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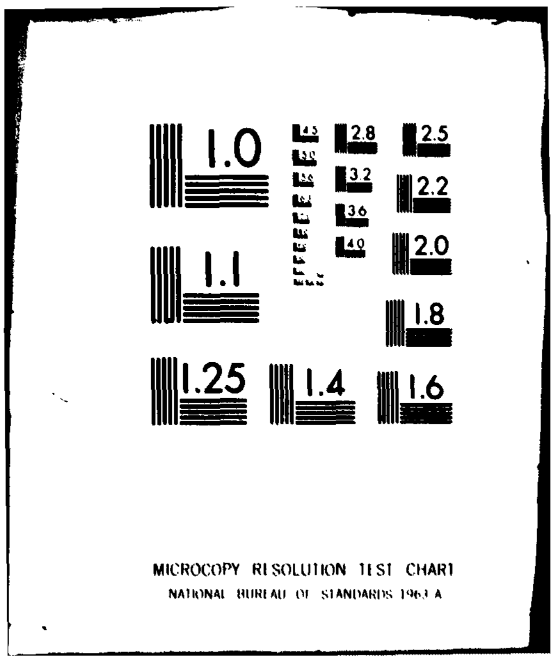
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SVIC NOTES

USSAMM PROGRAM

I would like to use this month's SVIC Notes to give our readers some background and a status report or. the U.S. State of the Art Assessment of Mobility Measurement Program (USSAMM).

Many investigators feel that mechanical impedance, or mobility, concepts are useful for determining the dynamic behavior of complex systems - the dynamic behavior of coupled systems is one application. In most cases the responsibility for such systems is divided among several organizations. Therefore, if mobility measurements are used to determine the dynamic behavior of the total coupled system, it is important to know that investigators in different organizations are able to make consistent measurements. That is, if different experimenters were to measure the mobility of a single structure the scatter in the results should be low. Valid measurements of the dynamic behavior of coupled systems cannot be obtained otherwise.

The objectives of this survey are to determine if different experienced investigators can make consistent mobility measurements on the same structure, using different experimental techniques, and to assess the ability to determine the modal properties of structures from mobility data. This is very similar to a survey that Dr. David Ewins conducted in Great Britain and France between 1977 and 1979, and in fact, the same structures will be tested.

The structures will be circulated to the participants early in 1981 and all participants should have completed testing by the end of the year. Four structures were designed and each is appropriate for testing in one frequency range. (One of the four structures is made from composite material.) The participants will be free to select which structure (s) they wish to test and they will also choose their own test methods. Some participants may use more than one test method and, in this case, they will be free to designate which set of data are to be considered as their primary data to be included in the survey. Data processing will begin in the spring of 1981 and it will be completed a year later. If all goes well the results of this program should be available for a de-briefing meeting at the 53rd Shock and Vibration Symposium.

R.H.V.

EDITORS RATTLE SPACE

REVIEW OF THE TECHNICAL LITERATURE

Each month you find several articles in the DIGEST that review specific topic areas in shock and vibration literature. These literature review articles are intended to provide on a periodic basis descriptions and critical evaluations of such literature that will be of use to experts in the field as well as engineers in related fields. Review articles are subjective reports on published literature; they therefore complement the objective listing of articles and reports published in the "abstracts" section of the DIGEST.

In my opinion, as the number of technical papers published continues to increase -- it has almost doubled in the past 5 years -- the literature review articles will become even more important to researchers and practicing engineers. It is a convenient way for engineers to keep abreast of current knowledge in major areas as well as related technical areas. In addition, literature review articles often provide an invaluable list of references in a few pages of text.

It is difficult to write these articles, and I want to commend our authors for 1980. I believe that their efforts have been a positive contribution to the engineering community. A list of authors and article titles for 1980 is given in this issue of the DIGEST.

If you are interested in joining our literature review program, please send me a brief description of the topic area you intend to review and critique. Topic areas should be as narrow as possible so that you can provide an in-depth analysis. We will respond with details of the program and initiate your complimentary subscription to the DIGEST.

R.L.E.

