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SVIC NOTES

MACHINE TOOL DYNAMICS

The key equipment in most manufacturing operations are machine tools such as lathes, grinders, etc. Other factors being equal, the company (or country) having the better equipment will gain a competitive advantage. There are two main reasons for this. First, with better machine tools, manufacturing can take place at a higher rate, with no loss in quality, thereby increasing productivity. Second, with better machine tools there will be less waste and the cost is reduced.

One way to improve the quality of a machine tool is by tailoring its dynamic characteristics. To design a lathe that is chatter-free or a surface grinder that will produce a flat surface with little or no waviness, the engineer must solve several dynamics problems. There are many design techniques available today for optimizing the dynamic characteristics of a machine tool. The finite element method, lumped parameter methods and computer-aided design techniques are all available. These techniques have been used extensively in the aerospace and transportation industries. They provide a good starting point for attacking machine tool dynamics problems.

Let us look at the importance of machine tool dynamics. In certain countries there is an increased amount of research and development on machine tools. In both Japan and West Germany, for example, there is strong Government and private financial support for R&D in this area. The effect of this R&D support is an increase in export sales of machine tools by those countries who have been actively funding R&D on machine tool dynamics. In 1979 the U.S. imported over a billion dollars worth of machine tools. Thirty-seven percent of these were from Japan and twenty-four percent were from West Germany. In addition, those countries having improved machine tools are able to produce manufactured goods at increased quality and reduced cost. Obviously, there is more to the U.S. balance of payments problem in machine tools than the amount of R&D support for machine tool dynamics, but it does have its effects.

A related problem concerns the dynamic characteristics of industrial robots. Today, industrial robots are run at fairly low speeds. Their motions can be analyzed with little or no concern with such dynamic concepts as coriolis forces, etc. But the future will certainly see pressure by management to increase productivity by making the robots work faster. Then the inertia of the robot manipulator arms and coriolis forces come into play. There will also be more problems with the stability of the control system. One major industrial robot manufacturer has already had to install a resonant spring-mass-damper device on a robot manipulator arm to solve a dynamics problem.

In conclusion I would like to emphasize the point that there are many vibration and structural dynamics problems related to machine tools and industrial manipulators which must be dealt with in the immediate future. Those companies (and countries) who attack and solve the dynamics problems first will gain the competitive advantage.

J.G.S.

EDITORS RATTLE SPACE

PRODUCTIVITY IN ENGINEERING

In these times of inflation engineers are increasingly called upon to improve the equipment or processes involved in making products. Increased productivity has long been one of the goals of engineering design and operations. Although engineers contribute to increased productivity with improved designs, processes, or maintenance procedures, they sometimes fail to evaluate their own productivity.

For anyone in the engineering profession management of time is the key to productivity. Delegation of work and maximum use of available technology can also result in greater operational efficiency. It is these two aspects of engineering productivity that I wish to comment on. Everyone -- engineers included -- suffers from the "I'll do it myself" syndrome. Perhaps this trait arises from previous failures in performance or lack of communication, or perhaps it is a result of imagined self importance. Whatever the reason, the failure of engineers to delegate work to subordinates and/or service people leads to inefficiency. It usually means that you, the engineer, either are not doing your job, are doing it inefficiently, or are complaining of being "overloaded" and overworked. The fact is that communicating and working with others would increase efficiency and therefore engineering productivity.

A closely related problem that has concerned this writer for years is the "not invented here" attitude -- that is, the tendency of some individuals not to use ideas, techniques, facts, and/or technology originated by others. Whether this attitude is of conscious or subconscious origin, it can be lethal to productivity in many areas. Actually this attitude is closely associated with the goal of the DIGEST – technology transfer. Engineers, by spending a small amount of time each month assessing the technology that has been developed, could often avoid the costs of redeveloping existing technology. Other forums for technology transfer such as meetings, courses, and symposia are also available today. It appears to me that technology transfer could be a most fruitful area of increased engineering productivity.

R.L.E.

VIBRATIONS OF TURBINE ENGINE BLADES BY SHELL ANALYSIS

A.W. Leissa*

Abstract. A great deal of research has gone into the analysis of free vibrations of rotating turbine engine blades. Most of the work has been done with the blades modeled as beams, however, and is inaccurate for higher frequency modes and for thin, short blades. This paper discusses considerations pertinent to accurate analyses of blade vibrations when the blades are modeled as shells, as well as the accomplishments to date.

With the continually increasing use of turbomachinery at higher performance levels, especially in aircraft, the study of vibration problems arising in rotating blades has become increasingly important. Free vibration frequencies and mode shapes are essential for the analysis of resonant response and flutter.

Literally hundreds of the references published in the past few decades relate directly to the blade vibration problem. However, for the most part the blade is treated as a beam; that is, the problem is characterized as one-dimensional, with the single coordinate measured along the axis of the beam. Among the numerous topics that have been considered in such analyses are: variable cross section, pretwist, nonstraight axes, centrifugal axial force, Coriolis force, shear deformation, rotary inertia, coupled bending and twisting, large amplitude displacements, elastic root constraint, attached shrouds, and damping mechanisms. Many of the references are listed in good review articles by J.S. Rao published previously in this journal [1-3].

A beam model will represent a turbine engine blade reasonably well if the blade is relatively long with respect to its width (i.e., large aspect ratio), the blade is reasonably thick, and only the first few vibration frequencies and mode shapes are needed accurately. Unfortunately, these requirements are often not met. Many blades in sections of turbomachinery have a small aspect ratio. Efficiency demands thin blades. Dynamic response studies require results for many modes, some of which cannot be approximated as beam modes. Furthermore, accurate and complete mode shapes are needed to permit coupling with the aeroelastic flutter problem and the elastic support disk.

It is therefore important to develop two-dimensional methods of analysis, in which the blade is treated as a shell. The purpose of the present paper is to point out the characteristics of such analyses and to summarize progress to date.

PROBLEM DESCRIPTION

The figure depicts a considerably simplified first model of a turbine engine blade. The blade is represented as a thin, shallow, cylindrical shell having one edge (x = 0) rigidly clamped and the other three completely free. The planform is rectangular, having length a and width b; the shell thickness is denoted by h. Displacements of the shell are completely characterized by its two-dimensional middle surface which, in turn, can be related to the xy reference plane. The three components of displacement are u (in the x-direction), v, tangent to the shell midsurface; and w, normal to it.

As depicted the blade rotates with angular velocity Ω about an axis located at some distance (r_0) from the blade root. The figure is drawn for zero angle of attack; that is, the xy plane is perpendicular to the rotational axis. In general, the attack angle can vary between (at least) 0° and 90°.

Rotation of the blade causes centrifugal body forces which, at large Ω, can cause effective stiffening of considerable magnitude. The frequencies and mode

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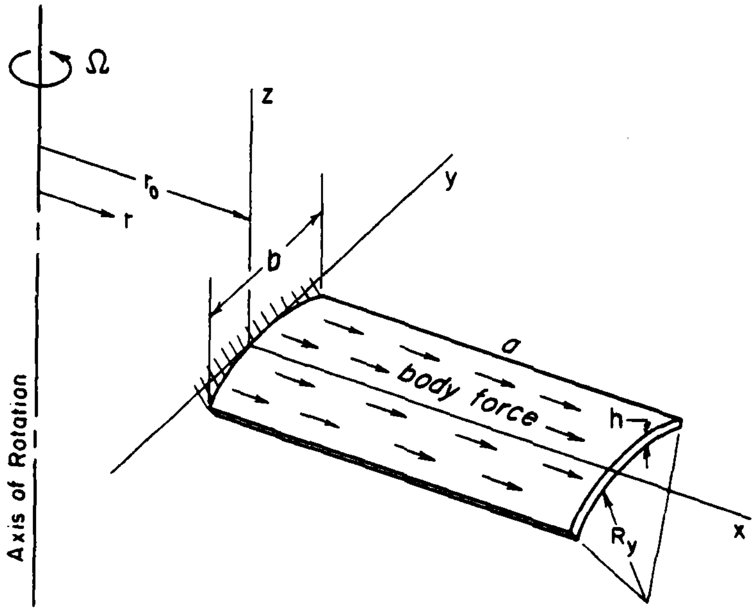

Rotating Blade, First Model

shapes are thus direct functions of Ω. The body forces cause initial stresses within the shell which, for constant Ω, can be considered constant in time and therefore static. As a first approximation the body force can be taken as parallel to the x-axis for all elements and proportional to r and Ω^2; this forces initial stresses that vary parabolically along the length.

A more careful analysis shows the existence of a y-component of centrifugal body force, and for non-zero angles of attack, a z-component of centrifugal force that is destabilizing -- causing lower frequencies -- and that can be significant. Coriolis forces also appear in the problem but for current applications are usually negligible.

A thorough analysis of the problem requires a two-step solution:

- determination of the initial stresses for the shell loaded by static body forces
- determination of the eigenvalues (frequencies) and eigenfunctions (mode shapes) of the free vibration problem, using the initial stresses as input

Significant thermal gradients can also affect the initial stresses.

In general, of course, the geometry of the mid-surface of a blade is considerably more complicated than that depicted in the figure. Rather than having curvature in only one direction, measured by the radius R_y shown, the mid-surface has two components of curvature and one of twist; these components require three coefficients R_x, R_y, and R_{xy} for definition. Although curvature in the x-direction is typically small, the twist is usually considerable. Furthermore, R_x, R_y, and R_{xy} are not constants but vary along the blade.

Blade thickness is typically not constant but varies with both x and y, generating an airfoil shape in the y-direction. In addition, blades often have hollow portions for cooling purposes. These portions must be considered in the effective thickness at each location and give rise to the possibility of different effective bending and stretching thicknesses. The blade planform is generally not rectangular. The width is usually tapered, and the shape can be skewed with respect to the x-axis. A shroud is often attached at a cross section along the x-axis to provide additional circumferential stiffening from the neighboring blades. Rotor disks typically have significant flexibility, which can be accommodated by utilizing elastic support conditions at the root.

Material properties need not be isotropic and are often anisotropic as, for example, in the case of advanced designs using composite materials. Hollow sections, composite materials, and temperature degradation can also require use of a nonhomogeneous material for the analytical model.

Finally, if the blade is not thin, thick shell theory must be used. If the curvatures are not shallow, deep shell theory must be used; serious difficulties arise in the geometry of the middle surface, however, because the desirable coordinate lines are not lines of principal curvature.

FLAT PLATE MODELS

A plate model of a blade is of limited value because the plate is flat and has no curvature; a very small amount of curvature will cause considerable increases in some of the natural frequencies. However, a plate model is useful

- in identifying the existence of modes that cannot be found by beam analysis, particularly those involving chordwise bending
- as a limiting case check for the results of shell analyses

Numerous references deal with the vibrations of cantilever plates of various shapes, especially rectangles, parallelograms (or skews), trapezoids, and triangles [4-7]. In 1952 Grinsted [8] compared experimental results for flat plates with actual turbine blades.

But in order to have a meaningful representation of the turbine engine blade problem, rotational effects must be included in a plate vibration analysis. These effects were included in an excellent paper by Dokainish and Rawtani [9], who used a rectangular plate. Of particular value in this work was the utilization of all three components of centrifugal body force which arise for non-zero attack angles. Their work shows the significant destabilization that can result from the z-component of force. The plate was modeled by a mesh of triangular finite elements. Convergence studies for various mesh sizes were made, and numerical results for frequencies and mode shapes were presented for the first five modes. The results showed the variation with rotation speed (Ω), disk radius (r_0), and aspect ratio (a/b). In addition, useful empirical formulas were derived that permit extrapolation of the results to other values of the operating parameters affected by the speed of angular rotation.

Similar results for rotating flat plates have been obtained by Bossak and Zienkiewicz [10], who used isoparametric, solid finite elements.

TWISTED PLATE MODELS

A twisted plate is a special case of a shell in which the curvature of the midsurface in two orthogonal directions is zero (i.e., $R_x = R_y = \infty$) and the torsion (or twist) is not zero (i.e., $R_{xy} \neq \infty$). Thus the resulting blade model has no camber. A number of researchers have examined the problem for the case when R_{xy} is a constant; the resulting surface is a right helicoid.

The twisted plate model, when properly used, will show not only the chordwise bending modes found in plates (but not in beams) but also the increasing frequency of torsional modes with increasing angle of pretwist.

Doktainish and Rawtani [11, 12] extended their rotating plate analysis to the case of a twisted plate; they again used flat triangular elements. They considered the effects of static deformation due to angular rotation upon vibration frequencies. Numerical results were given for a/b = 1, 2, 3 and for twist angles up to 90°.

Petricone and Sisto [13, 14] used the Rayleigh-Ritz method to examine two types of twisted plates corresponding to rectangular and skewed (i.e., parallelogram) plates pretwisted at a constant rate. Membrane strains and curvature changes were taken from helicoidal shell theory; displacements u, v, and w were represented as Legendre polynomials. Numerical results were obtained for twist angles up to 45°, for aspect ratios $1 \leq a/b \leq 2$, and for b/h = 20. Rotational effects were not considered.

The twisted plate problems were also studied by Walker [15] using quadrilateral, finite shell elements; he compared his results with ones obtained previously [12, 14].

The use of holographic interferometry to obtain experimental frequencies and nodal patterns for twisted plates has been demonstrated by MacBain [16]. The patterns, which were very clear, were presented for the first ten modes of a particular blade. Numerical results for both rotating and nonrotating blades were also obtained using the NASTRAN finite element program; they were compared with the holographic results.

Gupta and Rao [17] used Hamilton's principle and shallow shell equations to analyze the torsional vibration of twisted plates. They considered aspect ratios varying from 1 to 8 with pretwist angles of 0° to 90°. The results were compared with other numerical results [4, 12, 16] and beam results. Rotational effects were not considered.

Vibrations of nonrotating pretwisted plates were also investigated by Toda [18] and Beres [19]. Toda used the Galerkin method, beam functions, and shallow shell theory to analyze rectangular forms. He compared his results with those from experiments. Beres [19] used Hamilton's equations, Novozhilov strain-displacement shell equations, and power series trial functions. Nodal patterns and frequencies of the first five modes were given for several configurations of straight and skewed helicoidal shells.

The finite element method was also used [10] to study the pretwisted blade having linear thickness variation in the y-direction (see the figure). Numerical results were compared with experimental results obtained previously by Plunkett [20].

CAMBERED SHELL MODELS

Turbine engine blades typically have cambered cross sections. For the simple model shown in the figure, the cross section is determined by the radius of curvature R_y. A small amount of camber considerably increases the longitudinal (i.e., x-direction) stiffness of a blade and, correspondingly, the frequencies of vibration modes that are primarily longitudinal bending. For thin blades a beam model is less accurate in representing these modes, partly because of the warping of cross sections.

A significant number of studies [10, 15, 21-41] have involved the vibrations of cantilevered shells having camber. Most of the studies were based on some form of a finite element method of analysis, and virtually all of them treat only the statically-held blade, thereby ignoring rotational inertia effects. However, compared with a total literature of well over 1000 references dealing with the free vibrations of shells [7, 42], the number treating this important problem is small and recent.

Particularly notable is the relatively early work of Olson, Lindberg, and Sarazin [33, 35-37]. Their earliest work [35, 36] was based upon a cylindrical shell, quadrilateral finite element having 28 degrees of freedom. Numerical results were presented for the frequencies and mode shapes of the first 12 modes of a cantilevered cylindrical shell having $a/b \approx 1$, $b/R_y \approx 1/2$ and $R_y/h = 200$ (see the figure). Significant chordwise bending effects not determinable by beam theory were found in all but the first, second, and fourth modes. The effects upon frequencies and mode shapes of varying R_y/h (∞, 1000, 500, 300, 200) were also studied; most of the frequencies were strongly affected but others (predominantly chordwise bending) were affected relatively little. Numerical results were also compared with experimental ones.

Later work of Olson, Lindberg, and Sarazin [33, 37] utilized a doubly-curved triangular finite element. Such elements require fewer degrees of freedom to represent generally curved shells than do flat triangular elements. The procedure was demonstrated on two blade vibration problems: the constant thickness blade examined previously [35, 36] and a linear thickness variation in the y-direction (see the figure).

Walker [15] developed a conforming finite shell element in the form of a doubly curved right helicoidal shell and used it to analyze three types of cambered blades:

- a set of four constant thickness cylindrical shells including the one studied by Olson, Lindberg, and Sarazin [33, 35, 37]
- a cylindrically curved blade of trapezoidal planform

- a cylindrically curved blade with linear thickness variation in one direction; this blade was also analyzed previously [33]

The most severe test was one of the first set having the least shallowness ($b/R_y \approx 1$) and the largest thickness (R_y/h = 96). For this case, no classical first bending mode could be found and, even with 205 degrees of freedom, the first seven frequencies were poorly convergent. The method was also demonstrated on a Rolls-Royce compressor blade and compared with experimental results and those obtained by another finite element approach [20].

Several references [22, 23, 25, 26, 32] analyze the free vibrations of cambered turbine blades by methods other than finite elements. The Raleigh-Ritz-Galerkin methods or their equivalent are the approaches generally taken; the type of trial functions requires consideration. A hollow blade was represented by joining two cylindrical shells of different curvature using proper continuity conditions along the parallel free edges $y = \pm b/2$ [22, 23].

The work of Henry and Lalanne [29, 30] is notable because they considered the effects of rotation. They used a finite element method (plate triangular elements); results for the first five modes of an existing (nonspecified) compressor blade at 0 and 10,000 RPM were presented.

OTHER CONSIDERATIONS

Shrouds further complicate the blade vibration problem. They can be characterized as small, platelike elements attached to both sides of the blade, normal to the xy-plane, at some distance from the clamped root. Sagendorph [40] incorporated shrouds into a finite element analysis of an actual turbine blade. He considered free shrouds and locked-up shrouds. Shrouds were located at midspan ($x = a/2$). He compared finite element frequencies and mode shapes with experimental results obtained by holography.

Efforts to improve the operating capabilities of turbine engine blades with composite materials are being made. Finite element methods for determining the free vibration characteristics of such blades have been developed [43-45].

The problem of coupling between blades and disks is an important and difficult one, especially when both inertial and elastic coupling are considered. Although much work has been done in which the blades are treated as beams, very little has been accomplished thus far with the more sophisticated shell model of a blade [34].

Finally, it is obvious that the free vibration problem of a shell-like structure rotating at high speeds occurs in many technical applications other than turbine engine blades. Examples of applications in which shell models are necessary and finite element methods have been successfully employed include automobile radiator cooling fan blades [46], impeller blades [47-49], turbopump inducer blades [50], and marine propeller blades [51].

Related technical areas in which considerable research is being done into the free vibrations of rotating blades include helicopter blades, aircraft propeller blades, and wind turbine blades. For the latter problems, however, the aspect ratios are large, and beam models should be adequate for a large number of low frequency modes.

ACKNOWLEDGEMENT

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

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

This issue of the DIGEST contains articles about nonlinear rotor dynamics analysis and wave-induced ship hull vibrations.

Professor M.L. Adams of the Department of Mechanical Engineering, University of Akron, Akron, Ohio has written a paper which presents a state-of-the-art review of an increasingly important subject. nonlinear rotor dynamics.

Dr. J.J. Jensen of the Department of Ocean Engineering, Technical University of Denmark has written a paper reviewing methods for measuring wave-induced ship hull vibrations. The theoretical methods available for predicting whipping and springing vibrations are also reviewed.

NONLINEAR ROTOR DYNAMICS ANALYSIS

M.L. Adams*

Abstract. This paper presents a state-of-the-art review of an increasingly important subject: nonlinear rotor dynamics. Recent advances in this field have led to new computer simulation techniques that have been shown to be accurate and computationally efficient. These techniques simulate transient and steady-state system responses of complex multi-bearing flexible rotor machines that involve highly nonlinear effects. This new computational capability should be of great value in answering the increasing number of failure-mode analysis questions.

It has become apparent in recent years that an important class of rotor dynamics problems exist for which linear mathematical models do not provide realistic answers. The most important nonlinearities occur at bearings when vibration amplitudes become large, approaching the full bearing clearance. Typical examples include high unbalance from turbine blade loss at running speed, reactor coolant pump response to earthquakes, naval machines under conditions of high intensity shock, and gas turbine aircraft engine *squeeze-film damper performance*. When vibration levels are high, linear theory frequently predicts motions -- at the bearings and other close-running rotor-stator clearances -- that exceed actual clearances. In addition, linear theory automatically filters out such important vibratory phenomena as subharmonic resonance and motion limit cycles. When strong nonlinearities are present, therefore, linear theory can provide grossly erroneous predictions, qualitatively as well as quantitatively.

Proper analysis of nonlinear rotor dynamic phenomena requires doing away with classical linear journal bearing models; these typically utilize eight spring and damping coefficients: K_{xx}, K_{xy}, K_{yx}, K_{yy}, C_{xx}, C_{xy}, C_{yx}, C_{yy}. In nonlinear analysis system motions are computed by numerical integration of the governing equations of motion. Such integration requires solving appropriate bearing side equations for each bearing -- typically, Reynolds lubrication equation -- at each step of the numerical time integration scheme. The procedure is considerably more complex than that involving linear theory. The first use of this approach on a rotor was probably that of Castelli and McCabe [1] who, in 1967, analyzed a rigid rotor on two pivoted-pad, gas-lubricated journal bearings. Even for this simple system, computer costs were considerable because of the computers in use at that time and the numerical schemes employed ertheless, their work [1] set the stage for the work that is computationally feasible today because they identified the need for more advanced computational schemes for efficient analysis of multi-bearing flexible rotors under nonlinear conditions.

During the interim between 1967 and the last few years, analytical work basically involved attempts to enlarge the complexity of solvable problems and heuristic approaches to identify and explain nonlinear rotor vibration signals that were being captured from field and laboratory measurements. Sweet and Genin [2], for example, demonstrated in 1972 that nonlinear descriptions for journal bearing fluid-film forces are required in order to obtain results that agree with certain experimental observations.

Tondl [3] postulated that journal orbits are comprised of a rotational-speed harmonic component combined with various integer fractional harmonic components (1/2, 1/3, 1/4 . . . times rotational speed). He established the general orbital patterns observed when subharmonic resonances are present and thereby explained, within the context of subharmonic resonances, earlier experimental results by Licht [4] for a rotor supported on gas-lubricated foil bearings. Subharmonics are possible only if nonlinearities are present, because stable linear systems will exhibit only the excitation force frequency

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(e.g., the rotational-speed mass unbalance force) in steady-state motion, as dictated by the solution form of linear equations of motion.

TRANSFER MATRIX APPROACH AND LIMITATIONS

Initial efforts directed at the multi-bearing flexible rotor problem utilized computational approaches that were already being used for linear steady-state flexible rotor problems. The transfer matrix approach was embedded in a numerical time integration scheme known as marching. The popularity of the transfer matrix method in linear analyses grew out of its adaptability to early digital computers that had, by present standards, small memory core capacity. Modal decomposition schemes were not generally applied to large dynamic systems until the development of computers with expanded storage capacities.

Shen [5] was possibly first to adapt the transfer matrix approach to time-transient rotor dynamics problems. Shen's mathematical model, however, was based on a planar projection of the orbital motion of the rotor, i.e., planar motion of a beam. This was a major shortcoming, although Shen's work provided the groundwork for others who soon extended this approach to accommodate four degrees of freedom at each rotor mass station. Kirk and Gunter [6] and Giberson (see Rieger [7]) developed nonlinear time-transient rotor response computer programs based on the transfer-matrix method of solution. Application of these computer programs exposed two basic weaknesses of the transfer-matrix method when applied to time-transient problems. First, it was found that the inherent susceptibility of the transfer-matrix approach to round-off errors limits its use in time-transient problems to rotor models with ten or less mass stations [6]. Second, even for such small problems, this method was expensive from the standpoint of the computer costs associated with large central processor unit requirements.

Hibner [8] used the transfer-matrix method in a pseudo-nonlinear approach to compute steady-state unbalance response of a complete engine. He used an approximate solution to the Reynolds lubrication equation for squeeze-film dampers to generate an equivalent radial linear spring and damper for a specified circular orbit. He iterated between the rotor orbit radius and the associated radial spring and damper values until all of the rotor orbits at each of the squeeze-film dampers were consistent with their respective spring and damper values. Although Hibner's approach is actually more linear than nonlinear, he at least insured that the predicted rotor orbits did not violate the constraints imposed by the damper radial clearances.

Hibner's approach [8] is limited to a circular-orbit assumption and does not lend itself to the computation of steady-state motion. Because it is basically a linear approach, it also filters out such nonlinear phenomena as subharmonic resonances. The main value of the approach appears to be that it is an efficient means for performing large-scale parametric studies of entire engine configurations during the initial design phase of engine development.

MODAL METHOD

Initial use of the modal method in the field of rotor dynamics was for linear systems. This use was motivated by the weakness of round-off error inherent in the transfer-matrix approach, even in linear steady-state analyses. Notable applications of the modal method to linear rotor-bearing systems include those of Lund [9, 10] and Black [11] for steady-state motion and Childs [12] for transient linear systems.

During the mid-1970s, two uncollaborated efforts were under way to use the modal method to analyze complex multi-bearing flexible rotor systems and to account for all important nonlinearities. In each case free-free rotor undamped modes and frequencies were used to model such complex rotors as large steam turbine generator sets. The rotor was treated as a free-free flexible body in space, upon which any system of static and dynamic forces could act -- i.e., dead weight distribution, bearings, seals, aerodynamic forces, rubs, impacts, and unbalances.

Holmes [13, 14] focused his attention on the effects of vertical misalignment of bearings, a common problem on turbine generator (T/G) sets, which can have as many as 11 journal bearings on one rotational centerline. Holmes restricted his study to a four-bearing flexible rotor with fixed-arc journal bearings. Two-pole machines in Europe run at 3000 RPM (i.e., generate 50 CPS AC current) and are only marginally stable with fixed-arc bearings. In the United States two-pole T/G sets run at 3600 RPM and are also only marginally stable when fixed-arc bearings are used (see Adams [15]). As operating conditions change and as some initial settling of the support structure occurs, the statically indeterminate journal bearing loads can change considerably. On such machines of marginal stability, this shifting of static bearing loads can cause intermittent periods of rotor-bearing instability frequently called oil-whip. Holmes used his analysis to study inception of oil-whip and the ensuing nonlinear orbits under variable bearing load conditions with two types of fix-arc bearings: partial-arc and two-lobe (lemon bore) configurations.

Holmes' treatment of the bearings differs somewhat from that of Adams [16]. Holmes used the long-bearing approximate solution to the Reynolds lubrication equation with an end-leakage correction factor. Adams used a Fourier-series expansion of Reynolds partial differential equation into a truncated set of ordinary differential equations; the solution is convergent to the exact two-dimensional solution. Both treatments require that the Reynolds equation be solved for each bearing arc at each time step of the numerical marching integration scheme. Squeeze-film damping, film cavitation, and turbulence are all taken into account.

