*

5-8 **Truck Meeting,** [SAE] Marriott, Ft. Wayne, IN *(SAE Meeting Dept., 400 Commonwealth Dr., Warrendale, PA 15096)*

26-30 **Acoustical Society of America, Fall Meeting,** [ASA] Salt Lake City, UT *(ASA Hq.)*

DECEMBER 1979

Aerospace Meeting [SAE] Los Angeles, CA *(SAE Meeting Dept., 400 Commonwealth Dr., Warrendale, PA 15096)*

2-7 **Winter Annual Meeting,** [ASME] Statler Hilton, New York, NY *(ASME Hq.)*

FEBRUARY 1980

25-29 **Congress & Exposition,** [SAE] Cobo Hall, Detroit, MI *(SAE Meeting Dept., 400 Commonwealth Dr., Warrendale, PA 15096)*

APRIL 1980

21-25 **Acoustical Society of America, Spring Meeting,** [ASA] Atlanta, GA *(ASA Hq.)*

MAY 1980

25-30 **Fourth SESA International Congress on Experimental Mechanics,** [SESA] The Copley Plaza, Boston, MA *(SESA, 21 Bridge Square, P.O. Box 277, Saugatuck Sta., Westport, CT 06880 - Tel. (203) 227-0829)*

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
AHS:	American Helicopter Society 30 E. 42nd St. New York, NY 10017
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
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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 8404 Washington, D.C. 20375
URSI-USNC:	International Union of Radio Science - US National Committee c/o MIT Lincoln Lab., Lexington, MA 02173

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