TORSIONAL VIBRATION OF SHIP ENGINE SHAFTS

D.K. Rao* and A. Sanyal**

Abstract. Ship engine shafting can fail when the operating speed range contains torsional critical speeds. Such failures can be avoided if torsional vibration response characteristics of the shafting are analyzed during the design stage. This paper reviews the current literature dealing with determination of these characteristics using simple formulas, design charts, and complex computer programs.

It is a commonly known fact that crankshaft failures can occur in internal combustion (I.C.) engine driven installation when the operating speed range contains significant torsional critical speeds. Because of the pulsating nature of the gas pressure in the cylinder and the inertia of the reciprocating parts, severe torsional stresses can develop in the main shafting; the result is either reduction of shaft life or fatigue failure.

Recent advances in the shipbuilding industry have resulted in the construction of large and powerful vessels with extremely complex propulsion systems. These systems frequently are multi-branched, having two or more drive units. A set of propellers driven by a number of medium capacity diesel engines results in height-wise compactness, lowers capital costs, and reduces maintenance. Branched shaft drives are being used in large capacity cargo vessels and container ships as well as in smaller vessels such as trawlers, in which a single engine is geared to the propeller, trawl winches, generators, and auxiliary equipment.

In order to avoid fatigue failure of crankshafts in such capital intensive machinery, it is essential that the following be carried out at the design stage: calculation of natural frequencies and modes, harmonic analysis of excitation torques, determination of critical speeds and severe orders, and calculation of maximum torsional stresses in the operating speed range.

This paper presents a review of current literature dealing with solutions to these problems and augments bibliographic sources available in texts published up to 1960 [1-5]. A concise article on torsional vibration analysis of reciprocating engines is also available [6].

Designers can use computer programs based on the Holzer method to compute the lowest torsional frequencies and modes of interest. However, because the Holzer method is a time consuming procedure, shorter methods such as simple formulas or design charts are preferred during the initial design stages or whenever possible; these simple methods are used to estimate torsional frequencies and modes as rapidly and accurately as possible. Figure 1 shows various facets of the topic under consideration.

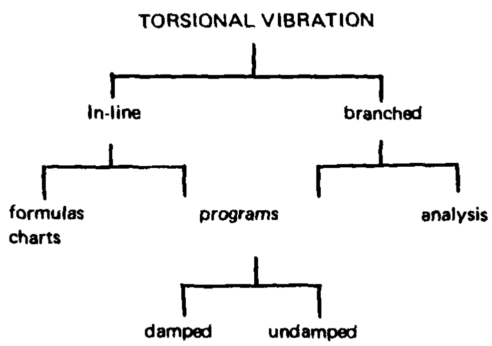

Figure 1. Torsional Vibration Problems in Diesel Engines

* *Associate Professor of Mechanical Engineering, Indian Institute of Technology, Kharagpur, India*
** *Graduate Engineer, Mining and Allied Machinery Corpn. Ltd., Durgapur, India*

IN-LINE ENGINES

Design formulas. The simplest torsional model of an m cylinder engine consists of m identical rotors attached to one or two additional rotors signifying flywheel and/or load (such as propeller or generator), as shown in Figure 2. Frequency equations of these simple models have been presented [3, 7-9]. Approximate formulas for estimating one-node torsional frequency were first developed by Bradbury [10]. More accurate formulas were compiled later [1, 2]. Gupta [11] formulated the dynamic matrix and used the matrix iteration method to develop formulas for one-node frequency and mode shapes of systems having four to eight cylinders. Accurate formulas and design charts for one-node frequency have also been presented for four cylinder engines [12, 13] and for six cylinder engines [14]. LR transformation with QD algorithm has been used [15] to determine formulas for one-node and two-node torsional frequencies of four, six, and eight cylinder engines having one or two additional rotors. A simplified procedure for calculating natural frequencies has also been outlined [16]. Panagopulos [17] described a method for reducing engine and propeller shafting to a two-rotor system; he developed formulas for calculating natural frequencies and torsional response amplitudes when damping is taken into account.