In addition to fixed-arc bearing configurations, Adams [16] treated general pivoted-pad journal bearing configurations. His pivoted-pad model includes options to handle rigid-pivots, linearly elastic pivots, Hertzian-contact pivots, Hertzian-contact pivots in series with a linearly elastic pivot support, and elastic-plastic pivots applicable to problems involving high-intensity shock loading. In all but the rigid-pivot model the pad can come off the pivot surface, as can occur with unloaded pads.

Adams [16] solved a number of different problems including rotor-bearing instability, emergency unbalance in T/G sets under conditions of turbine blade loss at running speed, T/G sets and PWR reactor coolant pumps under an earthquake base-motion input condition, and high-intensity shock of ocean vessel rotating machinery. The rotor-bearing stability study produced good agreement with results from a laboratory flexible rotor. One case analyzed involved eight journal bearings on one continuous rotational centerline.

Probably the most important and interesting problem analyzed was a low-pressure steam turbine under a blade-loss condition at 3600 RPM. The rotor shown in Figure 1 is a standard 3600 RPM low-pressure steam turbine. Analyses were performed to determine the vibration and transmitted force levels under a

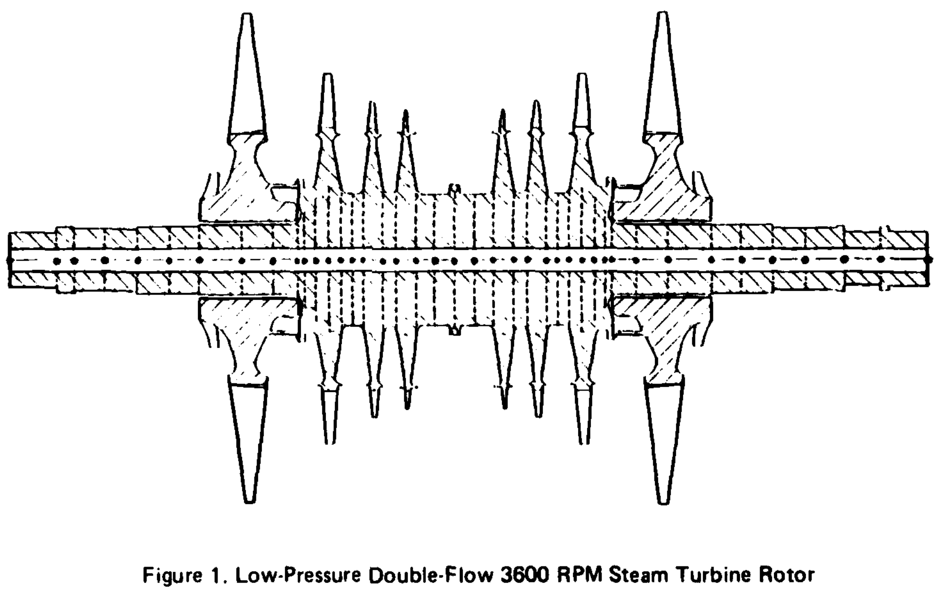

Figure 1. Low-Pressure Double-Flow 3600 RPM Steam Turbine Rotor

condition of blade failure at operating speed. Two types of systems were analyzed, both with the rotor of Figure 1. In the first system standard partial-arc journal bearings were used; in the second system pivoted-pad journal bearings were used. The conditions simulated corresponded to the loss of ½ of a single last stage blade, this loss is equivalent to a 100,000 lb co-rotational excitation force. Representative results at one of the journals are shown in Figures 2 and 3. Partial-arc bearings were shown to be susceptible to large amplitude subharmonic resonance vibration, whereas pivoted-pad bearings were shown to heavily damp subharmonic resonance (15, 16). This damping was more clearly seen when the maximum peak-to-peak signals of the journal orbits shown in Figures 2 and 3 were transformed using Fourier transforms into the frequency domain shown in Figure 4.

It is the author's opinion that rotor subharmonic resonance is the probable reason for two well known T/G catastrophic failures Kainan, Japan, in 1972 and Porcheville, France, in 1977. Both units were of 600 MW capacity and both used fixed-arc journal bearings to support the low-pressure turbine rotors.

SUMMARY

The state-of-the-art of computational nonlinear rotor dynamics has advanced considerably in the last ten years. The significance of this advancement is that, for many important specialized problems in this field, it is not feasible to obtain answers experimentally intentional failure of a turbine blade on a 600 MW steam turbine/generator unit is not feasible.

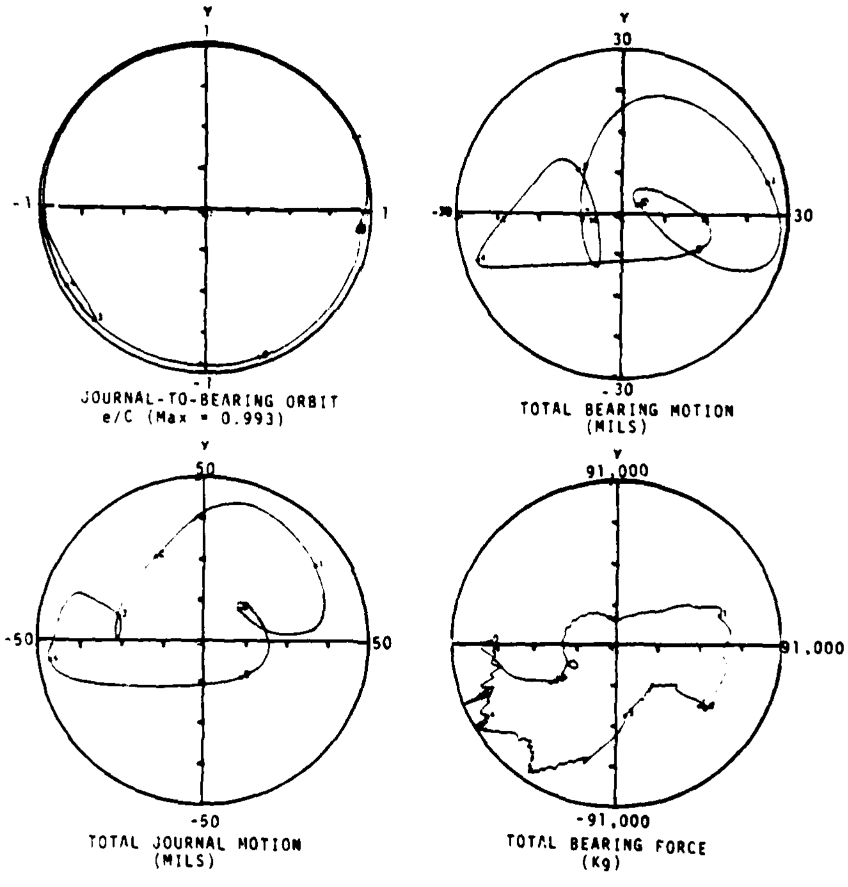

Figure 2. Turbine Nonlinear Steady-State Response at Journal Bearing; Blade Loss with Partial-Arc Bearings. Timing Marks Located at ½ Revolution Time Intervals

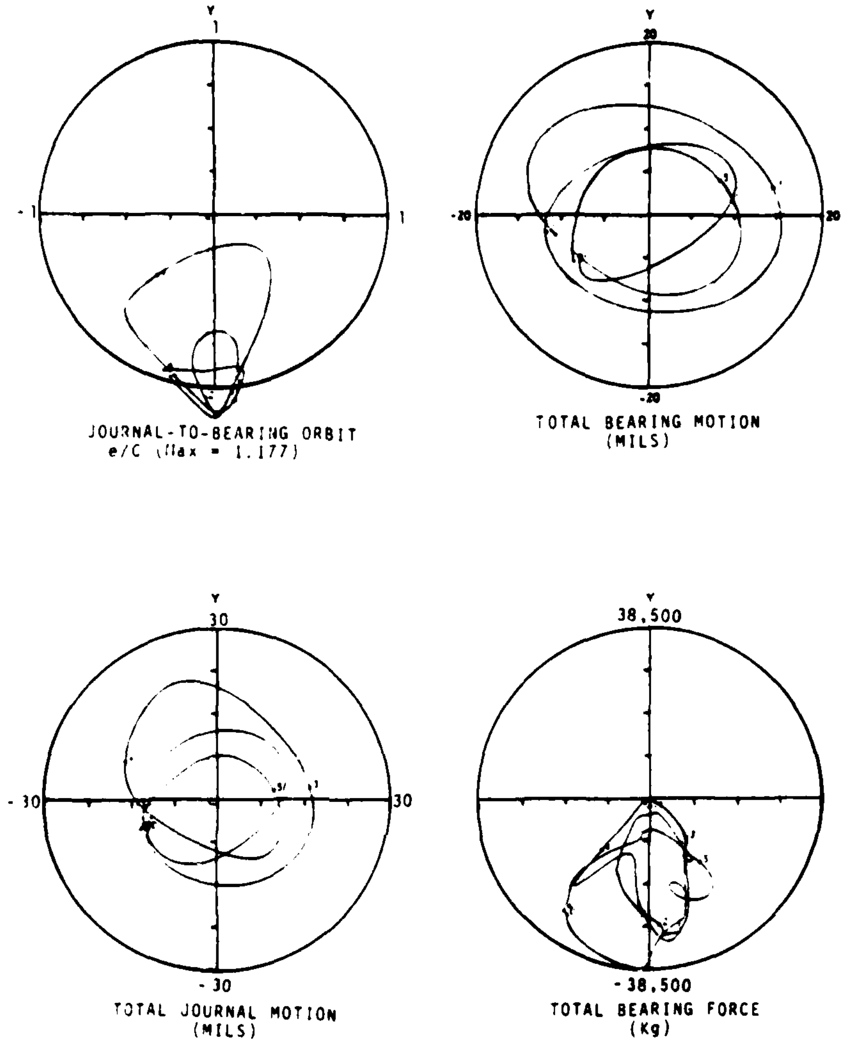

Figure 3. Turbine Nonlinear Steady-State Response at Journal Bearing; Blade Loss with Pivoted-Pad Bearings. Timing Marks Located at ½ Revolution Time Intervals

Recent advances now make it feasible to analyze efficiently and accurately most nonlinear problems that arise in actual machinery applications.

It is important to note that linear rotor dynamics analyses are still vitally important tools. For common design problems in which nonlinearities are not significant, the standard linear analytical tools are more appropriate than the advanced nonlinear time-transient schemes. Nonlinear rotor dynamics analysis is a highly specialized tool.

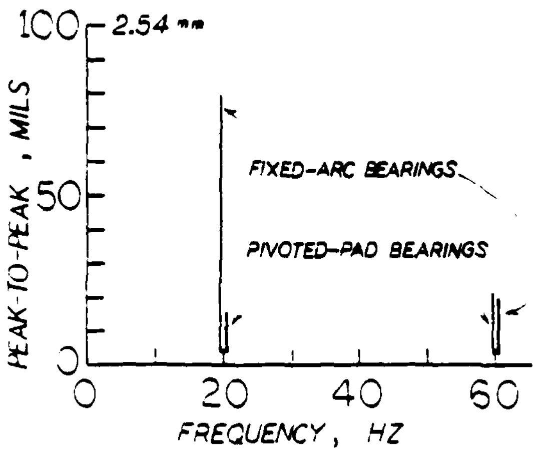

Figure 4. Journal Peak-to-peak Steady-state Vibration Frequency Content

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WAVE-INDUCED SHIP HULL VIBRATIONS: A REVIEW

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Abstract. This article reviews methods for measuring wave-induced ship hull vibrations. The theoretical methods available for predicting whipping and springing vibrations are also reviewed.

The rapid increase in speed and size of ships constructed during the 1960s led to the realization that wave-induced ship hull vibrations can give rise to significant stresses in the hull. These wave-induced vibrations are usually classified as whipping or springing motions, depending on whether the vibration pattern is transient or steady state.

Vertical modes of vibration have been the focus of interest, partly because vertical wave forces are dominant and partly because two-node vertical modes are usually associated with the lowest eigenfrequency of the hull. However, in ships with very large openings it is possible that torsional modes can also be excited by waves [10].

Previous reviews on wave-induced hull vibrations are available [11, 23, 28, 33, 37, 44, 56, 63]. In addition, the International Ship Structures Congress (ISSC) publishes reports every three years.

MEASUREMENTS OF WAVE-INDUCED HULL VIBRATIONS

Transient wave-induced hull vibrations are due to hydrodynamic impact pressures arising from bottom slamming, bow flare impact, and shipping green water. Full-scale measurements [2-4, 47, 55] performed on board container ships, ore carriers, and tankers have shown that, in rough seas, the magnitude of these whipping stresses can be at least the same order as wave bending stresses. The vibration pattern is mainly in the form of the two-node vertical mode [2-4]. Whipping stresses are important because they can cause plate panels in the ship's forebody to buckle, buckling has occurred in several fast cargo ships [46]. Because whipping stresses are caused by large relative motions of the ship, whipping is for the most part a problem for fast ships in rough seas.

Steady-state or continuous wave-induced hull vibrations have been measured in tankers [5, 18, 31, 32, 42, 50, 55, 57, 58], container ships [4, 58], and Great Lakes bulk carriers [13, 16, 45, 54], as well as in other ships [42, 58]. These measurements have shown steady-state hull vibrations mainly in the two-node vertical mode [16], associated bending stress amplitudes are as much as 50 percent of the corresponding wave bending stresses [6, 15, 42].

Springing stresses are explained as excitation of the two-node mode, in part due to the high frequency portion of the wave energy spectrum and in part due to nonlinear forces arising from changes in added mass of water and buoyancy during the vertical motion of the ship. Maximum stresses are measured in moderate seaways, perhaps because speed reduction and change of course are usually ordered by captains in rough seas. Although springing stresses can sometimes be almsot the same order of magnitude as wave-bending stresses, estimates for large tankers [15, 18, 61] show that the maximum bending stresses during 20 years of service will increase by only 5 to 10 percent due to springing. However, the significance of springing stresses has not yet been settled; obviously, high-frequency springing stresses increase the cumulative fatigue damage of the hull.

In addition to full-scale measurements, a large number of model experiments have been performed. In some of them [1, 26, 27, 36, 60, 61] the problem of scaling is discussed in detail.

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THEORETICAL METHODS - WHIPPING VIBRATIONS

The excitation forces for impulsive whipping vibrations are wave-impact loads -- mainly those resulting from bottom slamming, bow flare impact, and shipping green water. The spatial distribution and magnitude of the pressure impulse generated when a transverse section of the hull re-enters the water with sufficient velocity after a bottom emergence has been studied [35, 51]. Linear ship theory and an assumed time-history of this pressure field, partly verified by experiments, have been used to calculate the impact forces along the hull in regular waves [35]. The resulting whipping vibration bending moments are determined by the normal mode approach. In this approach the natural vertical bending modes are calculated by taking into account shear rigidity, rotatory inertia, and added mass of water (without free surface effects). Only a few modes need be calculated because the two-node mode dominates [35]. A commonly used empirical representation of structural damping is applied [7, 28]. The numerical results are in reasonable agreement with model experiments in regular waves [35].

Other approaches for determining whipping vibrations have been reported [12, 64]. The total hydrodynamic force distribution on the hull -- including both the impact forces and the usual added mass, buoyancy, and damping terms -- was calculated using current values of ship motion parameters. These methods thus take into account the effects of impact forces on vertical motion and hull velocity. However, the effect seems to be small [64] except for fast boats [48].

One solution procedure [64] for whipping vibration is a Galerkin method. Mode forms were used for a uniform beam, a direct time integration was then used. The problem has also been solved using finite differences and the Runge-Kutta method [12]. It was shown that the inclusion of hull flexibility is essential [64] and that the choice of structural damping is not so critical [12].

Other methods [12, 64] include, in addition to impact forces due to bottom slamming, the effects of bow flare impact. This impact is represented by the nonlinear and discontinuous change in momentum of the added mass of water. These hydrodynamic forces were previously studied using more approximate methods [19, 38]. In one case the impulsive forces induced at the bow due to different wave profiles were calculated [38]; in the other case the transient response of the hull was calculated using an assumed triangular wave at the bow [19]. Conclusions [19] with regard to the influence of hull flexibility and damping on the whipping bending moment were similar to those reported elsewhere [12, 64].

Although reasonable results can be obtained for whipping vibrations in regular waves, predictions in stochastic seaways are not yet reliable. The main problem in calculating whipping vibrations in a stochastic seaway has to do with correlating the magnitudes of impact pressures on the various transverse sections. In one method [35] pressures corresponding to a given probability level are calculated; the method then parallels that for analysis in regular waves. An approximate value for the whipping bending moment is obtained at the same probability level. In another approach [36] the mean value and standard deviation of the whipping bending moment are calculated. It is assumed that the impact pressures on each section are statistically independent. However, model experiments [36] indicate that the results thus obtained severely underestimate the standard deviations.

Still another method [65] involves approximating the excitation with a function of the relative vertical motion at a given time and location, including the first and second derivatives of this motion. The stationary stochastic properties of the motion quantities, as derived from linear analysis, are then used to calculate the statistical distribution of the excitation by the Monte-Carlo method.

Short-term predictions of whipping bending moment and the statistical distribution of sea states in operational routes have been used to make long-term predictions of the whipping response [35, 36]. The conclusion drawn for a fast container ship was that whipping stress corresponding to a probability level of less than 10^{-5} to 10^{-6} will exceed the wave bending stresses calculated to the same probability level [35, 36]. However, these results should not be extrapolated to very low probabilities because it is difficult to model the actions taken by captains in severe sea conditions.

THEORETICAL METHODS - SPRINGING VIBRATIONS

The possibility that a ship hull can experience continuous vertical vibration resulting from an unsteady hydrodynamic pressure field acting on the hull has been recognized since the early 1960s [5]. As previously stated, these so-called springing vibrations can give rise to significant hull bending stresses. At present, two theories are offered to explain and determine these stresses.

One group of authors [8, 9, 17, 20, 27, 43, 62] advocates determining hydrodynamic forces from linear strip theory. Springing motion is explained by an entirely linear theory: excitation of the lowest hull natural frequency by harmonic components in the high frequency part of the wave energy spectrum. Many comparisons with model experiments [26, 27, 59] and full-scale measurements [4, 22, 54, 58] have been made using these linear theories. For certain types of ships, comparisons between theoretical and measured springing stresses are in reasonable qualitative agreement. However, some fundamental problems arise with the application of linear theories.

One problem is the uncertainty of determining high-frequency hydrodynamic loads on the hull. Most theories thus far determine the loads by methods verified only for wavelengths greater than half the length of the ship [1, 60] -- that is, for far greater wavelengths than those relevant for the excitation of springing. A more accurate procedure [52] based upon a Green's function approach has recently been suggested. It is time-consuming on the computer, however, and numerical problems arise in short waves for ships with V-shaped sections.

The second problem with linear theories is concerned with the determination of appropriate damping values. Because springing response is mainly a resonance problem [27] in linear formulations, the choice of damping coefficients is essential. Sectional hydrodynamic damping is usually taken as the sum of damping due to generation of surface waves and a speed-dependent term given as the forward speed of the ship multiplied by the rate of change of the added mass of water along the hull [9, 17, 20, 54]. The first term is negligible compared with the second term, the second term is of the same order of magnitude as structural damping [17, 37, 54]. Definite conclusions regarding the calculation and importance of the high-frequency part of hydrodynamic damping have not yet been stated [1, 52, 54, 56, 65]. Various empirical formulas have been applied for structural damping; most are based on results from full-scale measurements. Structural damping for a large ship is generally from 25 to 50 percent or ¼ to ½ the value of critical damping [23].

The third problem arises when springing stresses in a stationary stochastic seaway are to be calculated. The response amplitude operator for the springing bending moment is easily determined in these linear theories [9, 17, 20, 54]. After the response amplitude operator has been determined, the frequency response method is applied. An assumed wave energy spectrum is used to obtain the response spectrum of the springing bending moments [17, 20, 54] in the stationary sea state. However, the results thus obtained depend heavily on the high-frequency part of the wave energy spectrum, where knowledge is limited [54].

Another problem recently pointed out by Van Gunsteren [23] is that the formation of wave groups can result in rapid changes in wave energy over small time intervals; the springing response thus becomes nonstationary. The effect of this response on the springing problem depends on the degree of damping and on the narrow-band characteristics of the wave energy spectrum. Underestimation of the springing response as a result of neglecting these nonstationary effects is likely, especially for broadband spectra and lightly damped systems. However, due to lack of sufficient wave data no quantitative analysis of nonstationary effects has been performed [23].

The springing stress amplitude obtained in a stationary seaway can be combined with the wave bending stresses [14, 15, 49, 58]. Because the two values are almost statistically independent, the resulting stress level is less than their algebraic sum. Finally, long-term (lifetime) statistical analyses have shown that the effect of springing on the maximum stress level is of the order of 5 to 10 percent [15, 18, 61].

Thus, although the background of linear theories used to predict the springing response in regular and irregular waves is questionable, these theories yield results that agree reasonably well with full-scale measurements, especially for such ships as loaded tankers and bulk carriers.

The second method used for the springing problem assumes that nonlinear exciting forces play a significant role. In a number of papers Kumai [39-41] and other Japanese researchers [31, 34] have elaborated a so-called momentum theory, in which the exciting springing force is due to the total time derivative of the momentum of the added mass of water. They assume various deterministic wave profiles and obtain springing vibrations as super-harmonic resonances with higher order exciting forces. It is difficult to apply this approach to a statistical seaway; furthermore, the theory neglects free surface effects in calculations for the added mass of water [56]. Some thought has also been given to the possibility of parametric excitation of springing due to the time variation of the sectional added mass of water [41].

Alternate and perhaps more promising ways of including nonlinear hydrodynamic forces in the analysis of springing in regular waves include time integrations of the governing equations, taking into account the total derivative of the added mass of water [44, 62, 63] and perturbational procedures [21, 24, 25, 29, 30, 65]. The perturbational procedures used for springing analysis include first and second order terms only; the first-order terms are identical to those of the linear theories mentioned above. Calculation of second-order terms is based either on an accurate solution of the two-dimensional pressure field around the hull [25] or on semi-empirical, but still rather accurate, perturbational methods [21, 29, 30]. Extensions of these nonlinear theories to random waves have been difficult; only few results are available [30, 62]. The results obtained in one case [30] involved using an exact stochastic procedure for quadratic functionals; the results indicate that, whereas a linear analysis such as those proposed [9, 17, 20, 62] will suffice for loaded ships such as tankers and bulk carriers, linear and nonlinear hydrodynamic forces will make contributions of equal importance to the springing bending moments in fast container ships.

CONCLUSIONS

The theoretical methods for calculating the transient whipping response in regular waves show reasonable agreement with measurements. However, for ships sailing in random waves, more research must be done before whipping stresses can be included in the design procedure in a rational way. The main problem concerns the correlation between the pressure peaks on each section on the hull and the influence of speed reduction and changes of course on the long-term prediction of whipping stresses.

The main problems in springing response relate to the determination of the high frequency parts of the sectional hydrodynamic forces, damping, and the wave energy spectrum. Solutions for these problems will require extensive measurements. In addition, the importance of springing stresses to calculation of the longitudinal strength of the hull must be settled, especially with regard to the possibility of fatigue failure.

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BOOK REVIEWS

KINEMATICS AND DYNAMICS OF PLANAR MACHINERY

B. Paul, Prentice-Hall, Inc.
Englewood Cliffs, New Jersey, 1979

The intent of this book is accurately described in the preface: to develop techniques for planar mechanism kinematic and dynamic analyses best suited to numerical solution. The replacement of graphical by numerical techniques has, of course, been made practical by digital computers.

Many of the topics in the book include clear descriptions of important applications and derivations of applicable equations to working FORTRAN programs. The author states that the book is suitable for undergraduates. More than 500 exercises (about half with answers) provide ample practice. The reviewer feels that the readability of the book makes it an *excellent text for independent study. The use of* analytical (Lagrange) kinematics rather than vector descriptions of motions and forces is a key to the development of efficient analysis procedures. Developing these procedures from first principles through the use of virtual work makes them accessible to the non-specialist. Coverage of topics is thorough with the exceptions of direct kinematic synthesis procedures and spatial mechanisms.

The 670-page book is divided into sections on geometrical kinematics, analytical kinematics, and analytical dynamics. An extensive appendix provides mathematical backup and numerical methods and listings of FORTRAN programs for dynamic analysis of reciprocating machines and sizing of fly wheels.

Chapter 1 introduces the terminology, the history, and some examples of mechanisms. Chapter 2 shows the utility of complex numbers in plane kinematics. Chapters 3 and 4 introduce the terminology, concepts, and some analysis of kinematics for gearing and cam systems. Chapter 5 describes centrodes, the Kennedy-Aronhold Theorem, properties of rolling circles, velocity and acceleration relationships, and the Euler-Savary equation. Chapter 6 describes graphical velocity and acceleration analysis. A large number of individual topics are covered in these chapters in a very readable manner.

Analytical kinematics comprises part two of the book (Chapters 7-10). Vector loop equations and derivatives based on these equations as developed by the author are the basis for position, velocity, and acceleration analysis. Cam and geared elements are included along with other joint types. Generalized coordinates are introduced; Paul's loop mobility criterion is described as an alternative to that of Gruebler. DKINAL, a FORTRAN program for kinematic analysis, is described and a listing is supplied.

Analytical dynamics based on virtual work is the subject of part three. The equations of motion for general planar mechanisms are derived in a form suitable for numerical calculation. The basis, organization, and usage of the general purpose DYMAC program are described. The general development is lengthy, with virtual work and static equilibrium covering 70 pages and single degree-of-freedom dynamic systems covering 80 pages. Friction, engine dynamics, and fly wheel design receive extended treatment. Chapter 13 on balancing of machinery treats rotor, engine, and linkage balancing. The goal is to permit readers to "solve most of the balancing problems they encounter and be well equipped to consult the literature on more difficult problems." The final chapter shows derivation and integration of multiple-degree-of-freedom system equations of motion. Program DYMAC, written and available from the author, is discussed.

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MECHANICS OF VIBRATION

K. Marguerre and H. Wölfel, Sijthoff and Noordhoff
The Netherlands, 1979

This book apparently evolved from the classroom lectures of the senior author, Professor Marguerre of the Technical University of Darmstadt, who is widely known for his numerous research contributions in the area of mechanics of deformable bodies. It is clearly a textbook suitable for a beginning course in vibrations, for advanced undergraduates, and for graduate students.

The work is divided into six chapters

- single-degree-of-freedom oscillators
- two-degree-of-freedom oscillators
- simple continuous oscillators (bars and beams)
- multicomponent oscillators derivation of the equations of motion - basic ideas
- finite elements (the incidence method) displacements as coordinates
- finite elements (the incidence method) forces as coordinates

Each chapter is subdivided into several sections. In addition, a set of 43 problems with answers is appended in the back.