Design charts. Design charts for estimating frequencies and modes of multi-cylinder engines having one or two additional rotors can be easily plotted from exact frequency equations or approximate frequency formulas. Gupta [11, 18] used the matrix iteration technique to develop design charts for one-node and two-node frequencies of engines with four to eight cylinders. The exact frequency equation has been utilized [7] to plot design charts for frequencies and modes of engines having as many as 12 cylinders. The Lewis method of reduction was used [19] to develop simple design charts for determining the lowest frequency. Ramanaiah and Nagaraj [14] have also developed design charts for one-node frequency of six-cylinder engines for a wide range of design parameters.

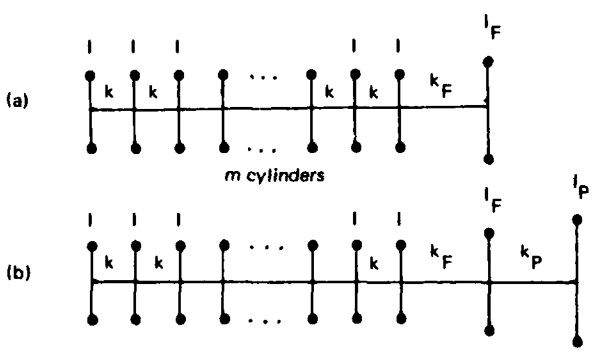

Figure 2. Multi-cylinder Engine with One or Two Additional Rotors

Computer programs. After the preliminary design has been completed using rough formulas or design charts, the system is analyzed in detail using specially developed computer programs. These general programs can be used to evaluate the free and forced vibration characteristics of general multi-rotor systems. They are usually based on the transfer matrix method originally developed by Holzer [20] and are designed to meet the input/output specifications of such classification societies as Lloyds [21]. Archer [22] presented a method for improving the computational accuracy of torsional stresses; he included appropriate formulas for propeller damping. The effect of propeller damping on torsional vibration amplitude is also taken into account in other formulas [23].

Orbeck [24] outlined a computer-oriented method for torsional vibration calculations and illustrated its use by a number of practical examples. Sarsten [25] presented a computer program that includes the effect of damping; the program uses a complex Holzer tabulation procedure for finding natural frequencies, modes, and maximum torsional stresses. Flowcharts for determining the harmonic components of crankshaft torque and forced torsional vibration response (either for resonant conditions or flank effects) have been presented by Archer [26]. The Archer method was used in stress calculation in another procedure [27]. Other computer programs for torsional vibration analysis of in-line engines have also been developed in Italy [28], in Norway [29], and in India [30].

A program for computing the torsional response of I.C. engine shafting subjected to constant or pulsating external torques uses a continuous model to simulate the shafts with lumped rotors and dampers [31]. Transfer matrix technique is used to compute the frequencies and modes. An ALGOL program for computing torsional or axial characteristics of turbine-geared shaft systems has been presented [32]. These programs are essentially two electrical linear network programs; one determines the resonance frequency of the circuit, and the other calculates the current and voltage drops across an element of the circuit.

Geislinger [33] recently described an example in which the programs used revealed the existence of torsional vibrations in the gearing; these vibrations are not influenced by crankshaft stiffness and coupling. Such a situation can arise if a high-speed alternator is geared to a low-speed marine engine. The theoretically calculated torsional/axial vibration response in the shafting of a cargo ship has been compared with measured values; it was concluded that the prediction accuracy is quite good [34].

Automated design. Bradshaw and McCallion [35] used the Holzer method to develop a set of computer programs that automatically search/determine the drive shaft stiffness and flywheel inertia of a propulsion system so as to give the best spacing of critical speeds arising out of one-node mode of vibration. The problem of selecting optimal stiffnesses in order to space favorably the critical speeds has also been studied by Karaban and Igumentsev [36].

Variable-inertia effects. Classical analysis of torsional vibration of reciprocating engine assumes that inertia per cylinder line is constant. But it is well known [4] that the effective inertia of the crank assembly depends on crank angle. The dominant component of inertia varies twice per crank revolution. Sometimes a large variation of cylinder inertia and crankshaft torques give rise to interesting secondary resonances. This phenomenon is governed by differential equations with periodic coefficients. Influence of secondary resonances on torsional vibration behavior has recently been investigated [37-40].

BRANCHED-SHAFT SYSTEMS

Analysis. In contrast to in-line engines -- which yield tri-diagonal mass and stiffness matrices -- branched shaft systems result in banded system matrices. Gilbert [41] used the dynamic matrix approach in a method for finding the natural frequencies of branched-shaft systems. The Lagrangian method was used [42] to compute the dynamic matrix; the matrix iteration method leads to one-node frequency. Shaikh [43] proposed a unique method for determining the natural frequencies of a branched system. All of the calculations start at the junction point and proceed simultaneously in all branches toward their respective ends. This procedure automatically eliminates matrix inversion. Dawson and Sidwell [44] investigated the relationship between frequencies of branched systems and frequencies of individual systems obtained when the branch point is clamped.

Computer programs. Computer programs for determining the torsional vibration characteristics of undamped branched systems are available [45, 46]. Other programs [32] are sufficiently general to include branched shaft system analysis. Computer programs based on the Jacobi method have been developed to determine the natural frequencies and modes of branched shaft system [45]. Salzman [46] used the Holzer-Newton method in a program for computing the natural frequencies and modes of branched shaft systems.

Computer programs for analysis of damped branched systems have also been developed [47]. This method eliminates the need for large matrices. Instead, characteristics of individual branches are evaluated separately and then combined in the form of a connection matrix the size of which depends on the number of branches of the system instead of the number of masses. Other programs [48] take into account the damping of propellers and the engines; equivalent viscous damping coefficients are determined from the formulas for energy dissipated per cycle. The energy balance principle is used to compute steady-state amplitudes.

The program developed by Liebig [49-52] uses Fast Fourier Transforms to perform harmonic analysis of excitation torques and computes natural frequencies by the Jacobi method. Larsen [53] developed a set of computer programs based on the theory of Hasselgruber [54] and Kritzer [55]. Larsen's programs include the effect of different phases between the engines and propellers and the influence of irregular cylinder pulses. These programs can take a maximum of 80 masses and can be composed of a maximum of 8 main branches. Another set of computer programs [56] determines the torsional vibration characteristics of a damped branch shaft system; the Holzer method is used to determine the frequencies and modes. Complex arithmetic is used to determine the amplitudes and torques at specified rotors. The size of the connection matrix to be solved is no larger than twice the number of branches in the system.

CONCLUSION

The existing literature on determining torsional vibration characteristics of shafting of diesel engine-driven ships is reviewed. The review establishes that fairly accurate formulas and design charts are available for computing one-node and two-node frequencies and modes of multi-cylinder engines having one or two additional rotors. Computer programs of varying complexity and limitations are also available for predicting torsional stresses in in-line and branched shaft systems. Most of the computer programs use the Holzer technique for computing frequencies and modes. But it appears that such modern computational tools as automatic bandwidth minimization and profile storage schemes have not yet been utilized to develop computer programs capable of predicting torsional vibration characteristics of complex ship propulsion systems.

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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 vibration of overhead transmission lines and free vibration analysis of cooling towers.

Professor R.N. Dubey of the University of Waterloo, Waterloo, Ontario, Canada and Dr. C. Sahey of the Indian School of Mines, Dhanbad, Bihar, India have written a paper describing investigations in which theoretical results are combined with experimental data in attempts to assess the efficiency of design mechanisms for reducing vibration amplitude of power transmission lines.

Dr. R.L. Nelson of Central Electricity Research Laboratories, Leatherhead, Surrey, England has written a review of many of the theoretical techniques used since 1965 to analyze the free vibration of cooling towers.

VIBRATION OF OVERHEAD TRANSMISSION LINES III

R.N. Dubey* and C. Sahay**

Abstract. This article describes investigations in which theoretical results are combined with experimental data in attempts to assess the efficiency of design mechanisms for reducing vibration amplitude of power transmission lines.