A first impression, especially after looking at the Table of Contents, is "Oh, no! Not <u>another</u> vibrations textbook!", for at least 20 other textbooks cover the first half of the material. However, the logic and clarity of the presentation are impressive. Unlike most standard texts, concepts are particularly well presented. A good example of this is the section of Chapter A entitled "Arbitrary Transient Excitation." In short, the book is recommended even to the knowledgeable reader, because of the presentation of fundamental vibration concepts.

Quite a few illustrative examples of problems are worked out in detail, numerical results are plotted very carefully for good choices of parameters.

The reviewer is not satisfied with the printing format. Apparently the pages were photocopied from typed manuscript, which is perhaps a necessity in these days of high typesetting costs, but the type used was not as heavy as it should have been. In addition, an annoying visual distraction is that certain words or phrases have been stretched to double length by placing spaces between each letter. This format is apparently an attempt at emphasis, however, underlining would have been much more effective.

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Professor of Engineering Mechanics
Ohio State University
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THE FINITE ELEMENT METHOD (REVISED)

O.C. Zienkiewicz
McGraw-Hill Book Co., New York, New York

This third edition remains the authoritative source in finite elements; it is three times the size of the original edition. Much material has been updated to conform with current usage of finite elements.

The book contains 24 chapters and six appendices. *The author* introduces the basis of finite elements -- elastic continuum and generalization -- and proceeds with discussions of plane stress and plane strain and their proper usage. Axisymmetric stress analysis using triangular elements is described. Three-dimensional stress analysis is introduced with a short discourse on tetrahedronal and hexagonical (brick) elements and some of their elementary shape functions.

Isoparametric elements are considered; they are nondimensionalized rectangular elements with specified nodes that are mapped into an actual curved boundary element having the same number of nodes. The author uses shape functions with direct application, parabolic (four nodes) and cubic (eight nodes), to a two-dimensional plane and to a three-dimensional brick element, eight nodes (parabolic) and twenty nodes (cubic). Simple problems are applied to rotating discs (two dimensions) and biomechanics and pressure vessels (three dimensions). Conforming and non-conforming shape functions are considered in plate bending using the proper patch test. Hybrid elements are discussed, including their limitations.

More complex axisymmetric and box-type structures are considered on the basis of an assembly of elements.

The versatility of finite elements is shown by employing them in heat transfer, fluid flow, and electromagnetic theory. Other new areas include such nonlinear material problems as creep, viscoelasticity, visco-plasticity, plasticity, and nonlinear quasi-harmonic field problems. The main deterrent to the use of nonlinear material finite element analysis is the tremendous computer costs. Nonlinear applications are thus limited to such two-dimensional problems as structural theory, stability, buckling, and fracture mechanics. Important dynamic problems and solutions include shell vibrations, wave equations (electromagnetic and fluid problems), and transient heat problems.

The latter part of the book has to do with initial value and transient problems and their application to transient heat conduction and structural problems. The relatively recent application of finite elements to flow of viscous fluids is introduced using a direct formulation of the elements. Such boundary problems as electrical fields, potential flow around an airfoil, and wave diffraction are described. The book also considers some of the steps involved in the development of finite element computer programs and presents some developed computer programs.

The book contains a great deal of information, adequate references, and an excellent nomenclature section. The reviewer highly recommends the book.

H. Saunders
General Electric Company
Schenectady, New York 12345

SHORT COURSES

NOVEMBER

BLASTING AND EXPLOSIVES SAFETY TRAINING

Dates: November 5-7, 1980
Place: Hershey, Pennsylvania
Dates: November 19-21, 1980
Place: Lexington, Kentucky
Dates: December 3-5, 1980
Place: Kansas City, Missouri
Dates: December 10-12, 1980
Place: Williamsburg, Virginia

Objective: This course is a basic course that teaches safe methods for handling and using commercial explosives. We approach the problems by getting at the reasons for safety rules and regulations. Helps provide blasters and supervisors with a practical understanding of explosives and their use - stressing importance of safety leadership. Familiarizes risk management and safety personnel with safety considerations of explosives products and blasting methods.

Contact: E.I. du Pont de Nemours & Co. (Inc.), Applied Technology Division, Wilmington, DE 19898 - (302) 772-5982/774-6406.

FINITE ELEMENTS: BASIC PRINCIPLES AND PRACTICAL ASPECTS

Dates: November 10-14, 1980
Place: Tucson, Arizona

Objective: The purpose of this course is to provide structural engineering practitioners with an understanding of the fundamental principles of finite element analysis, to describe applications of the method, and to present guidelines for the proper use of the method and interpretation of the results obtained through it. Emphasis will be placed upon the linear analysis of frameworks, plates, shells and solids; dynamic analysis will also be treated. Daily workshop sessions will utilize the GIFTS interactive graphics finite element system, which is a popular stand along analysis capability and which also serves as a pre- and post-processor for such widely used programs as SAP and NASTRAN.

Contact: Dr. Hussein Kamel, College of Engineering, The University of Arizona, Tucson, AZ 85721 - (602) 626-1650/626-3054.

18TH ANNUAL RELIABILITY ENGINEERING AND MANAGEMENT INSTITUTE

Dates: November 10-14, 1980
Place: Tucson, Arizona

Objective: This course will cover the following subjects: reliability engineering theory and practice; mechanical reliability; risk analysis; reliability testing and demonstration; maintainability engineering; product liability; and reliability and maintainability management.

Contact: Dr. Dimitri Kececioglu, Aeronautical Engineering, Bldg. 16, University of Arizona, Tucson, AZ 85721 - (602) 626-2495/626-3901/626-3054.

MACHINERY VIBRATION IV

Dates: November 11-13, 1980
Place: Cherry Hill, New Jersey

Objective: Lectures and demonstrations on vibration measurement rotor dynamics and torsional vibration are scheduled. General sessions will serve as a review of the technology; included are the topics of machine measurements, modal vibration analysis, and vibration and noise. The rotor dynamics sessions will include: using finite element, transfer matrix, and nonlinear models; vibration control including isolation, damping, and balancing. The sessions on torsional vibration feature fundamentals, modeling measurement and data analysis, self-excited vibrations, isolation and damping, transient analysis, and design of machine systems.

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

MODAL ANALYSIS, SUBSTRUCTURING AND TESTING

Dates: November 11-14, 1980
Place: Chicago, Illinois
Dates: November 18-21, 1980
Place: Dallas, Texas
Dates: December 2-5, 1980
Place: Salt Lake City, Utah
Dates: December 9-12, 1980
Place: Boston, Massachusetts

Objective: A state-of-the-art presentation on structural analysis techniques combined with laboratory demonstrations. Covers mechanical structures, modes of vibration, modal analysis, structural testing, finite element modeling and substructuring including structural dynamics modification techniques. Instructional laboratories and equipment demonstrations by manufacturer.

Contact: Onstead and Associates, Inc., 1333 Lawrence Expressway, Bldg. 100, Suite 103, Santa Clara, CA 95051 - (408) 246-7656.

DECEMBER

MACHINERY VIBRATION ANALYSIS

Dates: December 10-12, 1980
Place: New Orleans, Louisiana

Objective: The course covers causes, effects, detection, and solutions of problems relating to rotating machines. Vibration sources, such as oil and resonant whirl, beats, assembly errors, rotor flexibility, whip, damping, eccentricity, etc. will be discussed. The effect on the overall vibration level due to the interaction of a machine's structure, foundation, and components will be illustrated.

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

JANUARY

PROBABILISTIC AND STATISTICAL METHODS IN MECHANICAL AND STRUCTURAL DESIGN

Dates: January 5-9, 1981
Place: Tucson, Arizona

Objective: The objective of this short course and workshop is to provide practical information on engineering applications of probabilistic and statistical methods, and design under random vibration environments. Modern methods of structural and mechanical reliability analysis will be presented. Special emphasis will be given to fatigue and fracture reliability.

Contact: Dr. Paul H. Wirsching, Associate Professor of Aerospace and Mechanical Engineering, The University of Arizona, College of Engineering, Tucson, AZ 85721 - (602) 626-3159/626-3054.

DYNAMIC ANALYSIS IN TURBOMACHINERY DESIGN

Dates: January 12-16, 1981
Place: Madison, Wisconsin

Objective: The short course will be of interest and value to engineers and scientists in industry, government and education. Topics include dynamics of rotating shafts, dynamic response of turbomachinery blading and bladed disk systems and of stationary vanes. Aspects discussed for blades and vanes will include linear modal analysis and lumped mass analysis, effects of damping treatments and frictional damping, measurements of modal functions by laser holographic interferometry. Aspects discussed for rotor dynamics will include flexible and rigid bearings, damping, and coupled transverse and angular motion. Practical problems and case histories will be reviewed, to illustrate methods of solution and to illustrate analytical results.

Contact: Dr. Donald E. Baxa, Program Director, University of Wisconsin-Extension, Department of Engineering and Applied Science, 432 North Lake Street, Madison, WI 53706 - (608) 262-2061.

MARCH

VIBRATION AND SHOCK TEST FIXTURE DESIGN

Dates: March 2-6, 1981
Place: St. Petersburg, Florida

Objective: The seminar is designed mainly for dynamics test personnel desiring an understanding of practical approaches to the design and fabrication of test fixtures used in vibration and shock testing. Most of the potential students are employed by test activities of Government and military facilities, as well as major defense contractors.

Contact: Wayne Tustin, 22 East Los Olivos St., Santa Barbara, CA 93105 - (815) 682-7171.

MEASUREMENT SYSTEMS ENGINEERING

Dates: March 9-13, 1981
Place: Phoenix, Arizona

MEASUREMENT SYSTEMS DYNAMICS

Dates: March 16-20, 1981
Place: Phoenix, Arizona
Objective: Program emphasis is on how to increase productivity, cost-effectiveness and data-validity of data acquisition groups in the field and in the laboratory. Emphasis is also on electrical measurements of mechanical and thermal quantities.

Contact: Peter K. Stein, 5602 East Monte Rosa, Phoenix, AZ 85018 - (602) 945-4603/946-7333.

NEWS BRIEFS

news on current and Future Shock and Vibration activities and events

PRESSWORKING MACHINERY FOR THE EIGHTIES
March 31 - April 1, 1981
Birmingham, UK

The Institution of Mechanical Engineers has announced a conference to review the influence of modern technology on the design, development, control and operation of all types of pressworking machinery. Such machinery is defined as that which compacts, shapes or blanks material in single or multiple strokes and which may be operated by mechanical, fluid or other sources of power.

This conference will be held March 31 to April 1, 1981 at the University of Birmingham, Birmingham, UK. Registration forms, which will include the program, accommodation arrangements, and scale of fees, will be in circulation in January, 1981. To obtain a copy, please contact: Conference Department, The Institution of Mechanical Engineers, 1 Birdcage Walk, Westminster, London, SW1H 9JJ.

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

MECHANICAL SYSTEMS

ROTATING MACHINES

(Also see Nos 2458, 2468, 2473, 2480, 2482, 2505, 2520, 2521, 2522, 2558, 2559)

80-2380

On the Stability of a Rotating Asymmetric Shaft Supported by Asymmetric Bearings

T Iwatsubo, R. Kawai, and T Mitaji

Faculty of Engrg., Kobe Univ., Nada, Kobe, Japan, Bull JSME, 23 (180), pp 934-937 (June 1980) 6 figs, 2 tables, 5 refs

Key Words: Shafts (machine elements), Rotating structures, Combination resonance

The instabilities of an asymmetric flexible rotor in asymmetric bearings caused by combination resonances were investigated. It was found that in this system, in addition to the conventional parametric and subharmonic resonances, a sum type of combination resonances was generated; however, no difference type of combination resonances were observed.

80-2381

Theoretical Prediction of Nonlinear Propagation Effects on Noise Signatures Generated by Subsonic or Supersonic Propeller or Rotor-Blade Tips

R.L. Barger

Langley Research Center, NASA, Langley Station, VA, Rept. No. NASA-TM-1660, L-13388, 18 pp (May 1980)

N80-22265

Key Words: Blades, Propeller blades, Sound generation, Acoustic signatures, Nonlinear theories

The nonlinear propagation equations for sound generated by a constant speed blade tip are presented. Propagation from a subsonic tip is treated as well as the various cases that can occur at supersonic speeds. Some computed examples indicate that the nonlinear theory correlates with experimental results better than linear theory for large amplitude waves. For swept tips that generate a wave with large amplitude leading expansion, the nonlinear theory predicts a cancellation effect that results in a significant reduction of both amplitude and impulse.

80-2382

Investigation of the Vibration Characteristics of Shrouded Bladed Disk Rotor Stages

L.-T. Chen and J. Dugundji

McDonnell Douglas Research Labs., J. Aircraft, 17 (7), pp 479-486 (July 1980) 6 figs, 1 table, 10 refs

Key Words: Compressor blades, Beams, Disks, Blades, Natural frequencies

Coupled differential equations of motion are given for application to a rotating, pretwisted, and heated beam under the effects of thermal stresses and gas bending loads. A finite element method is developed for the dynamic and static deformation analysis of the blade. The deformations of a bladed disk and a shrouded bladed disk were studied by introducing a special bladed disk element and a special shrouded-blade element. Some features of the vibration of part-span-shrouded bladed-disk rotor stages are discussed.

80-2383

Experimental Study of Three Journal Bearings with a Flexible Rotor

M.E. Leader, R.D. Flack, and P.E. Allaire

Univ. of Virginia, Charlottesville, VA 22901, ASLE Preprint No. 79-AM-6D-2, 7 pp (1979) 11 figs, 3 tables, 15 refs

Key Words: Rotor-bearing systems, Flexible rotors, Journal bearings, Unbalanced mass response

The unbalance response and stability of a simple flexible rotor was tested over a speed range with three different types of journal bearings: axial groove, pressure dam and tilting pad. Measurements were made of total rotor response, synchronous response and frequency spectrums at various running speeds and at selected locations along the shaft.

80-2384

A Study on a Rotor Passing Through a Resonance

K. Matsuura

Mech. Engrg. Research Lab., Hitachi Ltd., Tsuchiurashi, Japan, Bull. JSME, 23 (179), pp 749-758 (May 1980) 12 figs, 2 tables, 6 refs

Key Words: Rotors (machine elements), Resonance pass through

A numerical and physical study is made of the non-stationary transitions of motion of a rotor with the condition that it can easily pass through a resonance. As a result of this study, theoretical design criteria for a rotor with a usable limit are introduced, and these criteria are compared with the results of experiments in which an actual rotor is used.

80-2385

The Bearingless Main Rotor

P.G.C. Dixon and H.E. Bishop

Boeing Vertol Co., J. Amer. Helicopter Soc., 25 (3), pp 15-21 (July 1980) 17 figs, 1 table, 2 refs

Key Words: Rotors (machine elements), Helicopter rotors, Vibration response, Flight tests

Design, development, and flight testing of a bearingless main rotor is described. Using a Messerschmitt-Boelkow-Blohm BO 105C helicopter as the flight-test vehicle, this rotor was designed to have characteristics similar to the standard BO-105 rotor. Loads, stability, flying qualities, and vibrational characteristics were successfully demonstrated in flight, proving the feasibility of a bearingless main rotor.

80-2386

Qualification Program of the Composite Main Rotor Blade for the Model 214B Helicopter

D.J. Reddy

Sr. Structures Engr., Bell Helicopter Textron, Fort Worth, TX, J. Amer. Helicopter Soc., 25 (3), pp 10-14 (July 1980) 12 figs, 2 refs

Key Words: Rotors (machine elements), Rotary wings, Helicopter rotors, Composite materials, Fatigue tests

The introduction of composite materials such as S-glass and E-glass in the 214B blade required the establishment of material strength values for design and special procedures for the qualification program. Extensive fatigue testing of coupons and structural elements was accomplished and full scale blade testing was conducted. Data from the coupon and element tests were used to establish S-N curve shapes, environmental effects, and fatigue strength data for these materials. Statistical analysis was performed on coupon and element data to establish minimum scatter reductions for these materials.

80-2387

The Description of the Natural Frequency of a Turbo-Rotor in Sleeve Bearings by Means of a Substitute Vibrator (Beschreibung des Eigenschwingverhaltens eines gleitgelagerten Turbo-Rotors anhand eines Ersatz-Schwingers)

H. Möhlenkamp

Mannesmann Demag Verdichtertechnik, Duisburg, Germany, Konstruktion, 32 (7), pp 227-284 (July 1980) 10 figs, 6 refs

(In German)

Key Words: Turbine components, Rotors (machine elements), Shafts, Sleeve bearings, Natural frequencies

A method for the calculation of the eigvenvalues and thus the damping behavior of a rotor in sleeve bearings is presented. The method drastically reduces the number of degrees of freedom, without significantly affecting the accuracy of important eigenvalues. The low frequency vibrations of interest are represented by a spring-mass model, while the higher frequency vibrations are suppressed and represented by rigid masses.

80-2388

Status of NASA Full-Scale Engine Aeroelasticity Research

J.F. Lubomski

Lewis Research Center, NASA, Cleveland, OH, Rept No. NASA-TM-81500, E-437, 21 pp (1980), Presented at the 21st Struct., Structural Dyn., and Mater. Conf., Seattle, May 12-14, 1980

N80-23678

Key Words: Turbofan engines, Turbine engines, Flutter

Data relevant to several types of aeroelastic instabilities were obtained using several types of turbojet and turbofan engines. Data relative to separated flow (stall) flutter, choke flutter, and system mode instabilities are presented. The unique characteristics of these instabilities are discussed, and a number of correlations are presented that help identify the nature of the phenomena.

80-2389

Avco Lycoming Quiet Clean General Aviation Turbofan Engine

C A. Wilson
Avco Lycoming Div , Stratford, CT, In NASA Lewis Research Center, Gen. Aviation Propulsion, pp 155-187 (Mar 1980)
N80 22333

Key Words: Fans, Turbofan engines, Noise control, Engine noise

A fan module was developed using an existing turboshaft engine The fan was designed using the latest in large engine noise control technology. Acoustic tests were made to verify the prediction and identify the noise characteristics of the fan, core, jet, and sound treatment. Analysis of the recorded data yielded close agreement with the expected results.

80-2390

The Trajectory Field of a Vibration Machine Driven by Synchronically Rotating Unbalanced Rotors

A. Zhgulev
Vsesoyuznii ordena Trudovogo Krasnogo Znameni nauchno issledovatelskii i proektnii institut mekhanicheskoi obrabotiki poleznikh iskopaemikh, USSR, Vibrotekhnika, 4 (28), pp 69-77 (1977), 3 figs, 2 tables, 1 ref. Kaunas A. Sniečkus Politechnical Institute, Kaunas, Lithuanian SSR, 1979
(In Russian)

Key Words Rotors (machine elements)

The field of trajectory points of the operating member of a vibration machine has the same pattern which is independent of the parameter of unbalanced rotors. In most cases of uniform fields the infinitely small sections of the universal field diagram are substantiated

RECIPROCATING MACHINES

(Also see No. 2394)

80-2391

Radial Thrust in Centrifugal Pumps with a Single-Vane Impeller

[illegible]
[illegible] Research Lab., Hitachi Ltd., Tsuchiura, Japan, Bull. JSME, 23 (180), pp 895-901 (June 1980) 18 figs, 1 table, 4 refs

Key Words: Pumps, Centrifugal pumps, Impellers

Experiments on radial thrust in centrifugal pumps with a single-vane impeller are carried out. Three impellers with different subtended angles of vane and two delivery casings; i.e., volute casing and circular ones, are designed. In the experiments the effect of the subtended angle of vane and that of the geometry of a delivery casing on radial thrust are examined. An analysis is also made to calculate the radial force acting on a single-vane impeller.

80-2392

Pump Theory (Beitrag zur Theorie des Pumpens)

A Tondl
Staatliches Forschungsinstitut fur Maschinenbau, CS 25097 Praha 9-Běchovice, Czechoslovakia, Ing Arch , 49 (3/4), pp 255-260 (1980) 4 figs, 5 refs
(In German)

Key Words: Pumps, Self-excited vibrations

The stability of the equilibrium state and the self-excited oscillation (surge) of a system representing a simplified model of a system with compressor, blower or centrifugal pump are analyzed. The model is governed by a system of two differential equations of the first order where the stationary non-oscillating solutions are represented in the phase plane by singular points and the oscillating solutions by limit cycles. The effect of a parameter proportional to the ratio of acoustic inductance to mass is analyzed.

METAL WORKING AND FORMING

80-2393

Acoustic Emission During Orthogonal Metal Cutting

D A Dornfeld and E Kannatey-Asibu
Dept of Mech Engrg , Univ of California, Berkeley, CA 94720, Intl J Mech Sci , 22 (5), pp 285-296 (1980) 11 figs, 1 table, 15 refs

Key Words Acoustic emission, Metal working, Cutting

The theory of acoustic emission and the analysis of emission signals is reviewed as it applies to generation of acoustic emission in metal cutting. Based upon the mechanics of the orthogonal cutting operation a relationship is developed between the root mean square (RMS) voltage of the acoustic emission and fundamental cutting parameters. The validity of this relationship is evaluated by a series of tests varying cutting speed, feed and rake angle for orthogonal machining. Strong dependence of the RMS voltage of the emission on both strain rate and cutting velocity was observed. The sources of acoustic emission in metal cutting are discussed and areas of additional work in the study of acoustic emission from metal cutting are identified.

ISOLATION AND ABSORPTION

80-2394

Noise Reduction of Diesel Engine Powered Installations

R.A. Pettitt

Perkins Engines, Noise Vib. Control Worldwide, 11 (5), pp 162-165 (May 1980) 7 figs, 4 tables, 2 refs

Key Words: Diesel engines, Noise source identification, Noise reduction

Diesel engine noise source ranking is described with the effect of reducing the noise level of individual sources. To demonstrate the principle of source ranking an exercise on a fork lift truck is described.

MATERIALS HANDLING EQUIPMENT

80-2395

Conveying by Means of Vibrating Helical Conveyors (Zum Fördervorgang im Vibrationswendelforderer)

H. Kettner, H. Ahrens, and G.W. Stoevesandt

VDI Z., 122 (8), pp 311-315 (1980) 5 figs, 9 refs (In German)

Key Words: Computer programs, Conveyors, Vibratory conveyors

A computer program is developed for the investigation of the rebound process of a point mass on a vibratory conveyor.

80-2396

Noise Abatement of Vibration-Stimulated Material-Handling Equipment

E.I. Rivan

Ford Motor Co., 24500 Glendale Ave., Detroit, MI 48239, Noise Control Engrg., 14 (3), pp 132-142 (May/June 1980) 19 figs, 4 refs

Key Words: Noise reduction, Vibrators (machinery), Materials handling equipment, Conveyors

Systematic abatement of identified noise-generating mechanisms in vibration stimulated material-handling equipment is described, which reduces noise by 20 to 25 dB(A) while simultaneously boosting performance.

80-2397

Tumbler Noise Reduction: The Close-Fitting Acoustical Enclosure

E.H. Toothman

Bethlehem Steel Corp., Room B-252, Martin Tower, Bethlehem, PA 18016, Noise Control Engrg., 14 (3), pp 143-145 (May/June 1980) 3 figs, 1 table

Key Words: Noise reduction, Industrial facilities, Cool handling equipment, Materials handling equipment

The noise generated by a coke tumbling barrel was reduced to an acceptable level by covering the barrel with a 0.003 inch thick asphalt-impregnated industrial sheeting felt.

80-2398

The Use of Disk in Resonance Vibration in Tape Transports

P. Vasijev and A. Kurtinaitis

Kaunas Antanas Sniečkus Polytechnical Institute, Kaunas, Lithuania, Vibrotechnika, 4 (28), pp 61-67 (1977), 7 figs, 1 table, 6 refs, Kaunas A. Sniečkus Politechnical Institute, Kaunas, Lithuanian SSR, 1979 (In Russian)

Key Words: Tape recorders, Vibrators (machinery), Moving strips

The analysis of wear of a disk vibrator and friction force on magnetic tape is presented as a function of tension and flutter. The effect of a vibrator on tape stability is also discussed.

80-2399

The Interaction Dynamics Investigation of the End Dimensions of the Object with Longitudinal Running High-Frequency Wave

R. Kurilo, K. Ragulskis, and [illegible]
Kaunas Antanas Sniečkus [illegible]
Kaunas, Lithuania, Vibrotechnika, 4 (28) [illegible]
(1977), 4 figs, 3 refs, Kaunas A. [illegible] nical Institute, Kaunas, Lithuanian SSR, [illegible]
(In Russian)

Key Words: Materials handling environment, Vibrators (machinery), Conveyors

The interaction of the end dimensions of a transported object and longitudinal high frequency wave is studied. The equation of motion with dry and viscous friction, as well as with resistance forces are presented. The effect of the length of body with the irregular motion is analyzed and the expression to establish the coefficient of efficiency is presented.

80-2400

The Principles of the Theory for Dry Substance Motion in a Vertical Vibro-Conveyor with Longitudinal Vibrations

M. Lipovskij
Vibrotechnika, 4 (28), pp 33-40 (1977), 4 figs, 6 refs, Kaunas A. Sniečkus Politechnical Institute, Kaunas, Lithuanian SSR, 1979
(In Russian)

Key Words: Vibrators (machinery), Materials handling equipment, Conveyors

A new type of vibration displacement of dry bodies in a vertically vibrating vessel with inclined bottom and a partition is investigated. On the basis of the most simple dynamic model the results of average speed on a vertical vibro-conveyor are obtained.

80-2401

The Analysis of Distortions of Vibro-Machine Trajectory Fields

A. Zhguljev
Vsesoyuznii ardena Trudovogo Krasnogo Znameni nauchno- issledovatelskii i proektnii institut mekhanicheskoi obrabotkii poleznikh iskopaemikh, USSR, [illegible] 4 (28), pp 47-53 (1977), 1 fig, 3 [illegible] Kaunas A. Sniečkus Politechnical [illegible] Lithuanian SSR, 1979
[illegible]

Key Words: Vibrators (machinery), Materials handling equipment

The trajectory forms and vibration parameters of characteristic points of a vibro-machine put into motion by two synchronically rotating masses in different coordinates, unbalanced and different phase values of initial rotation, are discussed. A method for the estimation of quantity and quality of distortion of the uniform field of trajectory in such a machine is suggested.

80-2402

The Dynamics of the Material Point Transported by Longitudinally Running High-Frequency Wave

R. Bansevičius, R. Kurilo, and K. Ragulskis
Kaunas Antanas Sniečkus Polytechnical Institute, Kaunas, Lithuania, Vibrotechnika, 4 (28), pp 79-82 (1977), 3 figs, 2 refs, Kaunas A. Sniečkus Politechnical Institute, Kaunas, Lithuanian SSR, 1979
(In Russian)

Key Words: Materials handling equipment

The interaction of a longitudinal high-frequency wave with mass in motion is investigated. The equations of motion under dry and viscous friction are presented. The results enable to establish the speeds under the above-mentioned conditions.

80-2403

The Establishment of Body Inertia Moments

M. Labokas, K. Ragulskis, R. Jonušas, and I.-O. Karužienė
Kaunas Antanas Sniečkus Polytechnical Institute, Kaunas, Lithuania, Vibrotechnika, 4 (28), pp 187-193 (1977), 2 figs, 1 table, Kaunas A. Sniečkus Politechnical Institute, Kaunas, Lithuanian SSR, 1979
(In Russian)

Key Words: Materials handling equipment

Body inertia determination based on pendulum principle is described and the formulas are presented.

80-2404

Study of Dynamic Features of Cohesionless Load Being Transported

V. Archipenko, N. Belkov, and I. Goncharevitch

Vibrotechnika, 4 (28), pp 177-188 (1977), 3 figs, 16 refs, Kaunas A. Sniečkus Politechnical Institute, Kaunas, Lithuanian SSR, 1979

(In Russian)

Key Words: Materials handling equipment

The contact and aerodynamic interactions of a layer of pelletized material transported on a vibroconveyor were measured and recorded by means of tensiometric transducers, a tensoamplifier YT4-1 and a self recorder H327.

80-2405

On the Problem of Parameter Determination for Resonance Vibro-Table Operating Conditions

G. Vishneveckij and A. Savčenko

Kharkovskii inzhenerno-stroitelnii institut, Vibrotechnika, 4 (28), pp 169-175 (1977), 3 figs, 1 ref, Kaunas A. Snieckus Politechnical Institute, Kaunas, Lithuanian SSR, 1979

(In Russian)

Key Words: Vibrators (machinery), Parameter identification technique, Materials handling equipment

The determination of resonance characteristics of vibromachines requires an understanding of the load feature of the vibrator and the mechanical feature of vibro-machines. The analytical expression of the vibrator loading feature is presented, and confirmed by means of vibro-table operation modeling on electronic computer.

80-2406

The Dynamics of Two-Mass Vibro-Machines with Nonaxial Distribution of Masses and Two Self-Synchronizing Vibrators

L. Goldin and B. Lavrov

Vsesoyuznii ardena Trudovogo Krasnogo Znameni nauchno issledovatelskii i proektnii institut mekhanicheskoi obrabotkii poleznikh iskopaemikh, USSR, Vibrotechnika, 4 (28), pp 83-97 (1977), 2 figs, 1 table, 7 refs, Kaunas A. Sniečkus Politechnical Institute, Kaunas, Lithuanian SSR, 1979

(In Russian)

Key Words: Vibrators (machinery), Materials handling equipment

A dynamic scheme is discussed which secures self-synchronization of two vibrators during their contra-phase rotation in opposite directions. The resonance frequency of system tested presents a combination of two frequencies. The analysis of amplitude-frequency graph permits selection of preferable adjustment field from resonance that secures the self-synchronization stability of two vibrators. The non-galloping of system with the application of forced synchronization of two debalanced vibrators is obtained by observing two conditions.

80-2407

Measurement of the Parameters of Interaction of a Vibrotransporting Layer with Load-Supporting Surface

V. Archipenko, N. Belkov, and I. Goncharevitch

Vibrotechnika, 4 (28), pp 163-168 (1977), 2 figs, 10 refs, Kaunas A. Sniečkus Politechnical Institute, Kaunas, Lithuanian SSR, 1979

(In Russian)

Key Words: Vibrators (machinery), Materials handling equipment

A brief revue of the aerodynamic interaction of a vibrotransporting load with a surface is given. Description of tensometric transducers and recording devices for the determination of these interactions is presented. Experiments were carried out in accordance with an elastic-tough-plastic model of a load on the vibroconveyer stand. Membranes of the transducers were examined in accordance with the condition of the tolerated load.

80-2408

Some Conditions of the Two-Coordinate Vibrator Operation

I. Dobinda, A. Paramonov, A. Sementchuk, and S. Fursov

Institut prikladnoi fiziki, AN MSSR, Vibrotechnika, 4 (28), pp 131-137 (1977), 2 figs, 3 refs, Kaunas A. Sniečkus Politechnical Institute, Kaunas, Lithuanian SSR, 1979

(In Russian)

Key Words: Vibrators (machinery), Materials handling equipment

The vibrations of the two-coordinate vibrators for electro-spark are studied. A system of equations for two-coordinate vibration in the case of unilateral limitation of motion along y coordinate is solved. The problems of motion periodicity are studied and periodical solutions of the system are found for the values of restoration coefficient of speed along coordinate X.

80-2409
The Dynamics of a Vibro-Conveyor with a Rigid Crank-Tiller Drive with Regard for Interaction with the Motor and Viscous Material Transported
Z. Filer
Donetskii ordena Trudovogo Krasnogo Z nameni politeknicheskii institut, Vibrotechnika, 4 (28), pp 121-129 (1977), 2 figs, 11 refs, Kaunas A. Sniečkus Politechnical Institute, Kaunas, Lithuanian SSR, 1979
(In Russian)

Key Words: Vibrators (machinery), Conveyors, Materials handling equipment

The dynamics of a vibro-conveyor with a rigid energization is discussed. For connecting rod relief the elastic coupling was erected. The exponential changes in viscosity during the vibration process caused by normal mixture pressure against the chute are taken into account. The dynamic feature of the asynchronous electric motor driving the vibration energizer is used. Differential equations of motion are obtained and and for their analysis the transition to an equivalent system of non-linear integral equations is solved by means of iterations.

80-2410
On the Problem of Body Inertia Moment Establishment by Means of Rotational Vibration Method
R. Jonušas, I. Karužienė, and M. Labokas
Kaunas Antanas Sniečkus Polytechnical Institute, Kaunas, Lithuania, Vibrotechnika, 4 (28), pp 149-155 (1977), 3 figs, 1 table, 1 ref, Kaunas A. Sniečkus Politechnical Institute, Kaunas, Lithuanian SSR, 1979
(In Russian)

Key Words: Vibrators (machinery)

An original device for measuring moment of inertia of a body is described. The formulae and calculations presented enable to carry out the measurements with great accuracy.

STRUCTURAL SYSTEMS

BRIDGES

80-2411
Dynamic Studies of Cable-Stayed Bridges
D. Mu
Ph.D. Thesis, Brigham Young Univ., 127 pp (1980)
UM 8016080

Key Words: Bridges, Cable-stiffened structures, Wind-induced excitation, Computer programs

The linear and nonlinear static and dynamic analysis of fifteen different types of cable-stayed bridges was studied in considerable detail using a computer program developed for general purposes. The results of different parameters are compared.

BUILDINGS

(Also see Nos. 2462, 2463, 2499)

80-2412
Traffic Induced Vibration in Buildings
R.C. Hill
Acoustical Investigation & Research Organization Ltd. (AIROS), St. Albans, Noise Vib. Control Worldwide, 11 (5), pp 176-180 (May 1980) 5 figs, 5 refs

Key Words: Buildings, Traffic-induced vibrations, Vibration prediction

The author shows that limited predictions of future vibration levels of buildings caused by traffic are possible in the specific but commonly occurring situation of suburban dwellings of conventional construction. Changes in floor vibration level can be predicted from changes in external noise level. The noise level can itself be predicted directly from traffic volumes. In this way an indirect relationship between traffic induced vibration in floors and the traffic causing it has been established and this provides the basis for a tentative prediction method that can be used at the design stage.

80-2413

Inelastic Seismic Response of a Torsionally Unbalanced Single-Story Building Model

H.M. Irvine and G.E. Kountouris

Dept. of Civil Engrg., Massachusetts Inst. of Tech., Cambridge, MA, Rept. No. R79-31, NSF/RA-79-389, 172 pp (July 1979)

PB80-164197

Key Words: Buildings, Seismic response, Torsional response

The dynamic effects of coupling between torsion and translocation using a simple torsionally unbalanced single-story building model are described. The investigation deals with a two-degree-of-freedom model in which two frames support a diaphragm the center of mass of which may be offset from the center of stiffness. Frames are assumed to behave as simple elastic-plastic springs and to have the same stiffness and strength levels. A comprehensive parameter study was undertaken to identify trends in the peak ductility demands of the worst situated frame. Results are plotted and interpreted.

80-2414

Studies on High-Frequency Vibrations of Buildings. I: The Column Effects

J. Lubliner

Earthquake Engrg. Research Center, California Univ., Berkeley, CA, Rept. No. UCB/EERC-79/21; NSF/RA-790351, 32 pp (Aug 1979)

PB80-158553

Key Words: Buildings, Columns, High frequency response

It is shown that, when column mass is taken into account in the vibration of buildings, the system acquires additional degrees of freedom. If column mass is small compared to floor mass, then the modes obtained from conventional analysis persist virtually unchanged; the additional modes involve almost exclusively column motion, the characteristic frequencies being in the low audio range. The nature of the modes, as well as the transmission of ground motion, depend on whether the columns in adjacent stories are tuned to each other.

TOWERS

80-2415

Dynamic Analysis of Cooling Towers Using a Frontal Based Frequency Solver

L. Cedolin

Dept. of Struc. Engrg., Politecnico of Milan, Milan, Italy, Engrg. Struc., 2 (3), pp 157-162 (July 1980) 5 figs, 3 tables, 16 refs

Key Words: Cooling towers, Shells, Earthquake response, Modal superposition method

A mode superposition analysis method for shells is proposed, which uses a general shell element and a novel scheme for static condensation of massless degrees of freedom, based on the wavefront algorithm. The method is suitable for the prediction of earthquake response of cooling towers with non-axisymmetric imperfections as well as for shells of more general form.

FOUNDATIONS

(See No. 2555)

HARBORS AND DAMS

80-2416

Quakes Force New Look at Dam Safety

Indus. Res. Dev., 22 (7), pp 95-100 (Jan 1980)

Key Words: Dams, Earthquake response

A technique for predicting dam safety is described, which takes into consideration the complexity of earthquake motion and types of soil.

CONSTRUCTION EQUIPMENT

80-2417

Reduction of Aerodynamic Blade Noise in a Rotary Lawn Mover

I.C. Shepherd and D.C. Gibson

Div. of Mech. Engrg., Commonwealth Scientific and Industrial Research Organization, Highett, P.O. Box 26, Victoria, Australia 3190, Noise Control Engrg., 14 (3), pp 110-118 (May/June 1980) 14 figs

Key Words: Lawn movers, Noise reduction, Blades, Aerodynamic noise

The role of blades in lawn mower noise is examined through experimental methods. Aerodynamic blade noise from two sources, blade-housing interaction and wake shedding, is found to be dominant in a popular commercial rear-catching mower.

PRESSURE VESSELS

80-2418

Fatigue of Weldments in Nuclear Pressure Vessels and Piping

M.K. Booker, B.L.P. Booker, H.B. Meieran, and J. Heuschkel

Oak Ridge National Lab., TN, Rept. No. ORNL/NUREG-64, 96 pp (Mar 1980)

NUREG/CR-1351

Key Words: Nuclear reactors, Pressure vessels, Piping systems, Fatigue life, Welded joints

Available information on fatigue of weldments relevant to nuclear pressure vessels and piping is reviewed to determine what, if any, changes in the current design rules appear to be dictated by the available information.

POWER PLANTS

(Also see Nos. 2465, 2495, 2512, 2517, 2577, 2578)

80-2419

Evaluation of Lagrangian, Eulerian, and Arbitrary Lagrangian-Eulerian Methods for Fluid-Structure Interaction Problems in HCDA Analysis

Y.W. Yang, H.Y. Chu, J. Gvildys, and C.Y. Wang

Argonne National Lab., Argonne, IL, Intl. Conf. on Structural Mechanics in Reactor Tech., Berlin, F.R. Germany, Aug 13, 1979, 17 pp (1979)

CONF-790802-55

Key Words: Interaction: structure-fluid, Nuclear reactor safety, Nuclear reactor components

The analysis of fluid-structure interaction involves the calculation of both fluid transient and structure dynamics. In the structural analysis, Lagrangian meshes have been used exclusively, whereas for the fluid transient, Lagrangian, Eulerian, and arbitrary Lagrangian-Eulerian (quasi-Eulerian) meshes have been used. This paper performs an evaluation on these three types of meshes. The emphasis is placed on the applicability of the method in analyzing fluid-structure interaction problems in HCDA analysis.

80-2420

Three-Dimensional Finite Element Formulation for Fluid-Structure Interaction

R.F. Kulak

Argonne National Lab., Argonne, IL, Intl. Conf. on Structural Mechanics in Reactor Tech., Berlin, F.R. Germany, Aug 13, 1979, 14 pp (1979)

CONF-790802-65

Key Words: Interaction: structure-fluid, Nuclear reactor safety, Nuclear reactor components

Several key areas for performing three-dimensional fluid-structure interaction calculations of various types of nuclear reactor components are discussed. A new development is presented for a three-dimensional hexahedral hydrodynamic finite-element based upon a Quasi-Eulerian approach. By using trilinear shape functions and assuming a constant pressure field within the element, simple relations are obtained for internal nodal forces. The forms developed are easily coded and computationally efficient.

80-2421

Quasi-Eulerian Formulation for Fluid-Structure Interaction

J.M. Kennedy, T. Belytschko, and D.F. Schoeberle

Argonne National Lab., Argonne, IL, Intl. Conf. on Structural Mechanics in Reactor Tech., Berlin, F.R. Germany, Aug 13, 1979, 20 pp (1979)

CONF-790802-66

Key Words: Interaction: structure-fluid, Nuclear reactor safety

Recent developments of a quasi-Eulerian finite element formulation for the treatment of the fluid in fluid-structure interaction problems are described. The formulation is applicable both to plane two-dimensional and axisymmetric three-dimensional problems.

80-2422

Fluid-Structure Interaction Analysis of a Deck Structure During a HCDA

R.F. Kulak

Argonne National Lab., Argonne, IL, Intl. Conf. on Structural Mechanics in Reactor Tech., Berlin, F.R. Germany, Aug 13, 1979, 19 pp (1979)

CONF-790802-70

Key Words: Interaction: structure-fluid, Nuclear reactors, Nuclear reactor safety, Finite element technique

An assessment of the structural integrity of the deck structure of a pool-type LMFBR during a Hypothetical Core Disruptive Accident (HCDA) is presented. During this accident the sodium above the core is propelled upward until it impacts against the deck structure. A finite-element model is used to study the deck dynamics during slug impact.

80-2423

Three-Dimensional Fluid-Structure Interaction of a Pool-Reactor In-Tank Component

R.F. Kulak

Argonne National Lab., Argonne, IL, Intl. Conf. on Structural Mechanics in Reactor Tech., Berlin, F.R. Germany, Aug 13, 1979, 16 pp (1979)

CONF-790802-67

Key Words: Interaction: fluid-structure, Nuclear reactor safety, Nuclear reactor components

To assess the structural integrity of nuclear reactor structural components, such as the primary pumps and the intermediate heat exchangers, a dynamic analysis in three-dimensional space is performed which accounts for the fluid-structure coupling. A model is developed which has many of the salient features of this fluid-structural component system.

80-2424

Induced-Draft Fan-Noise Measurements Solve Community-Relation Problem

W.J. Frederick, J.R. Shadley, and R.M. Hoover

Northern States Power Co., Power, 124 (8), pp 62-64 (Aug 1980) 6 figs

Key Words: Electric power plants, Noise reduction

A two-year noise measurement program at a power plant is described. Cooling towers, induced-draft fans, and ventilating fans were identified as primary sources of noise in the community. Noise was controlled by installing mufflers between fans and chimney.

80-2425

One Stacked-Column Vibration Test and Analysis for VHTR Core

T. Ikushima, H. Ishizuka, A. Ide, H. Hayakawa, and K. Shingai

Japan Atomic Energy Research Inst., Tokyo, Japan, Rept. No. JAERI-M-7727, 30 pp (July 1978)

Key Words: Columns, Nuclear reactor components, Vibration tests, Shakers

Results of a vibration test on a single stacked-column are compared with the analytical results. A ½ scale model of the core element of a very high temperature gas-cooled reactor was set on a shaking table. Sinusoidal waves, response time history waves, beat wave and step wave of input acceleration 100 - 900 gal in the frequency of 0.5 to 15 Hz were used to vibrate the table horizontally.

80-2426

Comparison of Transient PCRV Model Test Results with Analysis

A.H. Marchertas and T.B. Belytschko

Argonne National Lab., Argonne, IL, Intl. Conf. on Structural Mechanics in Reactor Tech., Berlin, F.R. Germany, Aug 13, 1979, 19 pp (1979)

CONF-790802-49

Key Words: Computer programs, Nuclear reactor containment, Dyna (computer program)

Comparisons are made of transient data derived from simple models of a reactor containment vessel with analytical solutions. This effort is a part of the ongoing process of development and testing of the DYNAPCON computer code. The calculations correctly predict the magnitudes of displacements of the PCRV model.

80-2427

Analysis of FFTF Response to Hypothetical Earthquake with Postulated Primary Piping Leak and Cooling by Natural Circulation

T.B. McCall and G.R. Franz

Hanford Engineering Development Lab., Richland, WA, Rept. No. CONF-790816-66, 11 pp (July 1979)

HEDL-SA-1715-FP

Key Words: Nuclear reactor components, Piping systems, Fast Fourier transform, Seismic response, Earthquake response

The predicted response of the FFTF to a hypothetical earthquake plus a postulated primary pipe leak with subsequent reliance on natural circulation cooling to demonstrate the independence of the primary loops under these conditions is studied. The most pessimistic leak location was selected on the basis of consideration of a sodium spray to maximize the cell gas pressure.

OFF-SHORE STRUCTURES

80-2428

Vortex Shedding Effects on Offshore Structure Fatigue

E.P. Russo, N.J. Loiacono, and W.S. Janna

School of Engrg., Univ. of New Orleans, LA, Engrg. Struc., 2 (3), pp 147-149 (July 1980) 3 figs, 10 refs

Key Words: Offshore structures, Fatigue life, Vortex-induced excitation, Vortex shedding

An equation from the U.S. Corp of Engineers Shore Protection Manual is used for estimating the stresses induced by vortex shedding on a cylindrical vertical pile penetrating the free surface. The analysis is based on the assumption that the force due to vortex is sinusoidal with twice the frequency of the drag force.

VEHICLE SYSTEMS

GROUND VEHICLES

(Also see Nos. 2412, 2467, 2524, 2575, 2576)

80-2429

An Analytical Study of Electric Vehicle Handling Dynamics

J.E. Greene and D.J. Segal

MGA Research Corp., Buffalo, NY, Rept. No. NASA-CR-162870, JPL-9950-297, 223 pp (May 1979) N80-23217

Key Words: Electric vehicles, Simulation, Dynamic structural response

Hypothetical electric vehicle configurations were studied by applying available analytical methods. Elementary linearized models were used in addition to a highly sophisticated vehicle dynamics computer simulation technique. Physical properties of specific EV's were defined for various battery and powertrain packaging approaches applied to a range of weight distribution and inertial properties which characterize a generic class of EV's. Computer simulations of structured maneuvers were performed for predicting handling qualities in the normal driving range and during various extreme conditions related to accident avoidance.

80-2430

Examination of a Nonholonomic Constraint Method for Handling Analyses of Articulated Vehicles

B.W. Mooring

Ph.D. Thesis, Purdue Univ., 153 pp (1979) UM 8015497

Key Words: Articulated vehicles, Nonholonomic systems, Constrained structures, Interaction: tire-pavement

A nonholonomic constraint formulation for analyzing the handling response and stability of an articulated vehicle is presented. Two vehicle models are analyzed using the standard slip angle approach and the constraint method. The models examined are a simplified, one degree of freedom trailer model and a four degree of freedom model of a tractor trailer system.

80-2431

Calculation Methods for Stochastic Vehicle Vibrations (Berechnungsverfahren für stochastische Fahrzeugschwingungen)

P.C. Müller, K. Popp, and W.O. Schiehlen

Lehrstuhl B für Mechanik, Tech. Univ. München, Arcisstrasse 21, D-8000 München 2, Ing. Arch., 49 (3/4), pp 235-254 (1980) 4 figs, 2 tables, 37 refs (In German)

Key Words: Automobiles, Ground vehicles, Random vibrations, Guideways, Surface roughness, Human response, Frequency domain, Time domain

The dynamic analysis of random vehicle vibrations and the consequences especially to human comfort requires an integrated investigation of guideway roughness, nonlinear vehicle dynamics and human response to vibration exposure. The complete system is characterized in the frequency as well as in the time domain. Multi-axle excitation inputs are included in the vehicle dynamics. Nonlinearities are considered by statistical linearization techniques. The variances of wheel load variation, car body acceleration and human perception are determined by spectral analysis in frequency domain as well as by covariance analysis in time domain.

80-2432

Method of Control of the Noise Level of Road Vehicles in Use

J. Miazga

Road Transport Institute Ul. Stalingradzka 40, 03-301, Warsaw, Poland, Appl. Acoust., 13 (3), pp 165-169 (May/June 1980) 3 figs, 7 refs

Key Words: Ground vehicles, Noise measurement, Noise reduction

A preliminary estimation of vehicle noise is obtained by measuring the external sound level pressure of the vehicle, as well as the band levels of the two frequency bands characteristic of the working engine at a definite speed of rotation. Vehicles above the specified noise and band levels can then be eliminated.

80-2433

Mathematical Modeling of DODX Railcars

C.T. Jones

Engrg. Test and Analysis Div., ENSCO, Inc., Alexandria, VA, Rept. No. ENSCO/DOT-FR-77-20; FRA/ORD-78/47, 168 pp (Feb 1980)

PB80-156961

Key Words: Freight cars, Railroad cars, Mathematical models, Damping characteristics, Interaction: rail-wheel

Roll stability characteristics of large capacity freight cars, 100 to 200 ton, loaded with high center of gravity containers is presented. The model is a 22 degree-of-freedom, non-linear, time domain model of railcars equipped with two axle trucks modified to include hydraulic dampers, an improved Coulomb friction damping model, and a track input to simulate perturbed track.

80-2434

Track Stiffness: Measurement System Evaluation Program

G. Hayes, P. Joshi, and J. Sullivan

Engineering Test and Analysis Div., ENSCO, Inc., Alexandria, VA, Rept. No. ENSCO/DOT/FR-79-30; FRA/ORD-79/30, 165 pp (Dec 1979)

PB80-165293

Key Words: Railroad tracks, Bridges, Stiffness coefficients, Measurement techniques

A three-phase program to develop and evaluate an on-board, track stiffness measurement system is described. A detailed study of long- and short-span bridge stiffness signatures was conducted. An analytical study of the relationship of the mid-chord-offset difference to absolute stiffness for bridge structures and continuous roadbed was made. Theoretical stiffness models were matched to actual short-span bridge stiffness signatures.

80-2435

Coupled Lateral-Vertical Dynamics of Rubber-Tired Automated Guideway Transit Vehicles with Random Guideway Inputs

Y.K. Kwak and C.C. Smith

Dept. of Ordnance Engrg., Korea Military Academy, Seoul, Korea, J. Dyn. Syst., Meas. and Control, Trans. ASME, 102 (2), pp 85-93 (June 1980) 8 figs, 4 tables, 12 refs

Key Words: Interaction: rail-wheel, Tires, Elastomers, Guideways

A method for the simulation of coupled lateral-vertical rigid body vibration response of a rubber-tired automated guideway transit vehicle subject to guideway random irregularities is presented. The general motions are expressed by Euler angles and inertial displacements. Basic vehicle dynamic modes are determined. A predicted lateral acceleration spectrum of the linearized model using guideway surface profile models for inputs are compared with the measured lateral acceleration spectra.

80-2436

The Investigation of the Stability of Motion of a Railroad Vehicle Using Newmark's Method. (Die Untersuchung der Stabilität der Bewegung eines Eisenbahnfahrzeuges mit Hilfe der Neumarkschen Methode)

A.D. de Pater

Delft University of Tech., Mekelweg 2, P.O. Box 5033, NL-2600 GA Delft, Netherlands, Ing. Arch.,

49 (3/4), pp 195-200 (1980) 7 figs, 3 refs
(In German)

Key Words: Railroad cars, Interaction: rail-vehicle

The method of D-partitioning enables to determine the stability limit curves of a linear system in a plane in which some parameter of the system represents the abscissa and another one the ordinate. Hitherto the method was used in the case where the coefficients of the characteristic equation are linear functions of both of the parameters. By applying it to the case of a single railway vehicle moving along the track, it is shown that the method is not restricted to such linearities.

80-2437
Block Pulse Functions Applied to Bounding Predictions for Impacted Structures of the Type Associated with Transportation Vehicle Collisions
M.S. Oskard
D. Eng., The Catholic Univ. of America, 106 pp (1980)
UM 8014184

Key Words: Collision research (automotive), Guiderails, Approximate methods

A method using orthogonal block pulse functions and a generalized vector mean is developed for application to impacted multi-node safety rails assuming the displacements are symmetric about the center of impact. The block pulse functions transform the integral inequalities to vector inequalities which bound the final deformed shape. Repeated optimization of the generalized vector mean on the lower bound solution vector provides an approximation to final displacement. An available lower bound on impact duration also permits approximation of average deceleration thus providing an estimate of occupant injury potential. Approximate solutions from some typical examples are presented and compared with full scale test results.

SHIPS

80-2438
Hydrodynamic Design and Analysis of a Towed Environmental Sensor Vehicle
D.C Summey
Naval Coastal Systems Center, Panama City, FL, Rept No NCSC TM-280-80, 48 pp (Mar 1980)
AD-A082 200/7

Key Words: Ships, Towed vehicles, Hydrodynamic excitation, Design techniques

A hydrodynamic vehicle design analysis of a towed environmental sensing system was conducted primarily to determine the towed vehicle geometry and mass characteristics which best meet the depth-keeping and stability requirements. The effects of the tow cable, depressor, and tow ship were also examined. The design requirements, initial vehicle geometry, the effects of geometry modifications, and the final vehicle geometry are presented.

80-2439
Normal Mode Analysis of the Dynamic Response of the OTEC Cold Water Pipe and Platform System to a Random Seaway
Y.-L. Hwang
D. Eng., University of California, Berkeley, CA, 92 pp (1979)
UM 8014581

Key Words: Normal modes, Frequency domain method, Pipes (tubes), Beams, Ships, Floating structures, Coupled response, Water waves

A general procedure for a linearized frequency domain analysis of the coupled OTEC cold water pipe and ship system in random waves is developed. The ship is represented as a free-floating rigid body, and the CW pipe is idealized by finite elastic beam elements with internal water flow. The dynamic response of the coupled system to the wave loads may be obtained by using the method of normal mode-superposition to solve the complete equations of motion in the frequency domain. This normal mode approach is capable of producing the results to any desired degree of accuracy by including the necessary number of modes of vibration of the CW pipe. Two examples are studied to present the effects of internal water flow and the effectiveness of this analytical formulation.