An earlier literature review on the vibration of overhead transmission lines appeared in 1978 [7]. Three additional review articles [1, 18, 23] have appeared since that time. Beards [1] considered aeolian vibration, including factors affecting amplitude and frequency of cable in aeolian vibration and methods for its control. Migliore and Webster [18] reviewed methods for analyzing dynamic cable response. The efficacies of the lumped parameter approach, the finite element technique, and the method of weighted residual were also discussed. Ramamurti et al [23] reviewed the general behavior of transmission lines.

Two main types of transmission line vibration have been identified. They are known as aeolian and galloping. A conductor can be excited in one or the other type of motion depending upon the ambience. The motion can consist of one or several loops. The exchange of instabilities from one mode to another and from one type of motion to the other presents a formidable problem. Wake-induced oscillations of bundled conductors complicates the situation even further.

Because of the complexity of the problem, it has not been possible to obtain an analytical solution that can simultaneously explain the effects of all of the parameters and account for the different modes and types of conductor vibration. Simple models are usually analyzed. The theoretical results obtained from these models are supplemented by controlled experimental results and field data. The combination of theory and experiment is the only way currently available to design and measure the efficiency of control mechanisms for reducing vibration amplitude.

AEOLIAN VIBRATION

Aeolian vibration is induced by a vortex shed alternately from the top and bottom of a conductor exposed to air flow. Steady wind flow is usually assumed, and vibration amplitude is obtained by equating power dissipated to wind power input. In practice, however, the air flow is seldom steady. Simmons and Cleary [26] have presented data obtained by direct measurement of the unsteady pressure distribution on a cylinder undergoing sinusoidal oscillation in turbulent air flow. The Reynolds number ranged from 3000 to 4000.

Other investigators [6] used a nonlinear oscillator to simulate the phenomenon of vortex shedding on a vibrating circular cylinder. The wind excitation was modeled with an aerodynamic mass, spring, and damper; their values were a nonlinear function of the amplitude. Gustiness and fluctuation in wind velocity were allowed for; the solution was obtained using a modal approach. The results seemed to fit the field observations.

The usefulness of various forms of dampers in suppressing aeolian vibration has been studied [5]. The finite difference and finite element methods were used to find the natural frequency and mode shapes.

It seems that a stochastic model would be more appropriate to describe aeolian vibration. Such a model would require more field data and careful correlation of interacting parameters.

GALLOPING

Galloping is caused by aerodynamic forces generated due to air flow past iced conductors. It is a large-amplitude low-frequency vertical motion that is often accompanied, at least initially, by torsional oscilla-

*Department of Mechanical Engineering, University of Waterloo, Waterloo, Ontario, Canada
**On leave of absence from Indian School of Mines, Dhanbad, Bihar, India

tion. The two theories that have been proposed to explain the phenomenon are the Den Hartog theory and the torsional theory.

The Den Hartog instability occurs when the negative slope of the lift coefficient is larger than the drag coefficient. Richardson [24] and Richardson and Fox [25] used this criterion to discuss galloping and methods for its control. The effect of twisting on single conductors under heavy ice is favorable [24]: for a figure-8 cable, the use of round snap-on cylinders inhibits galloping in high wind [25].

Nigol and Buchan [20] reported that the Den Hartog mechanism is not the cause of galloping. It was their opinion that galloping is caused largely by the self-excited torsional mechanism [21]. (According to torsional theory, galloping is caused by wind-induced torsional oscillations of the iced conductor that generate vertical oscillatory aerodynamic forces.) Moreover, Nigol and Buchan found it necessary to use dynamic test measurements with proper damping characteristics to predict dynamic conductor instabilities; static measurements were inadequate.

Moore [19] discussed wave-induced oscillations and conditions under which large amplitude oscillations are likely to occur. Gawronski and Hawk [10, 11] simulated caternary galloping on a computer. Their formulation includes motion with four degrees of freedom (three translational and one rotational) and span-wise variation in aerodynamic forces and cable elasticity. The theoretical results were compared with galloping observations on a bundled two-conductor transmission line. The agreement of these observations with experimental results and their comparison with computed results support the accuracy of simulation. In another study of conductor shape effects wake-induced galloping was simulated [10]. Results for bundled conductors having different span lengths and varying conductor separation were also reported [10]. The effect of using stranded conductor and initial torque was discussed. Other field data supports the assumptions in the model; the model supports the torsional theory. Nicol, Clark, and Howard [22] utilized the same torsional theory to calculate torsional moments and stiffness of bundle conductors. They concluded that the damping torque requirements of the spacer clamp should be based on the moments.