80-2440
Propulsion System Vibration Test and Evaluation Report USCGS KATMAI BAY
N.W. Huzil
David W. Taylor Naval Ship Research and Development Center, Bethesda, MD, Rept. No. DTNSRDC-80/030, 25 pp (Mar 1980)
AD-A081 599/3

Key Words: Icebreakers (ships), Ships, Propulsion systems, Vibration tests

Alternating thrust, torque, and thrustbearing housing vibration were measured on United States Coast Guard Cutter KATMAI BAY during open water, brash ice, and ice breaking operations. Longitudinal and torsional natural frequencies of the propulsion system were identified. The statistical distribution of peak alternating thrust amplitudes due to brash ice operation was found to be skewed and therefore not normal or Gaussian.

80-2441

Development of the Five Degree-of-Freedom Linear Model for the XR-3 Surface Effect Ship and Investigation of the Roll Behavior of the Craft in Turn Maneuvers

F. Ozanturk

Naval Postgraduate School, Monterey, CA, 119 pp (Dec 1979)

AD-A081 766/8

Key Words: Surface effect machines, Ships, Simulation, Mathematical models

A five degree-of-freedom linear model for the XR-3 surface effect ship is developed for constant speed operation. The weight removal transient response and the roll behavior of the craft in turn maneuvers are investigated by both linear and six degree-of-freedom nonlinear models, and the linear model simulation results are compared with the nonlinear model simulations. Some of the parameters of the craft are investigated for roll motion.

AIRCRAFT

(Also see Nos. 2385, 2386, 2468, 2469, 2551, 2569)

80-2442

QCGAT Aircraft/Engine Design for Reduced Noise and Emissions

L. Lanson and K.M. Terrill

Avco Lycoming Div., Stratford, CT, In NASA Lewis Research Center Gen. Aviation Propulsion, pp 101-133 (Mar 1980)

N80-22331

Key Words: Aircraft noise, Aircraft engine, Engine noise, Noise control

The high bypass ratio QCGAT engine played an important role in shaping the aircraft design. The design objectives, noise, and emission considerations, engine cycle and engine description are discussed as well as specific design features.

80-2443

Noise Generation by Jet-Engine Exhaust Deflection

B. Gehlar, W. Dobrzynski, and B. Fuhrken

European Space Agency, Paris, France, Rept. No. EAS-TT-553, 50 pp (July 1979) Engl. transl. of "Schallerzung durch Triebwerksstrahl-Deflexion," Rept. DFVLR-FB-78-21, DFVLR, Brunswick, Sept 1978

N80-23104

Key Words: Aircraft noise, Engine noise, Jet noise, Noise generation

Noise radiation by jet engine exhaust-flow-interaction with blast deflectors is investigated by means of model-experiments of scale 0.1. The investigations pertain to a specific deflector configuration. Noise spectra and directivity characteristics for various power-settings and configuration changes are determined and used for the prediction of noise generation by the full-scale configuration.

80-2444

USAF Environmental Noise Data Handbook. Volume 127. F-15A In-Flight Crew Noise

H.K. Hillie

Aerospace Medical Research Lab., Wright-Patterson AFB, OH, Rept. No. AMRL-TR-75-50-VOL-127, 15 pp (Aug 1979)

AD-A082 652/9

Key Words: Aircraft noise, Noise measurement, Interior noise, Manuals and handbooks

Measured data defining the bioacoustic environments at the pilot's location inside the F-15A aircraft are provided for 30 flight conditions. Data are reported for one location in a wide variety of physical and psychoacoustic measures.

80-2445

USAF Bioenvironmental Noise Data Handbook Volume 141, F/A-18 Aircraft, Far-Field Noise

R.G. Powell

Aerospace Medical Research Lab., Wright-Patterson AFB, OH, Rept. No. AMRL-TR-75-50-VOL-141, 126 pp (July 1979)
AD-A082 654/5

Key Words: Aircraft noise, Noise measurement, Human response, Manuals and handbooks

Far-field measured and extrapolated data are provided defining both physical and psychoacoustic measures of the bioacoustic environments produced by a carrier based fighter-attack aircraft powered by two F404-GE-400 turbofan engines operating on a ground runup pad for five engine conditions. Far-field data measured at 19 locations are normalized to standard meteorological conditions and extrapolated from 75-8000 meters to derive sets of equal-value contours as a function of angle and distance from the source.

80-2446

USAF Environmental Noise Data Handbook. Volume 139. E-3A Aircraft, Near and Far-Field Noise

R.G. Powell

Aerospace Medical Research Lab., Wright-Patterson AFB, OH, Rept. No. AMRL-TR-75-50-VOL-139, 108 pp (Aug 1979)
AD-A082 653/7

Key Words: Aircraft noise, Noise measurement, Manuals and handbooks

Measured and extrapolated data defining the bioacoustic environments produced by the USAF E-3A aircraft operating on a concrete runup pad for four engine/power configurations are presented. Near-field data are reported for nine locations in a wide variety of physical and psychoacoustic measures.

80-2447

Airsearch QCGAT Engine: Acoustic Test Results

L.S. Kisner

AiResearch Mfg. Co., Phoenix, AZ, In NASA Lewis Research Center, Gen. Aviation Propulsion, pp 65-100 (Mar 1980)
N80-22330

Key Words: Aircraft, Aircraft noise, Noise measurement

The noise levels of the quiet, general aviation turbofan (QCGAT) engine were measured in ground static noise tests. The measured QCGAT noise levels were correlated with analytical noise source predictions to derive free-field component noise predictions. These component noise sources were used to predict the flyover noise levels at FAR Part 36 conditions.

80-2448

Prediction of Changes in Aircraft Noise Exposure

D.K. Holger

Dept. of Engrg. Science and Mechanics, Engrg. Research Inst., Iowa State Univ., Ames, IA 50011, Noise Control Engrg., 14 (3), pp 119-126 (May/June 1980) 4 figs, 3 tables, 10 refs

Key Words: Aircraft noise, Airports, Noise prediction

Sets of numerically generated noise exposure contours are available for the vicinity of most domestic Air Force bases and many civilian airports. For such bases, a simple method for manually predicting the change in area enclosed by a given noise exposure contour is described. These predictions are used for determining whether a full-scale computer resimulation is necessary for a given set of operational changes.

80-2449

V/STOL Rotary Propulsor Noise Prediction Model Update and Evaluation

B. Magliozzi

Hamilton Standard Div., United Technologies Corp., Windsor Locks, CT, Rept. No. FAA-RD-79-107, 233 pp (Dec 1979)
AD-A082 616/4

Key Words: Helicopter noise, Noise measurement, Noise prediction

The V/STOL rotary propulsor noise prediction model was updated and evaluated. A literature review was conducted to identify and evaluate high quality noise measurements for the preparation of a data base with emphasis on recent measurements of in-flight propulsors. The effects of forward flight on V/STOL propulsor noise were evaluated and the noise prediction model was improved to give better agreement with current measurements. The performance of the noise prediction methodology was evaluated by comparison of calculations with measurements of propulsor noise from the data base.

80-2450

Test Installations to Investigate the Dynamic Behaviour of Aircraft with Scaled Models in Wind Tunnels

H. Subke
Institut f. Flugmechanik, DFVLR Braunschweig, Germany, Trans. Inst. Meas. Control, 1 (3), pp 135-140 (Sept 1979) 10 figs, 3 tables, 7 refs

Key Words: Wind tunnel tests, Scaling, Aircraft, Transformation techniques

The transformation laws between a scaled aircraft model and the actual aircraft are derived and the test installation is described. A comparison is given between the transient response of a model flying in a wind tunnel and the results of a flight simulation with an analog computer.

80-2451

The Rapid Prediction of Aircraft Store Loading Distributions at Transonic Speeds. Part II

A.J. Crisalli, S.S. Stahara, and M.J. Hemsch
Nielsen Engrg. and Research, Inc., Mountain View, CA, Rept. No. NEAR-TR-204, AFSOR-TR-79-1282, 80 pp (Oct 1979)
AD-A082 005/0

Key Words: Aircraft wings, Wing stores, Aerodynamic loads

A method for determining loading distributions on external stores located in the three-dimensional transonic flow field of a parent aircraft is provided. Emphasis is placed on developing accurate but rapid methods for predicting store loadings in transonic flow fields generated by wing-body/pylon combinations representative of modern fighter-bomber aircraft. Detailed evaluations, based on extensive comparisons with experimental data obtained from a parallel wind-tunnel test phase of the program, are presented for two store loading prediction methods. Results are provided for various wing-body/pylon/store configurations for flow conditions throughout the transonic regime.

80-2452

Decoupler Pylon: Wing/Store Flutter Suppressor

W.A. Reed, III
Langley Research Center, NASA, Langley Station, VA, US-Patent-Appl-SN-135057, 18 pp (Mar 1980)
N80-22359

Key Words: Aircraft wings, Wing stores, Mountings, Flutter

A device for suspending a store from a support such as an aircraft wing is described. The device allows the flutter speed of an aircraft flying with an attached store to be increased while reducing the sensitivity of flutter to changes in the pitch inertia and center of gravity location of the store.

80-2453

Minimum Mass Sizing of a Large Low-Aspect Ratio Airframe for Flutter-Free Performance

W.H. Greene and J. Sobieszczanski-Sobieski
Langley Research Center, NASA, Langley Station, VA, Rept. No. NASA-TM-81818, AIAA-80-0724CP, 40 pp (May 1980), Presented at the 21st Struct., Structural Dyn., and Mater. Conf., Seattle, May 12-14, 1980
N80-23683

Key Words: Aircraft, Flutter

A procedure for sizing an airframe for flutter-free performance is demonstrated on a large, flexible supersonic transport aircraft. The procedure is based on using a two-level reduced basis or modal technique for reducing the computational cost of performing the repetitive flutter analyses.

80-2454

The Failure of Aircraft Structures

E.A.B. DeGraaf
Structures and Materials Dept., National Aerospace Lab., Amsterdam, Netherlands, Rept. No. NLR-MP-78040-U, 36 pp (Dec 6, 1978)
N80-23285

Key Words: Aircraft, Fatigue life

Aircraft structural failures and the design measures taken to prevent them are discussed. Methods for determining static strength and stiffness, loads, and fatigue strength are surveyed. Modern design philosophies which take into account the possibility of initial defects from which fatigue damage could originate are considered. Examples of structural failure are given and discussed.

80-2455
Aircraft Crash Survival Design Guide. Volume II. Aircraft Crash Environment and Human Tolerance
D H Laananen
Simula, Inc, Tempe, AZ, Rept No TR 7820, US ARTL TR 79 22B 125 pp (Jan 1980)
AD A082 512/5

Key Words Crash research (aircraft), Anthropomorphic dummies

This volume contains information on the aircraft crash environment, human tolerance to impact, occupant motion during a crash, human anthropometry, and crash test dummies, all of which serves as background for the design information presented in the other volumes

80-2456
Aircraft Crash Survival Design Guide. Volume V. Aircraft Postcrash Survival
N B Johnson and S H Robertson
Simula, Inc, Tempe, AZ, Rept No TR 7823, US ARTL TR 79 22E 228 pp (Jan 1980)
AD A082 513 3

Key Words Crash research (aircraft), Crashworthiness

Information on the aircraft postcrash environment and design techniques that can be used to reduce postcrash hazards is assembled. Topics include the postcrash fire environment, crashworthy fuel systems, ignition source control, fire behavior of interior materials, ditching survival, emergency escape, and crash locator beacons.

80-2457
The VIBRA-8 Subsonic Aerodynamic Nuclear Gust Vulnerability Code
G Zartarian
Kaman Avidyne, Burlington, MA, Rept No KA-TR 164, DNA 4966F, AD E300 674, 22 pp (May 1979)
AD A081 722 1

Key Words Aircraft, Nuclear weapons effects, Computer programs

Modifications to the subsonic aerodynamic subroutine in the earlier versions of VIBRA to extend the applicability of the nuclear vulnerability code over broader ranges of Mach number, aspect ratio, and sweep angles are described. This modified version, designated as VIBRA-8, was developed in conjunction with a study of the nuclear vulnerability of an aeronautical system

80-2458
Effect of Some Structural Parameters on Elastic Rotor Loads by an Iterative Harmonic Balance
A Lipe
D Science, Washington Univ 122 pp (1979)
UM 8012195

Key Words Helicopters, Rotor blades (rotary wings), Rotors (machine elements), Harmonic balance method

Effects of various structural coupling parameters and blade EI distribution on rotor loads are studied for three typical rotors a stiff in-plane hingeless tail rotor, a soft in-plane hingeless main rotor and an articulated main rotor The results show excellent convergence of the iterative solution scheme.

BIOLOGICAL SYSTEMS

HUMAN

(See Nos 2431 2455)

MECHANICAL COMPONENTS

ABSORBERS AND ISOLATORS

80-2459
OSCEE Fan Exhaust Bulk Absorber Treatment Evaluation
H E Bloomer and N E Samanich
Lewis Research Center, NASA, Cleveland, OH, Rept No NASA TM-81498, E 435, 20 pp (1980), Presented at 6th Aeroacoustics Conf , June 4-6, 1980
N80-23314

Key Words: Acoustic absorption, Absorbers (materials), Acoustic linings, Ducts

The acoustic suppression capability of bulk absorber material designed for use in the fan exhaust duct walls of the quiet clean short haul experiment engine (QCSEE UTW) was evaluated. The acoustic suppression to the original design for the engine fan duct which consisted of phased single degree-of-freedom wall treatment was tested with a splitter and also with the splitter removed.

80-2460

Identification of Superior Energy-Absorbing Materials for School Bus Interiors. Volume I. Summary Report

L.S. Pauls

ASL Engineering, Inc., Santa Barbara, CA, Rept. No. DOT-HS-805 270, 49 pp (Jan 1980)
PB80-165269

Key Words: Energy absorption, Absorbers (materials), Buses

Identification and selection of superior energy absorbing materials for school bus interiors are investigated. The objectives were to develop material selection criteria, identify and select superior energy absorbing materials currently on or nearing the market, and verify material selections, using the established criteria. The established material selection criteria considers high temperature performance, shock attenuation, energy absorption, and general design. Materials were evaluated and screened, using this established criteria, and a set of preferred materials tested experimentally to verify their compliances to these criteria. Tests included flammability, dynamic drop and sled impact tests.

80-2461

Identification of Superior Energy-Absorbing Materials for School Bus Interiors. Volume II: Technical Report

L.S. Pauls

ASL Engineering, Inc., Santa Barbara, CA, Rept. No. DOT-HS-805 271, 106 pp (June 1979)
PB80-165277

Key Words: Energy absorption, Absorbers (materials), Buses, Crashworthiness

A study of school bus crashworthiness, primarily the design of interior crash padding systems and the identification and selection of outstanding padding materials for this design application, is reported.

80-2462

Testing of a Wind Restraint for Aseismic Based Isolation

J.M. Kelly and D.E. Chitty

Dept. of Civil Engrg., Univ. of California, Berkeley, CA, Engrg. Struc., 2 (3), pp 176-186 (July 1980) 17 figs, 2 tables, 7 refs

Key Words: Vibration isolation, Seismic isolation, Buildings, Seismic design

A series of shaking table tests were performed to test a building base isolation system equipped with a mechanical fuse sufficiently strong to resist wind loading, but which would fracture during an earthquake, leaving the building free on the isolation system. The design of a shear pin mechanical fuse system for a full-scale structure in view of the experimental results is discussed.

80-2463

Base Isolation for Torsion Reduction in Asymmetric Structures under Earthquake Loading

D.M. Lee

California Inst. of Tech., Pasadena, CA, Intl. J. Earthquake Engr. Struc. Dynam., 8 (4), pp 349-359 (Aug 1980) 9 figs, 29 refs

Key Words: Seismic isolation, Buildings

The effectiveness of a bilinear hysteretic base isolation system in lowering the shear forces and torques generated in a structure by two-way, translatory ground motions is examined. The study is restricted to single-story, three-dimensional structures having asymmetries in both horizontal directions and being excited by the El Centro (May 1940) earthquake motions. The dynamic action of the base isolation system is outlined and currently available isolation system components described.

80-2464

The Design and Use of Rubber Bearings for Vibration Isolation and Seismic Protection of Structures

C.J. Derham and A.G. Thomas

Malaysian Rubber Producers' Research Association, Hertford, Herts, UK, Engrg. Struc., 2 (3), pp 171-175 (July 1980) 8 figs, 4 refs

Key Words: Vibration isolation, Seismic isolation, Elastomers, Elastomeric bearings, Seismic design

The development and design of rubber structural bearings for civil engineering applications is investigated. Topics covered include the relevant static and dynamic properties of rubber, stability considerations, and the mathematical modeling of the rubber behavior.

80-2465

Control of Seismic Response of Piping Systems and Components in Power Plants by Base Isolation

J.M. Kelly and D.E. Chitty

Dept. of Civil Engrg., Univ. of California, Berkeley, CA, Engrg. Struc., 2 (3), pp 187-198 (July 1980) 10 figs, 1 table, 14 refs

Key Words: Vibration isolation, Seismic isolation, Piping systems, Electric power plants

A base isolation system for piping systems and components of power plants is described which reduces the accelerations induced in structures under earthquake motion. The experimental work demonstrates that the response of equipment in structures so isolated is greatly reduced. It is anticipated that the use of base isolation will reduce the cost of the design and construction of power plant components, piping systems, and structures.

80-2466

Isolation of Vibrations in Research and Production (Schwingungsisolierung in Forschung und Produktion)

L. Dietrich and K. Spanner

Feinwerktech. and Messtech., 88 (1), pp 1-6 (Jan/Feb 1980) 14 figs

(In German)

Key Words: Vibration isolators, Pneumatic isolators, Measuring instruments

Vibration isolation of sensitive measuring instruments and the interaction with the damping of the system is discussed. Pneumatic isolators with a two-chamber damping system are described, in which the gas pressure dependent elastic constants cause mass independent resonant frequency. Because of this property, pneumatic isolators are universally used.

80-2467

Natural Rubber as an Anti-Vibration Material - Transport Engineering

I.G. Rose

Malaysian Rubber Producers Research Assoc., Noise Vib. Control Worldwide, 11 (5), pp 182-187 (May 1980) 13 figs

Key Words: Elastomers, Transportation systems, Noise reduction, Vibration isolation

Various applications of natural rubber in transportation systems for the protection of environs from excessive vibrations, as well as for internal vibration isolation for the comfort of passengers, are discussed.

80-2468

Investigations into an Active Vibration Isolation System for Helicopters with Rigid and Elastic Airframe Modeling

J. Skudridakis

European Space Agency, Paris, France, Rept. No. ESA-TT-531; DLR-IB-552/78-6, 73 pp (1979) (Engl. trans. of "Untersuchung zu einen aktiven Schwingungsisolationssystem f. Hubschrauber bei Starrer und Elasticher Zellenomodellierung," Rept. DLR-IB-552-78-6 DFVLR, Brunswick, June 1978) N80-22315

Key Words: Vibration isolation, Active isolation, Helicopters, Rotor blades

A system for active rotor isolation was investigated to compensate for blade number harmonic excitation of the rotor and limit the static relative movement of the rotor drive unit. Several sensor configurations were studied for the first completed regulator design of a single rigid function model with a modified Riccati design. This single axis computer model was reviewed and extended for the elastic helicopter airframe modeling.

80-2469

Investigations of the Design of Active Vibration Isolation Systems for Helicopters with Rigid and Elastic Modeling of the Fuselage

G. Schulz

European Space Agency, Paris, France, Rept. No. ESA-TT-556, DFVLR-FB-78-04, 66 pp (Nov 1979) N80-23300

Key Words: Active isolation, Vibration isolation, Helicopters

Different methods for the design of controllers for active vibration isolation on helicopters are investigated. Based on the special structure of the controller, compensation for the rotor blade harmonic disturbance vibrations is achieved, guaranteeing good trim behavior during maneuvers.

80-2470

Shock Absorbers Critiqued

F. Yeaple

Des. Engrg., 51 (7), pp 41-44 (July 1980) 5 figs

Key Words: Shock absorbers

The comments of a number of experts, users as well as suppliers, are summarized describing and comparing a number of shock absorbers, enabling to choose among dramatically different concepts.

SPRINGS

80-2471

Finite Elements for Dynamical Analysis of Helical Rods

J.E. Mottershead

Lucas Research Center, Dog Kennel Lane, Shirley Solihull, West Midlands, UK, Intl. J. Mech. Sci., 22 (5), pp 267-283 (1980) 5 figs, 4 tables, 18 refs

Key Words: Rods, Helical springs, Rotatory inertia effects, Transverse shear deformation effects, Finite element technique

Finite elements are presented for dynamical analysis of helical rods. The element stiffness and mass matrices are based on the exact differential equations governing static behavior of an infinitesimal element. Natural frequencies obtained by use of the element, which allows for both shear deformation and rotary inertia, are compared to the frequency spectra of helical compression springs. The element performance is compared with that of other finite elements.

BLADES

(Also see Nos. 2381, 2382, 2458)

80-2472

A Simplified Method to Measure Unsteady Forces Acting on the Vibrating Blades in Cascade

Y. Hanamura, H. Tanaka, and K. Yamaguchi

Space and Aeronautical Science, Univ. of Tokyo, Megru-ku, Tokyo, Japan, Bull. JSME, 23 (180), pp 880-887 (June 1980) 18 figs, 2 tables, 10 refs

Key Words: Blades, Turbomachinery blades, Vibration measurement, Measurement techniques

A method for measuring vibration of blades in turbomachinery is described in which only the center blade is vibrating and the others are at rest. The unsteady forces induced on the vibrating blade and other neighboring blades at rest are measured and are linearly combined with arbitrary interblade phase angle.

80-2473

Coupled Bending-Torsion Flutter in Cascades with Applications to Fan and Compressor Blades

O.O. Bendiksen

Ph.D. Thesis, Univ. of California, Los Angeles, CA, 270 pp (1980)

UM 8015952

Key Words: Blades, Fan blades, Compressor blades, Flutter

A method is presented for determining the aeroelastic stability boundaries of a cascade with aerodynamic, inertial, and structural coupling between the bending and torsional degrees of freedom. Aeroelastic stability boundaries are presented for both the incompressible and the supersonic case, for several cascade configurations, locations of elastic axis, coupling strength, and structural damping. The results illustrate that the bending-torsion interaction has a pronounced effect on the cascade flutter boundary for both speed regimes, despite little or no tendency toward frequency coalese as flutter is approached.

80-2474

Propeller Dynamic and Aeroelastic Effects

B.W. McCormick

Pennsylvania State Univ., University Park, PA, In NASA Lewis Research Center Gen. Aviation Propulsion, pp 421-432 (Mar 1980)

N80-22348

Key Words: Propeller blades, Rotary wings, Blades

Various aspects of propeller blade dynamics are considered including those factors which are exciting the blades and the dynamic response of the blades to the excitations. Methods for treating this dynamic system are described and problems are discussed which may arise with advanced turboprop designs employing thin, swept blades.

80-2475
Slip Damping of Turbine Blades

M.C. Kimberling
School of Engrg., Air Force Inst. of Tech., Wright-Patterson AFB, OH, Rept. No. AFIT/GAE/AA.78D-11, 66 pp (Dec 1978)
AD A081 907/8

Key Words: Blades, Turbine blades, Slip damping, Damping

An experimental and analytical model of a turbine/compressor blade with a circular root geometry is developed for the purpose of studying the effects of slip damping on the response of the blade. The expressions for the energy dissipated by slip damping and by air and hysteresis damping are presented. The equation of motion for the blade is developed and solved to provide an expression relating the various parameters of the experimental and analytical models.

80-2476
Whistling Instability in Idling Circular Saws

C.D. Mote, Jr. and M.C. Leu
Dept. of Mech. Engrg., Univ. of California, Berkeley, CA, J. Dyn. Syst., Meas. and Control, Trans. ASME, 102 (2), pp 114-122 (June 1980) 17 figs, 1 table, 17 refs

Key Words: Circular saws, Saws, Blades, Self-excited vibration, Noise source identification

Whistling is a self-excited transverse instability that produces intense noise at a resonant frequency of a circular saw. Experiments were undertaken to examine the noise source dependence upon tooth shape, tooth number, rotation speed and the surrounding air pressure. The source model supported by the data is a self-excited fluid-structure instability possibly with a wake oscillation sustained or enhanced by the blade motion.

80-2477
Vibration and Stability of Band Saw Blades. A Theoretical and Experimental Study

A.G. Ulsoy
Ph.D. Thesis, Univ. of California, Berkeley, 132 pp (1979)
UM 8014912

Key Words: Blades, Saws, Plates, Flexural vibration

The problem of vibration and stability of band saw blades in the forest products industry is mathematically modeled as the transverse vibration of an axially moving plate subject to in-plane stresses. The resulting equation of motion is solved by two approximate techniques: the Ritz, and the Finite Element-Ritz methods. Both methods are shown, where applicable, to be sufficiently accurate, and their relative advantages and disadvantages are discussed.

BEARINGS

80-2478
The Effectiveness of Squeeze-Film Damper Bearings Supporting Flexible Rotors without a Centralising Spring

R.A. Cookson and S.S. Kossa
School of Mech. Engrg., Cranfield Inst. of Tech., Cranfield, Bedford MK43 OAL, UK, Intl. J. Mech. Sci., 22 (5), pp 313-324 (1980) 12 figs, 7 refs

Key Words: Squeeze-film bearings, Bearings, Squeeze-film dampers, Dampers, Rotor-bearing systems

The effectiveness of squeeze-film damper bearings incorporated into a flexible rotor system is investigated. A method has been devised for comparing the performance of squeeze-film damper bearings which operate without a parallel flexible support or centralizing spring (squirrel cage). The model used in this investigation is a relatively simple one in which a rotor mass is lumped at the mid-point of a horizontal flexible shaft and separate rotor masses are lumped at each bearing position. The performance of the squeeze-film damper bearing is expressed in terms of six dimensionless system parameters.

80-2479
Thermohydrodynamic Lubrication of Journal Bearings in Turbulent Flow

S. Wada, H. Hashimoto, and T. Nakagawa
School of Science and Engrg., Waseda Univ., Shin-

juki-ku, Tokyo, Japan, Bull. JSME, 23 (179), pp 773-780 (May 1980) 16 figs, 2 tables, 8 refs

Key Words: Journal bearings, Lubrication, Turbulence

The effects of film temperature and pressure on finite width journal bearing performance are evaluated and the dynamic characteristics such as stiffness and damping coefficients of lubricant film and the stability of rotor are analyzed. The results show that the thermal effects on the bearing performances and the dynamic characteristics are prominant in the turbulent lubrication.

80-2480
Rotor-Bearing Dynamics Technology Design Guide. Part IV. Cylindrical Roller Bearings
A.B. Jones and J.M. McGrew, Jr.
Shaker Research Corp., Ballston Lake, NY, Rept. No. SRC-79-TR-45; AFAPL-TR-78-6-PT-4, 73 pp (Dec 1979)
AD-A082 355/9

Key Words: Rotor-bearing systems, Computer programs, Roller bearings, Stiffness coefficients

A computer program is given for preparation of cylindrical roller bearing stiffness data input for rotor-dynamic response programs. The complete stiffness matrix is calculated including centrifugal effects. The resulting program is reasonably small and easy to use. This report is an update of the original Part IV of the Rotor-Bearing Dynamics Design Technology Series, AFAPL-TR-65-45 (Parts I through X).

GEARS

80-2481
A Volterra Series - Derived Describing Function for a Motor/Variable Gearbox/Load
P.J. Lawrence
Univ. of Southampton, UK, Trans. Inst. Meas. Control, 1 (4), pp 195-198 (Dec 1979) 3 figs, 3 refs

Key Words: Gear boxes, Variable speed drives

A solution to the speed variations of a load driven via a variable ratio gearbox from a non-constant speed drive is obtained as a Volterra series. A particular solution is found when the gear ratio is varied sinusoidally. This leads to a simple transfer function, with coefficients varying with input amplitude, which is shown to adequately model the overall dynamics.

COUPLINGS

80-2482
Coupling of Misaligned Shafts
J.F. Ohlson
Dept. of the Navy, Washington, D.C., U.S. PATENT-4 187 698, 4 pp (Feb 1980)

Key Words: Shafts, Couplings, Aligning

A coupling device for torque transmission in non-aligned shafts is described, mating splined halves having engaging teeth and a spherical surface at the interface thereof to accommodate misalignment of interconnected shafts. The halves are maintained in engagement by a nut and bolt longitudinally extending through the halves with a spring washer.

VALVES
(Also see No. 2507)

80-2483
Response of a Quick Acting Valve for Underground Nuclear Blast Containment
M.D. Bennett and W.H. Curry
Sandia Labs., Alburquerque, NM, Rept. No. SAND-79-1864, 37 pp (Oct 1979)

Key Words: Valves, Blast valves, Nuclear explosions, Underground explosions

The motion of a large, sliding piston impelled by the action of an inert gas at high pressure is modeled mathematically by assuming that the working fluid behaves as an ideal gas and that a steady flow process prevails. It is found from numerical solutions of the governing equations that as the aperture, which connects the gas reservoir and receiver, is enlarged, a critical size is reached, beyond which the valve response remains essentially independent of any further increases in the aperture dimension.

STRUCTURAL COMPONENTS

STRINGS AND ROPES

80-2484
Dynamic Modulus and Damping of Boron, Silicon Carbide and Alumina Fibers
J.A. Dicarlo and W. Williams
Lewis Research Center, NASA, Cleveland, OH, Rept. No. NASA-TM-81422; E-345, 44 pp (1980) Presented at the 4th Ann. Conf. on Composites and Advanced Mater., Cocoa Beach, Florida, Jan 20-24, 1980, Sponsored by the AM. Ceram. Soc.
N80-20313

Key Words: Fibers, Damping values, Vibration tests

The dynamic modulus and damping capacity for boron, silicon carbide, and silicon carbide coated boron fibers were measured from −190 to 800 C. The single fiber vibration test allowed measurement of transverse thermal conductivity for the silicon carbide fibers. Temperature dependent damping capacity data for alumina fibers were calculated from axial damping results for alumina-aluminum composites. The single fiber damping results were compared with composite damping data in order to investigate the practical and basic effects of employing the four fiber types as reinforcement for aluminum and titanium matrices.

CABLES

80-2485
A Simple Mathematical Model for Calculation of Wind-Excited Vibrations of High Voltage Lines with Dampers (Ein einfaches Rechenmodell zur Berechnung winderregter Schwingungen an Hochspannungsleitungen mit Dämpfern)
P. Hagedorn
Institut für Mechanik, Technische Hochschule Darmstadt, Hochschulstr. 1, D-6100 Darmstadt, Fed. Rep. Germany, Ing. Arch., 49 (3/4), pp 161-177 (1980) 12 figs, 14 refs
(In German)

Key Words: Cables (ropes), Power transmission systems, Wind-induced excitation, Damping

Wind-excited vibrations of overhead transmission lines are computed by an approach in which damping and wind power are calculated for the semi-infinite and for the infinite cable respectively. Good results are obtained due to the dense spectrum of eigenfrequencies of the finite cable. Simple formulas for the bending strain in the cable are obtained by applying singular perturbations.

80-2486
Evaluating the SEADYN Model. Mooring Dynamics Experiment Five
D.B. Dillon
EG and G. Washington Analytical Services Center, Inc., Rockville, MD, Rept. No. EG/G-TR-4999-0003, 47 pp (Mar 1980)
AD-A082 165/2

Key Words: Cables (ropes), Moorings, Geometric effects, Tension data, Computer programs, Finite element technique

The computer model of ocean cable structures SEADYN was used to calculate the anchor-last deployment of the sixth mooring of the Mooring Dynamics Experiment (MDE) conducted in Hawaii waters in 1976. Configuration and tension data obtained by SEADYN compared well with experimental data.

80-2487
The Effect of Compressive Loading on the Fatigue Lifetime of Graphite/Epoxy Laminates
J.T. Ryder and E.K. Walker
Rye Canyon Research Lab., Lockheed-California Co., Burbank, CA, Rept. No. LR-29168; AFML-TR-79-4128, 383 pp (Oct 1979)
AD-A082 150/4

Key Words: Fatigue tests, Layered materials

The effect of compressive loading on the fatigue response of graphite epoxy laminates containing a circular hole was investigated. The emphasis was on the accumulation of a statistically significant data base. The test program consisted of static tension and compression tests, tension-tension and tension-compression fatigue tests, and static tension and compression residual strength tests of coupons prior tested either under tension-tension or tension-compression fatigue loading.

BARS AND RODS

(Also see No. 2471)

80-2488

Dynamics Stress Concentrations Due to Flexural Waves in Bars with Various Bends (2nd Report: Solutions of Bars Excited in Arbitrary Directions)

Y. Hirano, K. Nagaya, and T. Kasai
Faculty of Engrg., Yamagata Univ., Yonezawa, Japan, Bull. JSME, 23 (180), pp 857-865 (June 1980) 10 figs, 10 refs

Key Words: Bars, Flexural vibration, Longitudinal vibration, Torsional vibration

Dynamic stress concentrations in bars with various bends are discussed. The elementary bar theory is applied for longitudinal and torsional waves, and the improved bar theory in which the effects of rotatory inertia and shear deformation are considered is applied for flexural waves. The analytical results for general problems are obtained, and the numerical calculations are carried out for cases of a circular arc bend, an L-bend and a Z-bend bars.

80-2489

Kinetic Branching Problems of Elastic Systems under Impact Loading (Über kinetische Verzweigungsprobleme elastischer Strukturen unter Stossbelastung)

J. Wauer
Institut für Technische Mechanik, Universität Karlsruhe, Kaiserstrasse 12, D-7500 Karlsruhe 1, Bundersrepublik Deutschland, Ing. Arch., 49 (3/4), pp 227-233 (1980) 2 figs, 9 refs
(In German)

Key Words: Rods, Continuum mechanics, Shock excitation

Dynamic stability problems of elastic systems subjected to non-periodic shock loading is discussed. Based on certain assumptions stability equations, characteristic for oscillators with time-dependent fundamental state, are given. Typical instabilities of these systems due to parametric main or combination resonance, along with phenomena which are connected to internal resonance and purely static buckling processes, are obtained.

80-2490

Reflection Characteristics of Torsional Waves in a Semi-Infinite Cylindrical Rod Connected to an Elastic Half Space

H. Wada
Dept. of Mech. Engrg., Tohoku Univ., Sendai 980, Japan, J. Acoust. Soc. Amer., 68 (1), pp 198-202 (July 1980) 6 figs, 15 refs

Key Words: Rods, Half-space, Pulse excitation, Torsional waves, Wave reflection, Laplace transformation

Reflection characteristics of torsional waves in a semi-infinite rod connected to an elastic half-space are analyzed under two specific incident pulse loads, applying Laplace transformations with respect to time and numerical inverse Laplace transformations. The time histories of the torsional stress and rotation of the semi-infinite rod at an arbitrary point are shown.

BEAMS

(Also see No. 2382)

80-2491

Free Vibrations of a Concentric Circular Conical Beam with a Concentric Circular Cylindrical Bore

R.K. Loder
Ballistics Research Lab., Army Armament Research and Development Command, Aberdeen Proving Ground, MD, Rept. No. ARBRL-TR-02216, AD-E430 396, 37 pp (Feb 1980)
AD-A083 292/3

Key Words: Flexural vibrations, Beams, Tubes, Shells

An analytical solution describing the free transverse vibration of a concentric circular conical tube with a concentric circular cylindrical bore has been derived for a variable domain which is characteristic for ballistic tubes. Eigenvalues and eigenvectors are discussed for a particular set of boundary conditions.

80-2492

Dynamic Simulation of a Cantilever Beam Type Force Transducer

D.A. Bayly
Defence Research Establishment Suffield, Alberta, Canada, Rept. No. DRES-TN-440, 60 pp (Feb 1980)
AD-A082 314/6

Key Words: Beams, Cantilever beams, Damping coefficients, Simulation, Computer programs

A cantilever beam force transducer was modeled as a massless elastic section at the base with the remaining section of the beam rigid and having mass. Computer programs were written to simulate free or forced, damped or undamped vibrations of the beam. Good agreement was found between predicted and experimental frequencies of undamped free vibration for two different beams.

80-2493

Analysis of Active Control of Cantilever Beam Bending Vibrations

D.T. Palac

School of Engrg., Air Force Inst. of Tech., Wright-Patterson AFB, OH, Rept. No. AFIT/GA/AA/78D-6, 99 pp (Dec 1978)

AD-A081 894/8

Key Words: Beams, Cantilever beams, Flexural vibrations, Active control

Active control of bending vibrations in a cantilever beam is examined using a digital computer model of beam and controller. The controller uses the discretized beam equation of motion in a linear control system, which uses a Luenberger observer to reconstruct modal amplitudes and velocities from the sensor output. Feedback gains obtained from a steady state optimal regulator drive a force actuator.

CYLINDERS

80-2494

An Analysis of the Static and Dynamic Instability of Thick Cylinders

J.D. Renton

Dept. of Engrg. Science, Oxford Univ., UK, Rept. No. OUEL-1292/79, 20 pp (1979)

N80-23709

Key Words: Cylinders, Natural frequencies, Differential equations

A general solution of Bolotin's differential equations for the dynamic stability of a homogeneous isotropic medium is given. This takes the form of displacement functions, which express the solution as a sum of dilatational and distortional effects. Solutions are found for the vibration of cylinders of finite thickness when initial axial stresses are present. It is shown that simple vibration and simple buckling are cases of the general solution. The results are compared with approximate formulas for the buckling of thin cylinders and it is shown that the known solution for the natural frequency of unloaded cylinders is a particular case.

80-2495

Hydroelastic Oscillations of Smooth and Tough Cylinders in Harmonic Flow

F. Rajabi

Naval Postgraduate School, Monterey, CA, Rept. No. AS-A081 760/1, 296 pp (Dec 1979)

Key Words: Interaction: structure-fluid, Cylinders, Harmonic excitation, Fluid-induced excitation

A comprehensive experimental and analytical investigation was undertaken to determine the hydroelastic response of elastically-mounted smooth and rough cylinders in harmonically-oscillating flow. The forces acting on the cylinder and the cylinder response have been measured together with the characteristics of the flow and analyzed through the use of the Fourier analysis, spectral analysis, Duhamel's integral, and the wake-oscillator model.

COLUMNS

(Also see No. 2414)

80-2496

Strong and Tough Concrete Columns for Seismic Forces

L. Selna, I. Martin, R. Park, and L. Wyllie

Mech. and Structures Dept., Univ. of California at Los Angeles, Los Angeles, CA, ASCE J. Struc. Div., 106 (ST8), pp 1717-1734 (Aug 1980) 8 figs, 1 table, 24 refs

Key Words: Columns, Reinforced concrete, Seismic excitation

Design procedures for reinforced concrete columns subjected to seismic forces are presented. Four types of column configurations are considered. Pertinent structural analysis methods, design procedures, and reinforcement detailing are discussed. State-of-the-art design by code, needed code improvements, and research needs are mentioned.

80-2497

Nonlinear Resonances in a Column Subjected to a Constant End Force

M.R.M. Crespo da Silva

Dept. of Engrg. Science, Univ. of Cincinnati, Cincinnati, OH 45221, J. Appl. Mech., Trans. ASME, 47 (2), pp 409-414 (June 1980) 8 figs, 13 refs

Key Words: Columns, Coupled response, Nonlinear response, Resonant response, Perturbation theory, Galerkin method, Hamilton-Jacobi theory

A canonical perturbation method based on Hamilton-Jacobi theory, used together with Galerkin's method, is employed to analyze the nonlinearly coupled transverse free oscillations of columns subjected to a constant end force. Integrals of motion, readily obtained from this type of analysis, are used to allow the analytical determination of the main characteristics of the resonant motion and of the region of resonance of the system.

FRAMES AND ARCHES

(Also see Nos. 2499, 2584)

80-2498

Optimum Inelastic Design of Seismic-Resistant Reinforced Concrete Frame Structures

S.W. Zagajeski and V.V. Bertero

Earthquake Engrg. Research Center, California Univ., Berkeley, CA, Rept. No. UCB/EERC-80/03, NSF/RA-800020, 122 pp (Jan 1980)

PB80-164635

Key Words: Reinforced concrete, Frames, Seismic design

The design of seismic-resistant reinforced concrete, moment-resisting frame structures is discussed and an inelastic optimum design procedure is described. This procedure is based on the philosophy of comprehensive design and employs a computer aided iterative technique in a series of five steps.

PANELS

80-2499

Infill Panels. Their Influence on Seismic Response of Buildings

J.W. Axley and V.V. Bertero

Earthquake Engrg. Research Center, California Univ., Berkeley, CA, Rept. No. UCB/EERC 79/28, NSF/RA-790352, 205 pp (Sept 1979)

PB80-163371

Key Words: Panels, Frames, Structural members, Buildings, Seismic response, Substructuring methods

A means to model the structural behavior of frame-infill systems is proposed wherein it is assumed that the primary structural system (the frame) constrains the form of the deformation of secondary structural elements (the infill panels). It is suggested that such a constraint approach may be considered to be generally useful in modeling the behavior of certain classes of secondary structural elements.

PLATES

(Also see No. 2477)

80-2500

Vibration of Cracked Rectangular Plates

Y. Hirano and K. Okazaki

Faculty of Engrg., Yamagata Univ., Yonezawa, Japan, Bull. JSME, 23 (179), pp 732-740 (May 1980) 9 figs, 2 tables, 8 refs

Key Words: Plates, Rectangular plates, Cracked media, Vibration response

Vibration analysis of a rectangular plate with line cracks parallel to its edge is described. The two opposite edges perpendicular to the line of the crack are assumed to be simply supported in these plates; therefore, the Levy-Nadai's form of solution is used. Fulfillment of mixed boundary conditions on the line of the crack are formulated by means of the weighted residual methods. Numerical calculations are carried out for three examples and compared with the works of other investigators.

SHELLS

(Also see Nos. 2415, 2578, 2582, 2584)

80-2501

Dynamic Instability of an Elastic Cylindrical Shell Excited by a Transient Acoustic Wave

T.L. Geers and C.L. Yen

Palo Alto Research Lab., Lockheed Missiles and Space Co., Inc., Palo Alto, CA, Rept. No. LMSC/D676760, 61 pp (July 1979)

AD A083 338/4

Key Words: Shells, Cylindrical shells, Submerged structures, Acoustic excitation, Interaction: structure-fluid

Governing equations are developed for the dynamic instability of an infinite, elastic, circular cylindrical shell submerged in an infinite fluid medium and excited by a transverse, transient acoustic wave. Extensive numerical results are presented.

80-2502

Dynamic Displacements and Stresses in a Circular Cylindrical Shell of Finite Length with Both Ends Clamped

S. Ujihashi, T. Koisumi, H. Matsumoto, and I. Nakahara

Faculty of Engrg., Tokyo Inst. of Tech., Tokyo, Japan, Bull. JSME, 23 (180), pp 837-848 (June 1980) 17 figs, 3 tables, 8 refs

Key Words: Cylindrical shells, Shells, Impact response (mechanical), Donnel theory, Flügges shell theory

Impulsive responses of a circular cylindrical shell of finite length with both ends clamped, which is suddenly subjected to radial concentrated loads on its surface, are analyzed on the basis of Flügge's shell theory. The purpose of this paper is to demonstrate the differences of the present results from those by Donnell's theory in the authors' previous paper and to examine the in-plane inertia effect of the shell.

80-2503

Transient Response of Thin Elastic Spherical Shells

A.V. Singh

Defence Research Establishment Suffield, Ralston, Alberta, Canada T0J 2N0, J. Acoust. Soc. Amer., 68 (1), pp 191-197 (July 1980) 8 figs, 3 tables, 13 refs

Key Words: Shells, Spherical shells, Transient response, Finite element technique, Natural frequencies, Mode shapes

Development of a finite element for the analysis of spherical shells is presented. The derivation of stiffness and mass matrices is based on the improved shell theory which takes into account the effects of rotary inertia and shear deformation. This finite element is then used to determine the natural frequencies and mode shapes for the free axisymmetric vibration case for free, hinged, and fixed boundary conditions. The transient response in the radial direction at the apex of the shell is calculated for shells subjected to time-dependent internal radial pressures.

80-2504

Hydroelastic Vibration Analysis of Partially Liquid-Filled Shells Using a Series Representation of the Liquid

J.M. Houser, R.W. Herr, and J.L. Sewall

Langley Research Center, NASA, Langley Station, VA, Rept. No. NASA-TP-1558; L-13279, 68 pp (Mar 1980)

N80-19563

Key Words: Shells, Fluid-filled containers, Fluid-induced excitation, Storage tanks, Computer programs, Sloshing

A series representation of the oscillatory behavior of incompressible nonviscous liquids contained in partially filled elastic tanks is presented. Each term is selected on the basis of hydroelastic vibrations in circular cylindrical tanks. Using a complementary energy principle, the superposition of terms is made to approximately satisfy the liquid-tank interface compatibility. This analysis is applied to the gravity sloshing and hydroelastic vibrations of liquids in hemispherical tanks and in a typical elastic aerospace propellant tank.

RINGS

80-2505

Dynamic Response to Rotating-Seat Runout in Non-Contacting Face Seals

I. Etsion

Lewis Research Center, NASA, Cleveland, OH, Rept. No. NASA-TM-81490; E-392, 25 pp (Apr 1980)

N80-22701

Key Words: Rings, Rotating structures

The dynamic response of a flexibly mounted ring to runout of the rotating seat in mechanical face seals is analyzed assuming small perturbations. It is found that tracking ability of the stator depends only on its dynamic characteristics and operating conditions and is not affected by the amount of runout. Three different modes of dynamic response are shown and the condition for parallel tracking is presented.

PIPES AND TUBES

(Also see Nos. 2418, 2439, 2465)

80-2506

Acoustic Analysis of Hydrodynamic Oscillations in the Gentilly-1 Steam Mains

W N Selander and P Y. Wong
Chalk River Nuclear Labs., Atomic Energy of Canada Ltd , Chalk River, Ontario, Canada, Rept. No. AECL 6176, 43 pp (Nov 1978)

Key Words: Pipes (tubes), Boilers, Acoustic detection, Fluid-induced excitation

A small amplitude (acoustic) wave equation is used to investigate pressure oscillations in the Gentilly-1 primary steam network, in both its existing form, and with the proposed modifications for LaPrade Heavy Water Plant.

80-2507

Stability and Self-Sustained Oscillations in Nozzle-Flapper Valve with Pipe Line

S Hayashi, T Matsui, and K Imai
Faculty of Engrg , Shizuoka Univ , Hamamatsu, Japan Bull JSME, 23 (179), pp 759-765 (May 1980) 10 figs, 1 table, 8 refs

Key Words: Valves, Pipelines, Self-excited vibrations

The stability of a system consisting of a nozzle-flapper valve and a pipe line and several features of the self-sustained oscillations occurring in the system are discussed. It is shown that the multiple modes of oscillations may simultaneously become unstable in a system with a long pipe line and that the most effective nonlinear characteristic for limiting the amplitude of the unstable oscillation is the collision of the flapper with the nozzle tip.

80-2508

Acoustic Loading in Straight Pipes

M El-Raheb
Applied Mechanics, Jet Propulsion Lab , California Inst of Tech , Pasadena, CA 91100, J Acoust Soc Amer , 68 (2), pp 665-672 (Aug 1980) 3 figs, 5 refs

Key Words: Pipes (tubes), Interaction structure-fluid, Geometric imperfection effects, Acoustic response

A theoretical model of the linear acoustic loading in straight pipes is developed that considers the acoustic wave distortion due to perimeter, axial, and wall thickness nonuniformities.

80-2509

Periodically Oscillating Turbulent Flow in a Pipe

U. Kita, Y Adachi, and K Hirose
School of Engrg., Okayama Univ Japan, Bull JSME, 23 (179), pp 656-664 (May 1980) 14 figs, 11 refs

Key Words: Pipes (tubes), Fluid-induced excitation, Turbulence

A fluctuating eddy viscosity model for Reynolds stress is proposed. The validity of this model is verified for all frequencies tested through comparisons between the calculations and measurements. The analysis yields three properly-modified Strouhal numbers: the first of them is adequate to illustrate similarly the velocity distributions in turbulent region over a wide range of frequencies and the time-mean Reynolds numbers, the second is adequate in the vicinity of wall, the last is for the instantaneous friction factor.

80-2510

Review of Methods and Criteria for Dynamic Combination in Piping Systems

M Reich, P C Wang, J Curreri, S Hou, and H Goradia
Brookhaven National Lab , Upton, NY, Rept No NUREG/CR-1330, 638 pp (Mar 1980)

Key Words: Piping systems, Distribution functions, Monte-Carlo method, Safety (nuclear reactors)

The probabilistic outcome of the combination of dynamic loads with a random time lag in structures such as nuclear power plant facilities is represented by a cumulative distribution function, obtained by using a Monte Carlo simulation procedure. This report details the finding of four specific items related to the problem of combinations of dynamic responses.

80-2511

Experimental Study of Hydraulic Systems Transient Response Characteristics

A Zur
School of Engrg , Air Force Inst of Tech , Wright-Patterson AFB, OH, Rept No AFIT/FAL/AA/78D-14, 63 pp (Dec 1978)
AD A081 909/4

Key Words: Hydraulic systems, Transient response, Geometric effects, Computer programs

The transient response characteristics of two laboratory hydraulic systems, consisting of a simple reservoir system and a pump system, were obtained both experimentally and by simulation with a computer program. Influence of various hydraulic components such as bends, filters and pulsation-dampening devices was determined by testing various experimental configurations and predicting the transient response with the computer program.

DUCTS

(Also see No. 2459)

80-2512

Added Mass and Damping Coefficients for Hexagonal Tube Arrays

D.E. Wilson

Argonne National Lab., Evanston, IL, Rept. No. ANL-CT 79-51, 24 pp (Aug 1979)

Key Words: *Interaction: structure-fluid*, Ducts, Harmonic response, Mass coefficients, Damping coefficients

An analytical investigation of the fluid coupling effects from an array of hexagonal cylindrical ducts undergoing harmonic oscillations is presented. A closed form solution for the velocity and pressure is obtained under a thin gap approximation for the case of moderate frequencies. From this solution, the usual viscous and inertial fluid coupling coefficients are easily obtained. These analytically derived coefficients indicate a strong dependence upon gap spacing and oscillating Reynolds number.

80-2513

Acoustic Flux Formulas for Range-Dependent Ocean Ducts

D.E. Weston

Applied Research Labs., The Univ. of Texas at Austin, Austin, TX 78712, J. Acoust. Soc. Amer., 68 (1), pp 269-281 (July 1980) 11 figs, 21 refs

Key Words: Ducts, Pipelines, Underwater pipelines, Underwater sound

A concise energy-flux formulation is used to investigate the range-averaged acoustic propagation in ocean ducts. Examples treated have isovelocity, linear, and parabolic sound speed profiles. The results are expressed as the product of a scale factor and, for the latter two examples, a depth factor. The scale factor has a similar form in each case, and remains simple and easy to use even when the profile is asymmetrical and the parameters vary with range.

80-2514

Time Dependent Difference Theory for Sound Propagation in Axisymmetric Ducts with Plug Flow

K.J. Baumeister

Lewis Research Center, NASA, Cleveland, OH, Rept. No. NASA-TM-81501; E-438, 12 pp (1980)
N80-23096

Key Words: Ducts, Sound propagation

The time dependent governing acoustic-difference equations and boundary conditions are developed and solved for sound propagation in an axisymmetric (cylindrical) hard wall duct with a plug mean flow and spinning acoustic modes. The analysis begins with a harmonic sound source radiating into a quiescent duct. This explicit iteration method then calculates stepwise in real time to obtain the transient as well as the steady state solutions of the acoustic field.

80-2515

Higher Order Mode Propagation in Nonuniform Circular Ducts

Y.C. Cho and K.U. Ingard

Lewis Research Center, NASA, Cleveland, OH, Rept. No. NASA-TM-81481; E-418, 11 pp (1980)
N80-23101

Key Words: Ducts, Sound propagation

Higher order mode propagation in a nonuniform circular duct without mean flow was investigated. An approximate wave equation is derived on the assumptions that the duct cross section varies slowly and that mode conversion is negligible. Exact closed form solutions are obtained for a particular class of converging-diverging circular duct which referred to as 'circular cosh duct.' Numerical results are presented in terms of the transmission loss for the various duct shapes and frequencies.

80-2516

Acoustic Propagation in Rigid Three-Dimensional Waveguides

M. El-Raheb

Jet Propulsion Lab., Applied Mechanics Tech., California Inst. of Tech., Pasadena, CA, J. Acoust. Soc. Amer., 67 (6), pp 1924-1930 (June 1980) 6 figs, 3 tables, 5 refs

Key Words: Ducts, Elastic waves, Wave propagation

The linear acoustic propagation in finite rigid three-dimensional waveguides is determined analytically using an eigenfunction expansion of the Helmholtz equation. The geometry considered consists of straight and circular bends of rectangular cross section with continuous interface. The phenomena of resonance shift and relocation are explained for a bend-straight duct combination.

80-2517

Dynamic Response of Cracked Hexagonal Subassembly Ducts

J.L. Glazik and H.J. Petroski

Argonne National Lab., Argonne, IL, Intl. Conf. on Structural Mechanics in Reactor Tech., Berlin, F.R. Germany, Aug 13, 1979, 17 pp (1979) CONF-790802-50

Key Words: Nuclear reactor components, Ducts, Finite element technique, Computer programs

The dynamic elastic response of flawed and unflawed fast reactor subassembly ducts is examined. A plane-strain finite element analysis was performed for ducts containing internal corner cracks, as well as external midflat cracks.