Goto and Koike [11], however, utilized the Den Hartog mechanism to suggest a method for preventing galloping. The results of numerical calculations were shown to agree with the observations. It is possible, therefore, that both mechanisms contribute to galloping. The conditions favoring one or the other remain to be determined.

Tsui [28, 29] made theoretical and experimental studies on Pylone, a Chainette line. He simulated two-span three-conductor models. Calculations were done for fixed end conditions in order to obtain the maximum load and stress levels in the members of the supporting structure. Perturbation and finite element techniques were used for theoretical calculations. Results of the two methods were in good agreement. More realistic end conditions have been achieved by using a horizontal variable spring constant to include the effect of adjacent span. Calculations indicate that, beyond a particular stiffness value, dynamic effects are more significant than static ones. Four-span models have also been formulated and studied. Experimental results have been obtained for a full-scale two-mile long St.-Melaine line consisting of 10 unequal spans and 11 towers. Two- and three-loop modes were excited by suitably placed shakers. The results reported for two-loop modes were not as good as for the three-loop modes; it is likely that the discrepancies are atrributable to the spring stiffness chosen to simulate the end conditions.

Brokenshire [3] presented results of an experimental study and a fatigue analysis of the members of a structure under dynamic loads resulting from galloping of conductors.

Bouche [2] discussed the characteristics of vibration dampers after studying the attenuation pattern of overhead lines. Theoretical results and experimental observations showed that the attenuation effect was present throughout the span. The results were extrapolated to infer that dampers with similar values of dynamic mass should produce about the same attenuation throughout the frequency and wind speed ranges of interest. Such an inference would be safer with more exhaustive results. Hardy and Bourdon [13] considered the influence of spacer dynamic properties as a control of bundle conductor motion. Articulated damping and non-damping spacers as well as commercial types were observed. For aeolian vibration the damping spacers yielded better control. For sub-span oscillations, however, the results showed that non-damping spacers were better.

Howard [15, 16] studied the effect of detuning pendulums for single and bundled conductors. He formulated the detuning method of control from the torsional theory for single and bundle conductors. Field trail data were reported by Howard and Pohlman [14].

CONCLUSIONS

A stochastic model for aeolian vibration and galloping is appropriate; therefore, a statistical analysis of field data is desirable. The IEEE recommendation of 150 microns (μ) has been accepted as the limiting value of strain and the acceptable level of line vibration [4]. Crossover frequency/amplitude analysis, peak-through analysis incorporating randomness in peak-through vibration, and spectral analysis of line vibrations are used to estimate the vibration pattern. The paucity of experimental observations stands in the way of comparisons of the effects of different variables by the procedures listed above. Gambhir and Batchelor [8, 9] do not write directly of galloping, but their parameter study of free vibration of sagged cables could be adapted to solving a galloping problem. Stafford's method [27] would be expected to give faster results in less time.

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FREE VIBRATION ANALYSIS OF COOLING TOWERS

R.L. Nelson*

Abstract. A critical review of many of the theoretical techniques used since 1965 to analyze the free vibration of cooling towers is presented. Comparison of theoretical methods and experimental results shows that most theoretical methods have not yielded accurate results, primarily because the column-supports of the tower have not been accurately modeled. Explicit definition of column-supports and use of the property of rotational periodicity lead to accurate predictions of the free vibration of cooling towers and allow efficient use of computer facilities.

It is now realized that the dynamic stress induced in a cooling tower at resonance is a crucial structural factor. Wind-induced resonant stress is approximately inversely proportional to the square of the resonant frequency; therefore, the lowest resonant frequency of a tower is arguably the single most important parameter with respect to dynamic behavior. It is thus important to have an accurate estimate of the lowest resonant frequency (or frequencies) of a cooling tower during the design stage. Such information is also required for assessments of the structural integrity of existing cooling towers. Accurate, inexpensive, and efficient theoretical techniques are thus of immediate interest.