BUILDING COMPONENTS

(Also see No. 2584)

80-2518

Seismic Response of Partially Prestressed Concrete

K.J. Thompson and R. Park

Ministry of Works and Development, Invercargill, New Zealand, ASCE J. Struc. Div., 106 (ST8), pp 1755-1775 (Aug 1980) 13 figs, 3 tables, 11 refs

Key Words: Structural members, Reinforced concrete, Seismic response, Earthquake response

Idealizations for the cyclic moment-curvature behavior of prestressed, partially prestressed, and reinforced concrete members are presented. These idealizations are used in a comparative study of the earthquake response of partially prestressed concrete single degree-of-freedom systems, ranging from fully prestressed to reinforced, to different earthquake acceleration records. Maximum displacement ductility factors are tabulated for varying values of system strength, initial period of vibration and viscous damping ratio, and for different earthquake excitations.

ELECTRIC COMPONENTS

MOTORS

80-2519

The Dynamics of Closed Drive with Stepping Motor

V. Barzdaitis and S. Kaušinis

Kaunas Antanas Sniečkus Polytechnical Institute, Kaunas, Lithuania, Vibrotechnika, 4 (28), pp 17-21 (1977), 1 fig, 3 refs, Kaunas A. Sniečkus Politechnical Institute, Kaunas, Lithuanian SSR, 1979 (In Russian)

Key Words: Motors, Measuring instruments

A discrete drive with a stepping motor is discussed. Differential equations of motion for the drive dynamics are developed describing quasi-optimal processes during self-commutation. For determining rotor position of the stepping motor a photo-pickup is used.

DYNAMIC ENVIRONMENT

ACOUSTIC EXCITATION

(Also see Nos. 2381, 2389, 2393, 2396, 2397, 2417, 2442, 2443, 2444, 2445, 2446, 2447, 2448, 2449, 2513, 2516, 2547, 2548, 2573, 2575, 2576, 2583)

80-2520

An Exploratory Survey of Noise Levels Associated with a 100 kW Wind Turbine

J.R. Balombin

Lewis Research Center, NASA, Cleveland, OH, Rept. No. NASA TM 81486, E-424, 20 pp (1980)
N80-23102

Key Words: Wind turbines, Noise generation, Noise measurement

Noise measurements of a 125-foot diameter, 100 kW wind turbine are presented. The data include measurements as functions of distance from the turbine and directivity angle and cover a frequency range from 1 Hz to several kHz. Potential community impact is discussed in terms of A-weighted noise levels relative to background levels, and the intrasonic spectral content. The change in the sound power spectrum associated with a change in the rotor speed is described.

80-2521

Analytical Study of the Effects of Wind Tunnel Turbulence on Turbofan Rotor Noise

P.R. Gliebe and E.J. Kerschen

General Electric Co., Cincinnati, OH, Rept. No. NASA-CR-152359, 126 pp (Dec 1979)

N80-23099

Key Words: Rotors (machine elements), Turbofan engines, Noise generation, Turbulence

The influence of tunnel turbulence on turbofan rotor noise was carried out to evaluate the effectiveness of the NASA Ames 40 by 80 foot tunnel in simulating flight levels of fan noise. A previously developed theory for predicting rotor/turbulence interaction noise was refined and extended to include first-order effects of inlet turbulence anisotropy. This theory was then verified by carrying out extensive data/theory comparisons. The resulting model computer program was then employed to carry out a parametric study of the effects of fan size, blade number, and operating line on rotor/turbulence noise for outdoor test stand, NASA Ames wind tunnel, and flight inlet turbulence conditions.

80-2522

Acoustic Test and Analyses of Three Advanced Turboprop Models

B.M. Brooks and F.B. Metzger

Hamilton Standard, Windsor Locks, CT, Rept. No. NASA-CR-159667, 245 pp (Jan 1980)

N80-23311

Key Words: Turbine engines, Noise reduction, Design techniques

Results of acoustic tests of three 62.2 cm diameter models of the prop-fan are presented. Correlation between noise measurement and theoretical predictions as well as comparisons between measured and predicted acoustic pressure pulses generated by the prop-fan blades are discussed.

80-2523

Transition from a Nonreverberant to a Reverberant Dynamic System

G. Maidanik

Ship Acoustics Dept., David W. Taylor Naval Ship Research and Development Center, Bethesda, MD, Rept. No. DTNRSDC/SAD-260E-1902, 65 pp (Jan 1980)

AD-A082 816/0

Key Words: Acoustic insulation, Material damping

The transition from a nonreverberant to a reverberant situation in a dynamic system introduced by isolation is considered. The power radiated from an enclosure to its environment is isolated by covering the outside walls with a decoupling coating. It is shown that to render the isolation effective, damping may be used. This is true even if, prior to isolation, the application of damping did not reduce the power radiated. A discussion of the principle of supplementarity is presented.

80-2524

Road Surfaces and Traffic Noise

R.E. Franklin, D.G. Harland, and P.M. Nelson

Transport and Road Research Lab., Crowthorne, UK, Rept. No. TRRL-RL-896, 41 pp (1979)

PB80-158918

Key Words: Traffic noise, Road roughness, Surface roughness, Friction

Noise of vehicles on a wide range of road surfaces was studied to investigate the relationship between noise and the frictional properties of the road surface.

80-2525

NAUSEA and the Principle of Supplementarity of Damping and Isolation in Noise Control

G. Maidanik

Ship Acoustics Dept., David W. Taylor Naval Ship Research and Development Center, Bethesda, MD, Rept. No. DTNSRDC/SAD-263E-1902, 34 pp (Feb 1980)
AD-A082 746/9

Key Words: Statistical energy methods, Noise reduction, Damping, Isolation

New approaches and uses of the statistical energy analysis (NAUSEA) are presented. The principle of supplementarity of damping and isolation is discussed. The principle states that in situations in which the application of either damping or isolation does not perform satisfactorily in controlling a noise problem, the supplemental application of damping and isolation may perform effectively.

SHOCK EXCITATION

(Also see Nos. 2388, 2415, 2416, 2427, 2437, 2456, 2457, 2462, 2464, 2465, 2483, 2489, 2490, 2496, 2518, 2572, 2577)

80-2526

Resonance Capacity Method for Earthquake Response Analysis of Hysteretic Structures

M. Yamada and H. Kawamura

Faculty of Engrg., Kobe Univ., Kobe, Japan, Intl. J. Earthquake Engr. Struc. Dynam., 8 (4), pp 299-313 (Aug 1980) 11 figs, 14 refs

Key Words: Resonance capacity method, Seismic response, Hysteretic damping

The resonance capacity method is proposed for the earthquake response analysis of hysteretic structures. Resonance capacity is a physical quantity of structures which is related to the hysteretic energy absorbed by structures in one cycle and is equated to the acceleration, velocity and displacement amplitudes of earthquake ground motions at resonance. By means of this method the earthquake response analysis of hysteretic systems can be performed easily, and the hysteretic energy and fatigue characteristics of structures may be taken into account directly, up to the point of fracture.

80-2527

Estimating Inelastic Response Spectra from Elastic Spectra

W.D. Iwan

California Inst. of Tech., Pasadena, CA, Intl. J. Earthquake Engr. Struc. Dynam., 8 (4), pp 375-388 (Aug 1980) 8 figs, 3 tables, 12 refs

Key Words: Inelastic response spectra, Response spectra, Buildings, Seismic response, Hysteretic damping

Inelastic displacement response spectra are determined for a broad class of single-degree-of-freedom hysteretic structures. Based on these spectra, effective linear period and damping parameters are defined as a function of ductility. A simple empirical formula is derived which may be used to estimate the mid-period range inelastic response spectrum of a general hysteretic structure given the linear response spectrum of the excitation. The estimates obtained from this formula are compared with those obtained by the Newmark-Hall method, the substitute-structure method and the ATC-3 tentative procedure.

80-2528

Probability of Spilling a Liquid in a Tank under Seismic Excitation (Überschwappwahrscheinlichkeit für einen Flüssigkeitsbehälter unter Erdbebeneinwirkung)

H. Parkus

Institut für Mechanik, Technische Universität Wien, Karlsplatz 13, A-1040 Wien, Austria, Ing. Arch., 49 (3/4), pp 179-185 (1980) 2 figs, 2 tables, 4 refs
(In German)

Key Words: Containers (tanks), Fluid-filled containers, Seismic excitation, Sloshing

The probability of spilling of a liquid sloshing in a tank under seismic excitation is treated as a first-passage problem by an approximation method. A numerical example is presented.

80-2529

A Model with Non-Reflecting Boundaries for Use in Explicit Soil-Structure Interaction Analyses

R.R. Kunar and L. Rodriguez-Ovejero

Principia Mechanica Ltd., London, UK, Intl. J. Earthquake Engr. Struc. Dynam., 8 (4), pp 361-374 (Aug 1980) 7 figs, 1 table, 25 refs

Key Words: Interaction: soil-structure, Seismic excitation, Mathematical models

A model for use in explicit soil-structure interaction analyses for seismic excitation is presented emphasizing the implementation of non-reflecting boundaries at the base and vertical faces of a two-dimensional finite element or finite difference soil mesh. An example is presented to demonstrate the accuracy of the proposed model.

80-2530
Dynamic Versus Static Behaviour of a Masonry Structure Under Lateral Loads
D. Benedetti and A. Castellani
Instituto de Scienza e Tecnica delle Costruzioni del Politecnico di Milano, P.za Leonardo da Vinci 32, 20133 Milano, Italy, Engrg. Struc. 2 (3), pp 163-170 (July 1980) 18 figs, 1 table, 15 refs

Key Words: Masonry, Seismic excitation

A set of physical models of masonry structures was tested. The significance of a static approach for seismic studies is discussed and a nonlinear dynamic numerical model is worked out.

80-2531
Rocking Response of Rigid Blocks to Earthquakes
C.S. Yim, A.K. Chopra, and J. Penzien
Earthquake Engrg. Research Center, California Univ., Berkeley, CA, Rept. No. UCB/EERC-80/02, NSF/RA-800019, 75 pp (Jan 1980)
PB80-166002

Key Words: Seismic excitation, Ground motion, Computer programs, Numerical analysis

The rocking response of rigid blocks subjected to earthquake ground motion is investigated. A numerical procedure and computer program were developed to solve the nonlinear equations of motion governing the rocking motion of rigid blocks on rigid base subjected to horizontal and vertical ground motions.

80-2532
Enhanced Coupling and Decoupling of Underground Nuclear Explosions
R.W. Terhune, C.M. Snell, and H.C. Rodean
Lawrence Livermore Lab., California Univ., Livermore, CA, Rept. No. UCRL-52806, 31 pp (Sept 1979)

Key Words: Nuclear explosions, Underground explosions

The seismic coupling efficiency of nuclear explosions was studied in granite by means of computer calculations as a function of scaled explosion source radius.

VIBRATION EXCITATION

(Also see Nos. 2452, 2536)

80-2533
Stationary Random Vibration of a Nonlinear System with Collision
T. Fujita and S. Hattori
Inst. of Industrial Science, Univ. of Tokyo, Tokyo, Japan, Bull. JSME, 23 (179), pp 741-748 (May 1980) 10 figs, 5 refs

Key Words: Nonlinear systems, Random vibration

The vibration of a nonlinear system with collision subjected to a stationary random excitation is investigated. The system consists of an oscillator and reflectors at both sides. Various stochastic properties of the response are determined analytically and experiments are carried out to examine the analytical results.

MECHANICAL PROPERTIES

DAMPING

(Also see Nos. 2475, 2478, 2512, 2523, 2537, 2581)

80-2534
Development of Procedures for Calculating Stiffness and Damping of Elastomers in Engineering Applications, Part 6
A. Rieger, G. Burgess, and E. Zorzi
Mechanical Technology, Inc., Latham, NY, Rept. No. NASA-CR-159838, MTI-80TR29, 157 pp (Apr 1980)
N80-22733

Key Words: Elastomeric dampers, Dampers, Stiffness coefficients, Damping coefficients

An elastomer damper was designed, tested, and compared with the performance of a hydraulic damper for a power transmission shaft. The six button Viton-70 damper was designed so that the elastomer damper or the hydraulic damper could be activated without upsetting the imbalance condition of the assembly. This permitted a direct comparison of damper effectiveness.

80-2535

Instabilities of a Damped Oscillator with Almost Periodic Parametric Excitation (Instabilitäten eines gedämpften Schwingers mit fast-periodischer Parametererregung)

F. Weidenhammer
Bismarckstr. 11, D-7500 Karlsruhe 1, Bundersrepublik Deutschland, Ing. Arch., 49 (3/4), pp 187-193 (1980) 1 fig, 4 refs
(In German)

Key Words: Damped structures, Oscillators, Periodic excitation

The most important regions of instability for a damped oscillator with almost-periodic parametrical excitation are given.

80-2536

Damping of Anisotropic Composites Studied from the Properties of the Rolled Components (Verfahren zur Bestimmung des Daempfungsverhaltens anisotroper Verbundbauteile aus den Eigenschafter der Laminatkomponenten)

K. Kehl
Inst. fuer Luft- und Raumfahrt, Technische Univ., Berlin, Germany, Rept. No. ISBN-3-79830-660-5, 137 pp (1978)
N80-20324
(In German)

Key Words: Composites, Fiber composites, Damping, Natural frequencies

The rigidity and damping properties of the glass and carbon fiber reinforced plastics were studied as well as applications for determining the frequencies and damping in the rolled product. Coefficients of rigidity for surface planes of disk and plates in the case of linear tension and torsion were calculated. Dynamic behavior, including unidirectional and multidirectional loads for composite materials was analyzed. The influence of temperature, frequency of vibration, and fiber orientation on the behavior of the reinforced plastics, and their applications were determined.

FATIGUE

(Also see Nos. 2386, 2418, 2428, 2454, 2546, 2554)

80-2537

Material Damping as a Means of Quantifying Fatigue Damage in Composites

C.A. Bourne
School of Engrg., Air Force Inst. of Tech., Wright-Patterson AFB, OH, Rept. No. AFIT/GA/AA/78D-2, 67 pp (Dec 1978)
AS-A081 890/6

Key Words: Composites, Fatigue tests, Damping values

The feasibility of quantifying damage in composites in terms of their damping characteristics was investigated experimentally. Bending fatigue tests were performed by exciting a cantilever beam so as to maintain a constant amplitude at resonance. Results indicate that the amount of damage occurring in this composite can be explained in terms of an increase in its material damping.

80-2538

The Prediction of Fatigue Life Under Random Loading. A Diffusion Model

K.P. Oh
General Motors Research Labs., Warren, MI 48090, Intl. J. Fatigue, 2 (3), pp 99-104 (July 1980) 4 figs, 8 refs

Key Words: Fatigue life, Crack propagation, Random loads

A diffusion model is used to analyze the growth of a fatigue crack under random loading. The randomness in loading is embedded in the coefficients of the diffusion equation, whose solution leads to the determination of fatigue life. To demonstrate the potential of this method, some calculations are made using typical values for material properties. The results show that fatigue life under random loading is governed, in addition to material properties, by such statistics as the mean and the mean square value of the loading.

EXPERIMENTATION

MEASUREMENT AND ANALYSIS

(Also see Nos. 2472, 2573, 2574, 2585)

80-2539

Noise and Vibration Analysis at Cranfield

M.A. Tomlinson

Signal Processing and Applications Group, Cranfield Inst. of Tech., Noise Vib. Control Worldwide, 11 (5), pp 167-173 (May 1980) 6 figs, 4 refs

Key Words: Vibration measurement, Vibration analyzers, Noise measurement, Noise analyzers

A few of the analytical techniques and functions available to the noise and vibration engineer are outlined. They include amplitude analysis, spectral analysis, coherence functions, frequency response function, and modal analysis.

80-2540

Wind Energy System Time-Domain (West) Analyzers Using Hybrid Simulation Techniques

J.A. Hoffman

Paragon Pacific, Inc., El Segundo, CA, Rept. No. NASA CR-159737, PPI-1030-6, 30 pp (Oct 1979) N80-20909

Key Words: Electric power plants, Real time spectrum analyzers, Digital simulation

Two stand-alone analyzers constructed for real time simulation of the complex dynamic characteristics of horizontal-axis wind energy systems are described. Mathematical models for an aeroelastic rotor, including nonlinear aerodynamic and elastic loads, are implemented with high speed digital and analog circuitry. Models for elastic supports, a power train, a control system, and a rotor gimbal system are also included.

80-2541

Characterization of Digital Filters Used in Sandia Laboratories Test Data Analysis Division

P.L. Walter and R. Rodeman

Sandia Labs., Alburquerque, NM, Rept. No. SAND-79-1230, 56 pp (Dec 1979)

Key Words: Filters, Digital filters, Measuring instruments

The design of digital filters for a test data analysis facility, with minimum errors introduced by the filters, is discussed.

80-2542

Iterative Calculation of Impulse Responses from Ultrasonic Signals

R.C. McClung and M.W. Moyer

Instrumentation and Characterization Dept., Oak Ridge Y-12 Plant, TN, Rept. No. Y/DW-23, 20 pp (Sept 1979)
N80-23103

Key Words: Impact response (mechanical), Ultrasonic techniques, Iteration

Iterative techniques were developed to calculate the impulse response of a medium under ultrasonic interrogation. This permits the identification and separation of reflected signals with pulse widths greater than the distance between two adjacent reflecting surfaces. The results may provide significant new information with respect to the spatial distribution and geometry of material discontinuities.

80-2543

Measurement, Calculation and Analysis of Vibrations. Part I. Fundamentals of Theoretical and Experimental Modal Analysis (Messung, Berechnung und Analyse von Schwingungen Teil 1: Grundlagen der rechnerischen und experimentellen Modalanalyse)

R.D. Müller

VDI Z., 122 (8), pp 325-330 (Apr 1980) 10 figs, 3 refs

(In German)

Key Words: Vibration measurement, Modal analysis

The fundamentals of theoretical and experimental modal analysis for systems with any number of degrees of freedom are described.

80-2544

Measurement, Calculation and Analysis of Vibrations. Part II. Fundamentals of Measurement and Digital Signal Processing (Messung, Berechnung und Analyse von Schwingungen Teil 2: Messtechnische Grundlagen und digitale Signalverarbeitung)

R D Müller

VDI Z , 122 (9), pp 365-368 (May 1980) 11 figs (In German)

Key Words: Vibration measurement, Digital techniques

The experimental modal analysis technique is described using the digital Fourier analyzers for the measurement of the frequency curve of the mechanical systen .

DYNAMIC TESTS

80-2545

On the Application of Linear Pendular Motion Synchronous Electric Motors for the Dynamic Testing Stands

S Kudarauskas, V Paškevičius, and A.-Č. Šukelis

Kaunas Antanas Sniečkus Polytechnical Institute, Kaunas, Lithuania, Vibrotechnika, 4 (28), pp 55-59 (1977), 2 figs, 10 refs, Kaunas A Sniečkus Politechnical Institute, Kaunas, Lithuanian SSR, 1979 (In Russian)

Key Words: Test stands, Electric motors

The calculation showing the principal fitness of linear pendular motion synchronous electric motors for the dynamic testing stands is suggested.

80-2546

Generation of Random Signals with Required Probability Density and Power Spectral Density Functions for Fatigue Life Testing (Erzeugung von Zufallssignalen mit vorgegebener Wahrschein-lichkeitsdichte-Verteilungsfunktion und vorgegebener Kraftdichte-Spektralfunktion für praktische Anwendungen)

E Macha and I. Kozicki

Institut f Werkstofftechnik und Angewandte Mechanik, Technische Universität Wroclaw, Series 9, No. 23 (1980) Fortschrett Berichte der VDI-Zeitschriften, 52 pp, 34 figs. Availability VDI Verlag Summarized in VDI Z , 122 (8), pp 331-332 (1980) (In German)

Key Words: Fatigue tests, Testing techniques

A procedure and apparatus for fatigue life testing of materials and mechanical systems is described. The advantages and disadvantages of three different random signal sources for regulation and control of the procedure are analyzed. The magnetic tape recorder, the electronic calculator for the control of random signals, as well as the random signal generators are investigated.

80-2547

Testing of Containers Made of Glass-Fiber Reinforced Plastic with the Aid of Acoustic Emission Analysis

K. Wolitz, W. Brockmann, and T Fischer

NASA, Washington, D.C , Rept. No. NASA-TM-75737, 11 pp (Nov 1979) (Engl. transl. of Neure entwicklungen und Besondere Veriahren der ZFP (Berlin), v. 3, 1978, p 789-795. Proceedings of the First European Conf. on Non-Destructive Testing, Mainz, West Germany, 24-26 Apr 1978)

N80-22411

Key Words: Plastics, Fiber composites, Acoustic emission, Nondestructive tests

Acoustic emission analysis as a quasi-nondestructive test method makes it possible to differentiate clearly, in judging the total behavior of fiber-reinforced plastic composites, between critical failure modes (in the case of unidirectional composites fiber fractures) and non-critical failure modes (delamination processes or matrix fractures).

80-2548

Acoustic Emission from Composite Materials

I.C. Visconti and R. Teti

NASA, Washington, D.C., Rept. No. NASA-TM-75740, 31 pp (Mar 1979) (Engl. transl. of paper "Emissioni Acustiche dai Materiali Compositi", 1978, 34 p, Presented at the 3d Asmeccan. and Assoc. Meridionale di Meccan., Milan, 11-13 May 1978)

N80-22413

Key Words: Composite materials, Acoustic emission, Nondestructive tests, Fracture properties

The two basic areas where the acoustic emission technique can be applied are materials research and the evaluation of structural reliability. This experimental method leads to a better understanding of fracture mechanisms and is not an NDT technique particularly well suited for the study of propagating cracks. Experiments are described in which acoustic emissions were unambiguously correlated with microstructural fracture mechanisms. The advantages and limitations of the AE technique are noted.

80-2549

Comparative Measurements in Four European Wind Tunnels of the Unsteady Pressures on an Oscillating Model (The NORA Experiments)

N. Lambourne, R. Destuynder, K. Kienappel, and R. Ross

Advisory Group for Aerospace Research and Development, Neuilly-sur-Seine, France, Rept. No. AGARD-R-673, 52 pp (Feb 1980) Presented at the Structures and Materials Panel Meeting (49th), Porz-Wahn, Germany, Oct 1979

AD A082 958/0

Key Words: Wind tunnels, Test facilities

To obtain experience of the influence of tunnel wall interference on flutter and other unsteady tests in transonic wind tunnels, a program of oscillatory pressure measurements was repeated in four tunnels. These tunnels differ in the size of working section and in the form of wall ventilation. The results of the comparisons, while unable on their own to lead to rules regarding acceptable model-to-tunnel size ratios, tend to confirm current procedure.

80-2550

A Subseismic Test Platform as a Motion Exciter

B.J. Simmons

Frank J. Seiler Research Lab., USAF FJSRL/NHL, USAF Academy, CO 80840, ISA Trans., 19 (2), pp 95-104 (1980) 16 figs, 1 table, 4 refs

Key Words: Test facilities, Vibration tests, Instrumentation response

The technique and use of a large pneumatically supported test platform as a motion excite is described. Maximum motion capability, and the effects of system resonances of the 450,000 lb, servo-controlled, isolation test platform is shown for use in tests of motion sensors. The possibility of large test specimens, such as a complete navigation system, is considered. Information is provided on the construction of the test platform and the electropneumatic control system.

80-2551

Comparative Measurements in Four European Wind Tunnels of the Unsteady Pressures on an Oscillating Model

N. Lambourne, R. Destuynder, K. Kienappel, and R. Roos

Royal Aircraft Establishment, Bedford, England, Rept. No. AGARD-R-673, 50 pp (Feb 1980) Presented at the 49th Struct. and Mater. Panel Meeting, Porz Wahn, West Germany, Oct 1979

N80-23338

Key Words: Wind tunnel tests, Flutter, Aircraft

The effects of the walls of a wind tunnel on the behavior of dynamic models used for flutter certification of aircraft were investigated. Tests were completed in four European wind tunnels and the results were analyzed. The results and conclusions are summarized.

80-2552

Single-Mode Panel Flutter of a Wind Tunnel Flex-Wall

L.L. Erickson, D.K. Kassner, L.R. Guist, and M.K. Chargin

NASA Ames Research Center, Moffett Field, CA, J. Aircraft, 17 (7), pp 521-527 (July 1980) 14 figs, 11 refs

Key Words: Wind tunnels, Test facilities, Flutter

The cause of severe dynamic instability of the two steel-plate flex-walls that form the variable-geometry nozzle of the transonic wind tunnel at Ames Research Center is investigated. The steps taken to prevent a recurrence and the requalification of the facility are described.

80-2553

Seismic Qualification of Electrical Equipment Using a Uniaxial Test

C.W. da Silva

Dept. of Mech. Engrg., Carnegie-Mellon Univ., Pittsburgh, PA, Intl. J. Earthquake Engr. Struc. Dynam., 8 (4), pp 337-348 (Aug 1980) 9 figs, 7 refs

Key Words: Testing techniques, Dynamic tests, Seismic response, Electrical machines

The analytical development of a uniaxial test for the seismic qualification of electrical equipment is presented. This method comprises a single test using a uniaxial excitation having certain minimum intensity applied at the base of the test package in a predetermined optimal direction.

80-2554

Simulation of Service Loads with Regard to Free Inertia Forces Demonstrated by a Multicomponent Car Body Test Stand (Mehrkomponenten-Karosserieprüfstand zur Simulation von Betriebsbeanspruchungen unter Berücksichtigung freier Massenkräfte)

B. Fiedler, K.-H. Knoche, and K.-P. Weibel

Riesstrasse 67, 8000 München 50, Germany, Automobiltech. Z., 82 (6), pp 329-334 (June 1980) 5 figs, 18 refs

(In German)

Key Words: *Test stands, Automobiles, Fatigue tests*

A servohydraulic test stand is presented, simulating all forces required in the evaluation of the car body's fatigue resistance.

SCALING AND MODELING

80-2555

Before-the-Fact Modeling Solves Turbomachinery-Foundation Problems

R.L. Bannister and I.K. Aneja

Westinghouse Electric Corp., Power, 124 (8), pp 59-61 (Aug 1980) 6 figs, 2 tables

Key Words: Scaling, Foundations, Machine foundations, Turbomachinery

The use of scale plastic models to verify finite element analysis of turbomachinery foundations is illustrated. Basic procedures for designing, building, and testing laboratory models, as well as comparison of lab test data with field measurements and calculations made on analytical models are examined.

DIAGNOSTICS

80-2556

Monitoring Acoustic Emission to Detect Mechanical Defects

P.C. Sundt

Metrix Instrument Co., Instrumentation Tech., 26 (12), pp 43-45 (Dec 1979)

Key Words: Monitoring techniques, Acoustic emission

Acoustic emissions can be used to indicate mechanical faults before problems have developed to the point where increased vibration or temperature levels can be detected. Signal conditioning is needed to compensate for normal acoustic noise and discriminate contributions to the characteristic frequency spectrum caused by defects.

BALANCING

80-2557

Force Balancing Machines and Optimization of Dynamic Reactions for Planar Mechanisms

S.J. Tricamo

Ph.D. Thesis, City Univ. of New York, 321 pp (1980) UM 8014992

Key Words: Balancing, Plane mechanisms, Computer-aided techniques

Theoretical and experimental investigations in the field of force balancing of planar mechanisms, which introduce novel computer-aided design methods, are presented. A new two-counterweight method of partial force balancing of planar mechanisms is presented which by means of the equipollent circle constraint equation enables to prescribe the maximum shaking force of a constant input speed four-bar linkage by way of a wide range of practical counterweight configurations. A novel nonlinear optimization formulation minimizes the maximum values of the various dynamic reactions of a four-bar linkage while maintaining the ability to prescribe the maximum shaking force. This computer-aided design technique, which employs counterweights on all links, was applied to both partial as well as full force balancing and produced gratifying results.

80-2558

Balancing of a Flexible Rotor (The Seventh Report. A Case of a Rotor Supported by Members Having any Mechanical Impedance)

K. Shimada and S. Miwa

Central Engrg. Labs., Nissan Motor Co., Ltd., Yokosuka, Japan, Bull. JSME, 23 (180), pp 938-944 (June 1980) 10 figs, 3 tables, 3 refs

Key Words: Rotors (machine elements), Flexible rotors, Balancing, Forced mode method

Unbalanced vibration and balancing of a flexible rotor supported at both ends by members having any mechanical impedances is studied theoretically by aid of the forced mode method, and the results are verified by experiments.

MONITORING

80-2559

Vibration Monitoring for Rotating Machinery

I.R. Hitchen

Manager Instruments, U.K.F. Fertilizers Ltd., UK, Meas. Control, 13 (3), pp 97-102 (Mar 1980) 9 figs

Key Words: Rotors (machine elements), Vibration monitoring, Vibration probes, Accelerometers, Measuring instrumentation

A guide for instrument personnel involved in specifying and/or maintaining vibration monitoring equipment is presented. The topic is based on two measurement techniques - non-contact proximity probes and contact accelerometers.

ANALYSIS AND DESIGN

ANALYTICAL METHODS

(Also see Nos. 2437, 2490, 2494, 2526)

80-2560

A One-Step Method for Direct Integration of Structural Dynamic Equations

L. Brusa and L. Nigro

CISE, Segrate (MI), Italy, Intl. J. Numer. Methods Engr., 15 (5), pp 685-699 (May 1980) 8 figs, 2 tables, 10 refs

Key Words: Dynamic structural analysis, Equations of motion, Integration

The choice of an efficient one-step direct integration procedure for linear structural dynamic equations of motion is discussed. Numerical comparisons with some well-known integration schemes showed the efficiency of the proposed method.

80-2561

Integration of Stochastic Systems with Piecewise Linear Characteristics (Zur Integration stochastischer Systeme mit stückweise linearen Kennlinien)

W. Wedig

Institut für Technische Mechanik, Universität Karlsruhe, Kaiserstrasse 12, D-7500 Karlsruhe 1, Fed. Rep. Germany, Ing. Arch., 49 (3/4), pp 201-215 (1980) 6 figs, 8 refs

(In German)

Key Words: Stochastic processes, Vibration response spectra, Distribution functions, Mean square response, Spectral densities

Stochastic dynamical systems with piecewise linear characteristics or hysteretic properties are exactly integrable by means of the theory of the Markow diffusion processes. This new application enables simple and closed calculations of multidimensional distribution functions and therewith mean values and spectral densities.

80-2562

Band-Schemes vs. Frontal-Routines in Nonlinear Structural Analysis

A.B. Agrawal, A.A. Mufti, and L.G. Jaeger

M.N.R. Engrg. College, Allahabad, U.P., India, Intl. J. Numer. Methods Engr., 15 (5), pp 753-766 (May 1980) 4 figs, 2 tables, 19 refs

Key Words: Nonlinear analysis, Seismic excitation, Dynamic structural analysis

The relative merits of the band-schemes over the frontal-routines in the solution of the linearized algebraic equations resulting from a nonlinear structural analysis are evaluated. It is shown by examples that the use of the former in the nonlinear analysis programs results in considerable savings in computer time, especially when the structure under consideration is subject to dynamic loads due to earthquakes or simulated ground motions.

80-2563

Theory of Index for Dynamical Systems of Order Higher Than Two

C.S. Hsu

Dept. of Mech. Engrg., Univ. of California, Berkeley, CA 94720, J. Appl. Mech., Trans. ASME, 47 (2), pp 421-427 (June 1980) 1 fig, 25 refs

Key Words: Nonlinear vibrations, Differential equations

The degree of a map concept is used to present a theory of index for higher-order systems in a form which might make it more accessible to engineers for applications. The theory utilizes the notion of the index of a hypersurface with respect to a given vector field which is then applied to dynamical systems governed by ordinary differential equations and also to dynamical systems governed by point mappings. Illustrative procedures of evaluation for two kinds of hypersurfaces are discussed in detail and an example of application is given.

80-2564

Eigenvalue and Near Eigenvalue Problems Solved by Brandt's Multigrid Method

K.G. Guderley and D.S. Clemm

Research Inst., Dayton Univ., OH, Rept. No. AFFDL-TR 79-3147, 28 pp (Sept 1979)

AD-A081 318/8

Key Words: Eigenvalue problems

To illustrate Brandt's multigrid method this report considers the Helmholtz equation in cases where the frequency is close to an eigenfrequency. In a second part the eigenvalue problem is discussed.

80-2565

Quadratic Reduction for the Eigenproblem

C.P. Johnson, R.R. Craig, Jr., A. Yargicoglu, and R. Rajatabhothi

Univ. of Texas at Austin, TX, Intl. J. Numer. Methods Engr., 15 (6), pp 911-923 (June 1980) 2 figs, 5 tables, 8 refs

Key Words: Eigenvalue problems, Multi degree of freedom systems

A quadratic method is presented for solving the eigenvalue problem of a structural system having a large number of degrees-of-freedom. Numerical examples of vibrations of a bar, a beam and a plate demonstrate that the solutions obtained from the quadratic reduction procedure are very accurate.

MODELING TECHNIQUES

(See Nos. 2433, 2441, 2529, 2580)

NONLINEAR ANALYSIS

(See Nos. 2497, 2562)

STATISTICAL METHODS

(See Nos. 2525, 2561)

PARAMETER IDENTIFICATION

80-2566

Nonlinear System Identification Study. Part II. Computational Complexity Study

E.J. Ewen

Aerospace Electronic Systems Dept., General Electric Co., Utica, NY, Rept. No. RADC-TR-79-199-PT-2, 102 pp (Feb 1980)

AD-A082 714/7

Key Words: System identification techniques, Nonlinear systems

The computational complexity of a nonlinear system identification technique is evaluated in this report. The computational aspects of the technique are evaluated in terms of the complexity of the calculations and the complexity of the system being implemented. Techniques for reducing the order of the second order response are investigated. The class of systems to which the technique can be applied is evaluated.

80-2567

Structural Parameter Identification of Member Characteristics in a Finite Element Model

J.K. Sprandel

Ph.D. Thesis, Purdue Univ., 487 pp (1979)

UM 8015522

Key Words: Parameter identification technique, Finite element technique

A methodology to identify member characteristics in a general, user-definable finite element model is developed for which joint characteristics may be explicitly modeled. Bayes parameter estimates are obtained using time domain response data from either forced vibration, imposed base motion or snapback testing. The structural excitation must be measured. Interval estimates are obtained. Four examples are analyzed using the methodology.

COMPUTER PROGRAMS

(Also see Nos. 2395, 2411, 2426, 2457, 2492, 2504, 2517, 2531)

80-2568

Preliminary User's Manuals for DYNA3D and DYNAP

J.O. Hallquist

Lawrence Livermore Lab., California Univ., Livermore, CA, Rept. No. UCID-17268 (Rev. 1), 77 pp (Oct 1979) 23 refs

Key Words: Computer programs, Finite element techniques, DYNA (computer program)

This report provides a user's manual for DYNA3D, an explicit three-dimensional finite-element code for analyzing the large deformation dynamic response of inelastic solids. A user's manual for DYNAP is also provided.

80-2569

Analysis of Trunk Flutter in an Air Cushion Landing System. User's Manual

R.B. Fish

Foster-Miller Associates, Inc., Waltham, MA, Rept. No. AFFDL-TR-79-3121, 179 pp (Nov 1979)

AD-A082 087/8

Key Words: Computer programs, Air cushion landing systems, Flutter

This user's manual describes the computer programs for trunk flutter analysis. It includes descriptions, user instructions, and a sample run for the trunk flutter dynamic simulation program, and an eigenvalue calculation program for a linearized static trunk model.

80-2570

Initial Development for a Flutter Analysis of Damaged T-38 Horizontal Stabilators Using NASTRAN

J.O. Lassiter

School of Engrg., Air Force Inst. of Tech., Wright-Patterson AFB, OH, Rept. No. AFIT/GAE/AA/80M-2, 125 pp (Mar 1980)

AD-A082 168/6

Key Words: Computer programs, NASTRAN (computer program), Flutter

The development and response of a finite element model of the T-38 horizontal stabilator using NASTRAN is demonstrated. The finite element model is to be used in a flutter analysis of damaged or repaired stabilators. The objective of the flutter analysis is to determine absolute values and degradations of the flutter speed due to different types of damages and repairs. Development of a finite element model with two dimensional quadrilateral and bar elements is described. A brief description of a method of simulating repairs and damages of a horizontal stabilator is included.

80-2571

Development of Modal Techniques Using Experimental Modal Data. End of Phase 2 Report

A. Bertram

Inst. for Aeroelasticity, Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Goettingen, Germany, Rept. No. DKR-IB-253-79/C/09, 20 pp (Feb 1979)

N80-21796

Key Words: Computer programs, Modal analysis

Work performed during the development of three software packages for use in modal analysis is outlined, and the programs described. Program DIMOC is used for calculating the effect of small structural modifications, MODAS for modal coupling analyses, and RESPON for dynamic response analyses of a satellite coupled to a launcher.

80-2572

User's Manual to the Action Computer Code

M.P. Kamat

Virginia Polytechnic Inst. and State Univ., Blacksburg, VA, Rept. No. NASA-CR-144973, 78 pp (Apr 1980)

N80-23680

Key Words: *Computer programs, Transient response, Nonlinear systems*

The form and interpretation of input and output data are defined. The Analysis of Crash Transients in Inelastic and Geometrically Nonlinear structures program (ACTION) performs nonlinear transient response analysis of structures subjected to time varying loads, allowing for nonlinear, time independent material properties and large geometry changes.

80-2573

True-Integrating Environmental Noise Monitor and Sound-Exposure Level Meter. Volume III. Microprocessor Program and Data Interface Description

A.J. Averbuch and L.M. Little

Construction Engineering Research Lab., Army, Champaign, IL, Rept. No. CERL-TR-N-41-VOL-3, 178 pp (Mar 1980)

AD-A083 320/2

Key Words: *Computer programs, Sound level meters*

The internal microprocessor program used to operate the U.S. Army Construction Engineering Research Laboratory (CERL) True-Integrating Environmental Noise Monitor and Sound-Exposure Level Meter is described. Several data interface accessories and complete program listings are included.

80-2574

Technical Manual: Primary Data Reduction Programs for the Eclipse S-200/230 Shock and Vibration Measurement Systems

H.W. Swan

Sandia Labs., Livermore, CA, Rept. No. SAND-79-8054, 41 pp (Nov 1979)

N80-23698

Key Words: *Computer programs, Measuring instruments, Test facilities*

The internal workings and computational algorithms for the quick-look plotting programs and primary data reduction programs for the Eclipse computer-based shock and vibration test centers are described.

80-2575

User's Manual: FHWA Level 2 Highway Traffic Noise Prediction Model, STAMINA 1.0

F.F. Rudder, Jr., D.F. Lam, and P. Chueng

Energy and Environmental Sciences, Science Applications, Inc., McLean, VA, Rept. No. SAI-5-451-00-066-06, FHWA/RD-78-138, 230 pp (May 1979)

PB80-162340

Key Words: *Computer programs, Traffic noise, Noise prediction*

Modifications to the TSC MOD-04 highway traffic noise prediction program to extend the scope of problem formulation are described. Problem formulation, input data requirements, output error messages, examples of usage, and computer program documentation are also described. This program is given the acronym STAMINA 1.0 for Standard Method in Noise Analysis (Version) 1.0.

80-2576

User's Manual: FHWA Highway Traffic Noise Prediction Model, SNAP 1.0

F.F. Rudder, Jr. and D.F. Lam

Energy and Environment Sciences, Science Applications, Inc., McLean, VA, Rept. No. SAI-5-451-00-066-05, FHWA/RD-78-139, 124 pp (Jan 1979)

PB80-162357

Key Words: *Computer programs, Traffic noise, Noise prediction*

The FHWA Level 1 Highway Traffic Noise Prediction Model is described. This model is given the acronym 'SNAP 1.0' for Simplified Noise Analysis Program 1.0. The model is designed to allow the quick calculation of highway traffic noise emissions for simple roadway-receiver configurations. All computed output is presented in tabular format for direct inclusion in reports. The report describes the formulation of input data, input data format, and the predicted traffic noise estimates. Barrier attenuation is considered for traffic lanes parallel to the barrier. Both thin screen and berm type barriers are considered by the model. Vehicle noise emissions are estimated by vehicle type and vehicle speed.

80-2577
Study of Structural Attachments of a Pool Type LMFBR Vessel Through Seismic Analysis of a Simplified Three Dimensional Finite Element Model
H Ahmed and D Ma
Argonne National Lab., Argonne, IL, Intl Conf. on Structural Mechanics in Reactor Tech., Berlin, F.R. Germany, Aug 13, 1979, 15 pp (1979)
CONF-790802-63

Key Words: Computer programs, Seismic analysis, Joints (junctions), Nuclear reactor safety, Nuclear reactor components, Viscous damping

A simplified three-dimensional finite element model of a pool type LMFBR in conjunction with the computer program ANSYS is developed and scoping results of seismic analysis are produced. Various structural attachments of a pool type LMFBR are studied. This study provides useful results on equivalent viscous damping approach and some improvements to the treatment of equivalent viscous damping are recommended.

80-2578
Three-Dimensional Finite-Element Computations of the Transient Response of Components Typical of a Reactor Structure
J E. Ash, R.F. Kulak, and A.H. Marchertas
Argonne National Lab., Argonne, IL, Intl Conf. on Structural Mechanics in Reactor Tech., Berlin, F.R. Germany, Aug 13, 1979, 17 pp (1979)
CONF-790802-52

Key Words: Computer programs, Finite element technique, Shells, Nuclear reactor components

A structural analysis, finite-element code is developed to compute the elastoplastic response of thin-walled structural members undergoing rapid, large displacements in three-dimensional space. Code predictions are compared with analytical calculations and published experimental data, and the correlations validate the capability of the code to provide reliable predictions for three-dimensional shell-type structure.

80-2579
Piezoelectric Finite Elements for NASTRAN
R R. Lipman and M.M. Hurwitz
David W Taylor Naval Ship Research and Development Center, Bethesda, MD, Rept. No. DTNSRDC-80/045, 32 pp (Apr 1980)
AD-A082 965/5

Key Words: NASTRAN (computer program), Piezoelectricity, Cylinders, Disks, Natural frequencies

The NASTRAN structural analysis program has been modified so that its finite elements may handle piezoelectric material properties. These elements are solid, axisymmetric ring elements capable of handling non-axisymmetric loads. The natural frequencies of a piezoelectric hollow cylinder and a piezoelectric disk with electroded surfaces were computed with this modified version of NASTRAN and were found to be in excellent agreement with experimental and other numerical results.

GENERAL TOPICS

TUTORIALS AND REVIEWS

80-2580
Modeling of Fluid Transients in Machines. Part 1: Basic Considerations
R. Singh
Dept. of Mech. Engrg., Ohio State Univ., 206 W. 18th Ave., Columbus, OH 43210, Shock Vib. Dig., 12 (6), pp 7-10 (June 1980) 4 refs

Key Words: Reviews, Mathematical models, Machinery

A state-of-the-art literature review of the mathematical modeling of fluid transients in machines is presented including basic equations, assumptions, and various factors involved with the models. Typical boundary conditions, source descriptions, and solution methods as pertinent to the machines are also discussed.

80-2581
Stable Response of Damped Linear Systems
D.W. Nicholson
Naval Surface Weapons Center, White Oak, Silver

Spring, MD 20910, Shock Vib. Dig., 12 (6), pp 3-4 (June 1980) 8 refs

Key Words: Reviews, Damped structures

Simple conditions in the damping matrix under which a linear mechanical system is stable are reviewed. A Lyapunov theorem and several examples are discussed. Some recent results are also mentioned on conditions for subcritical damping in all modes, in which event the response is oscillatory damped.

80-2582

Dynamic Buckling of Cylindrical Shells: A Literature Survey

D.B. Grenier

Naval Surface Weapons Center, Silver Spring, MD, Rept. No. NSWC/TR-79-447, 82 pp (Oct 1979)
AD-A082 049/8

Key Words: Shells, Cylindrical shells, Dynamic buckling, Reviews

A literature survey was conducted in order to ascertain the current theoretical methods available for predicting dynamic buckling behavior of cylindrical shells. Existing theories which give consideration to advanced shell wall geometries and materials are examined. Emphasis is placed on theories which lend themselves either to a closed form solution or to an iterative solution which does not require finite difference or finite element modeling. A brief summary and critique of each significant article is included.

80-2583

Applications of Acoustical Phenomena

W.P. Mason

Columbia Univ., New York, NY 10027, J. Acoust. Soc. Amer., 68 (1), pp 53-63 (July 1980) 25 figs, 24 refs

Key Words: Reviews, Ultrasonic techniques, Underwater sound, Nondestructive testing, Acoustic emission, Internal friction, Fatigue life

This paper briefly reviews progress in research on specific applications of acoustic radiation during the past 50 years. Topics discussed are underwater ultrasonic detectors, the ultrasonic interferometer, use of ultrasonics in the nondestructive testing of metals, acoustics delay lines, improvements in the materials used in ultrasonic transducers, surface wave devices, acoustic emission, use of ultrasonics in the study of internal friction and fatigue in metals, and the ultrasonic microscope.

80-2584

Dynamic Stability of Shallow Elastic Arches and Shells

S.M. Holzer and R.H. Plaut

Dept. of Civil Engrg., Virginia Polytechnic Inst. and State Univ., Blacksburg, VA, Rept. No. VPI-E080-13, 15 pp (Apr 1980)
PB80-171077

Key Words: Reviews, Dynamic buckling, Arches, Grids (beam grids), Shells

Recent work on the snap-through instability of shallow elastic structures under dynamic loading is reviewed. The investigations cited involve circular arches, lattice structures, and spherical shells. A variety of load applications is considered and a number of techniques are used for discretization in space and time. Various definitions of critical load are employed.

BIBLIOGRAPHIES

80-2585

Band Pass Filters. February, 1977 - April, 1980 (Citations from the NTIS Data Base)

W.E. Reed

NTIS, Springfield, VA, 249 pp (Apr 1980)
PB80-809676

Key Words: Bibliographies, Band pass filters, Filters

The design, fabrication, characterization, and application of band pass filters are investigated in the cited federally-sponsored research reports. Radiofrequency, digital, acoustic surface wave, and x-ray filters are included. Optical filters are excluded.

AUTHOR INDEX

TECHNICAL NOTES

K.R. Schneider
On the Existence and Numerical Approximation of Forced Oscillations
Z. angew. Math. Mech., 59 (12), pp 739-740 (Dec 1979)

J. Thomas and B.A.H. Abbas
Dynamic Stability of Off-Shore Structures
J. Mech. Engr. Sci., 22 (1), pp 37-39 (Feb 1980) 4 figs, 1 ref

E.K. Pritchard
Step Motor Accuracy at Low Frequencies
Mach. Des., 52 (17), pp 111-112 (July 24, 1980) 1 fig, 1 table

B.A. Schmidt
Vibrated Pendulum with a Mass Free to Move Readily
J. Appl. Mech., Trans. ASME, 47 (2), pp 428-430 (June 1980) 1 fig, 8 refs

T.A.E. Akeju
Performance of the Axisymmetric Linear Shell Element for Vibration of Thin Circular Plates
J. Appl. Mech., Trans. ASME, 47 (2), pp 433-434 (June 1980) 1 fig, 2 tables, 5 refs

G. Prathap and G.R. Bhashyam
Comments on Nonlinear Vibrations of Immovably Supported Beams by Finite-Element Method
AIAA J., 18 (6), pp 733-734 (June 1980) 5 refs

D. Ginnestad
Effect of Adding Structural Damping on a Wing/Nacelle Hump Type Flutter Mode
J. Aircraft, 17 (7), pp 542-543 (July 1980) 1 fig, 2 refs

G.C. Li and C.S. Desai
Vibration Analysis of Planar Structures
ASCE J. Struc. Div., 106 (ST8), pp 1813-1817 (Aug 1980) 5 figs, 5 refs

J. Lubliner
The Effect of Column Mass on Shear Building Vibrations
Intl. J. Earthquake Engrg. Struc. Dynam., 8 (4), pp 395-398 (Aug 1980) 5 figs, 1 ref

CALENDAR

NOVEMBER 1980

16-21 ASME Winter Annual Meeting [ASME] Chicago, IL *(ASME Hq.)*

18-21 Acoustical Society of America, Fall Meeting [ASA] Los Angeles, CA *(ASA Hq.)*

DECEMBER 1980

Aerospace Meeting [SAE] San Diego, CA *(SAE Hq.)*

8-10 INTER-NOISE 80 [International Institute of Noise Control Engineering] Miami FL *(INTER-NOISE 80, P.O. Box 3469, Arlington Branch, Poughkeepsie, NY 12603)*

9-11 Western Design Engineering Show [ASME] Anaheim, CA *(ASME Hq.)*

MARCH 1981

8-12 26th International Gas Turbine Conference and Exhibit [ASME] Houston, TX *(ASME Hq.)*

21-Apr 1 Lubrication Symposium [ASME] San Francisco, CA *(ASME Hq.)*

31-Apr 1 Pressworking Machinery for the Eighties Conference [IMechE] Birmingham, UK *(IMechE, 1 Birdcage Walk, Westminster, London, SW1H 9JJ*

APRIL 1981

6-8 22nd Structures, Structural Dynamics, and Materials Conference [AIAA, ASME, ASCE, AHS] Atlanta, Georgia *(AIAA, ASME, ASCE, AHS Hqs.)*

MAY 1981

4-7 Institute of Environmental Sciences' 27th Annual Technical Meeting [IES] Los Angeles, CA *(IES, 940 East Northwest Highway, Mt. Prospect, IL 60056)*

JUNE 1981

1-4 Design Engineering Conference and Show [ASME] Chicago, IL *(ASME Hq.)*

8-10 NOISE-CON 81 [Institute of Noise Control Engineering and the School of Engineering, North Carolina State University] Raleigh, North Carolina *(Dr. Larry Royster, Program Chairman, Center for Acoustical Studies, Dept. of Mechanical & Aerospace Engr., North Carolina State University, Raleigh, NC 27650)*

22-24 Applied Mechanics Conference [ASME] Boulder, CO *(ASME Hq.)*

SEPTEMBER 1981

20-23 Design Engineering Technical Conference [ASME] Hartford, CT *(ASME Hq.)*

OCTOBER 1981

Eastern Design Engineering Show [ASME] New York, NY *(ASME Hq.)*

4-7 International Lubrication Conference [ASME ASLE] New Orleans, LA *(ASME Hq.)*

NOVEMBER 1981

15-20 ASME Winter Annual Meeting [ASME] Washington, D.C. *(ASME Hq.)*

30-Dec 4 Acoustical Society of America, Fall Meeting [ASA] Miami Beach, Florida *(ASA Hq.)*

DECEMBER 1981

8-10 Western Design Engineering Show [ASME] Anaheim, CA *(ASME Hq.)*

CALENDAR ACRONYM DEFINITIONS AND ADDRESSES OF SOCIETY HEADQUARTERS

AFIPS	American Federation of Information Processing Societies 210 Summit Ave., Montvale, NJ 07645	IEEE	Institute of Electrical and Electronics Engineers 345 E. 47th St. New York, NY 10017
AGMA	American Gear Manufacturers Association 1330 Mass. Ave., N.W. Washington, D.C.	IES	Institute of Environmental Sciences 940 E. Northwest Highway Mt. Prospect, IL 60056
AHS	American Helicopter Society 1325 18 St. N.W. Washington, D.C. 20036	IFToMM	International Federation for Theory of Machines and Mechanisms U.S. Council for TMM c/o Univ. Mass., Dept. ME Amherst, MA 01002
AIAA	American Institute of Aeronautics and Astronautics, 1290 Sixth Ave. New York, NY 10019	INCE	Institute of Noise Control Engineering P.O. Box 3206, Arlington Branch Poughkeepsie, NY 12603
AIChE	American Institute of Chemical Engineers 345 E. 47th St. New York, NY 10017	ISA	Instrument Society of America 400 Stanwix St. Pittsburgh, PA 15222
AREA	American Railway Engineering Association 59 E. Van Buren St. Chicago, IL 60605	ONR	Office of Naval Research Code 40084, Dept. Navy Arlington, VA 22217
ARPA	Advanced Research Projects Agency	SAE	Society of Automotive Engineers 400 Commonwealth Drive Warrendale, PA 15096
ASA	Acoustical Society of America 335 E. 45th St. New York, NY 10017	SEE	Society of Environmental Engineers 6 Conduit St. London W1R 9TG, UK
ASCE	American Society of Civil Engineers 345 E. 45th St. New York, NY 10017	SESA	Society for Experimental Stress Analysis 21 Bridge Sq. Westport, CT 06880
ASME	American Society of Mechanical Engineers 345 E. 45th St. New York, NY 10017	SNAME	Society of Naval Architects and Marine Engineers 74 Trinity Pl. New York, NY 10006
ASNT	American Society for Nondestructive Testing 914 Chicago Ave. Evanston, IL 60202	SPE	Society of Petroleum Engineers 6200 N. Central Expressway Dallas, TX 75206
ASQC	American Society for Quality Control 161 W. Wisconsin Ave. Milwaukee, WI 53203	SVIC	Shock and Vibration Information Center Naval Research Lab., Code 5804 Washington, D.C. 20375
ASTM	American Society for Testing and Materials 1916 Race St. Philadelphia, PA 19103	URSI USNC	International Union of Radio Science U.S. National Committee c/o MIT Lincoln Lab. Lexington, MA 02173
CCCAM	Chairman, c/o Dept. ME, Univ. Toronto, Toronto 5, Ontario, Canada		
ICF	International Congress on Fracture Tohoku Univ. Sendai, Japan		

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