HISTORICAL BACKGROUND

Until 1965 considerable effort was expended in analyzing the structural implications of static wind loading on cooling towers [1-10]. It was shown by serveral workers, including Der and Fidler [10], that hyperboloidal shells-of-revolution are reasonably resistant to buckling under steady-state wind loading up to wind speeds of 200 miles (320 kilometers) per hour. Little if any attention was given, however, to analyzing the dynamic response of cooling towers; the reason was that the possible resonant stress caused by wind-induced vibrations was considered to be of secondary importance.

Engineers became aware of the crucial importance of dynamic stresses induced in cooling towers by winds with dynamic components of force when gale force winds caused the collapse of three newly constructed cooling towers in England at Ferrybridge 'C' Power Station in November, 1965. Observers present at the collapse of one of the towers reported that a general ovalling and rippling below the throat were followed by large movements over an area whose diameter was about half that of the tower. A few seconds later the tower collapsed. The large amplitude vibrations had periods of several seconds. The report of the Committee of Inquiry of the Central Electricity Generating Board (C.E.G.B.) into the collapse of the towers emphasized the need for a more realistic appraisal of wind loading, and for a better representation of the fluctuating component in the structural analyses of cooling towers [11].

A major program of investigation was begun at the Central Electricity Research Laboratories of the C.E.G.B. to determine the mechanics of the collapse of the Ferrybridge towers. The behavior of carefully designed model towers in wind tunnels was observed [12]. It is of interest that this was probably the first experimental program reported in the literature in which accurate dimensions of the column-supports and variation of thickness in the shells-of-revolution were used for the cooling tower models. It was deduced that resonant stresses were partly responsible for the collapse of the Ferrybridge towers. The possible failure mechanism was that resonance along the meridia of the towers caused excessive tensile stresses, which resulted in failure of the steel reinforcements. Cracks then developed and the buckling mode caused the eventual collapse of the towers. It was concluded that resonant stresses could be a

*Research Officer, Engineering Sciences Division, Central Electricity Research Laboratories (of the C.E.G.B.), Kelvin Avenue, Leatherhead, Surrey KT22 7SE, England

serious problem with some tower designs and that the single most important parameter appeared to be the lowest natural frequency.

THEORETICAL AND EXPERIMENTAL ANALYSES

Since the C.E.G.B. report [11] was published in 1965, a considerable degree of effort has been expended to determine both experimentally (on model structures) and theoretically the free vibration characteristics of cooling towers. The first stage of such investigations is usually the determination of the lowest natural frequencies and corresponding mode shapes of the towers, because if these vibrating properties are not measured or calculated accurately, ensuing resonant stresses would be subject to even greater error.

Except in the case of relatively simple geometries such as cylinders, cones, and spheres, comparatively little effort has been directed toward analyzing vibrating general shells-of-revolution -- i.e., shells with meridia that are more properly defined by a polynominal function than by a simple analytical expression, as for example, a hyperbola.

Kalnins [8] described a method of solution for obtaining the eigenvalues and eigenvectors of general shells-of-revolution. His method is based on the classical linear bending theory of shells derived by Reissner [13]. The method is analogous to the Mykestad-Prohl method for beams [14, 15] and is therefore a trial and error method. Prior knowledge of the approximate frequency of the required solution is necessary for economical application of the method. For each trial frequency a determinant is evaluated. When the determinant changes sign, the interpolated value of the natural frequency obtained is considered to be the solution.

The resonant frequency of axisymmetric structures can be obtained using the method of Percy, Pian, Klein, and Navaratna [16] and Webster [17]. Webster's method [17] uses a ring finite element and appears to be reasonably efficient. The former method [16] involves conical elements; thus a large number of elements are required to obtain an accurate solution for structures with meridional curvature.

Hashish [18] analyzed the free vibration of a hyperboloidal cooling tower using a modified finite difference method and compared the results with measured values. (The same structure was also analyzed by other investigators [37], who solved the differential equations of motion.) The theoretical values were significantly lower than the experimental ones.

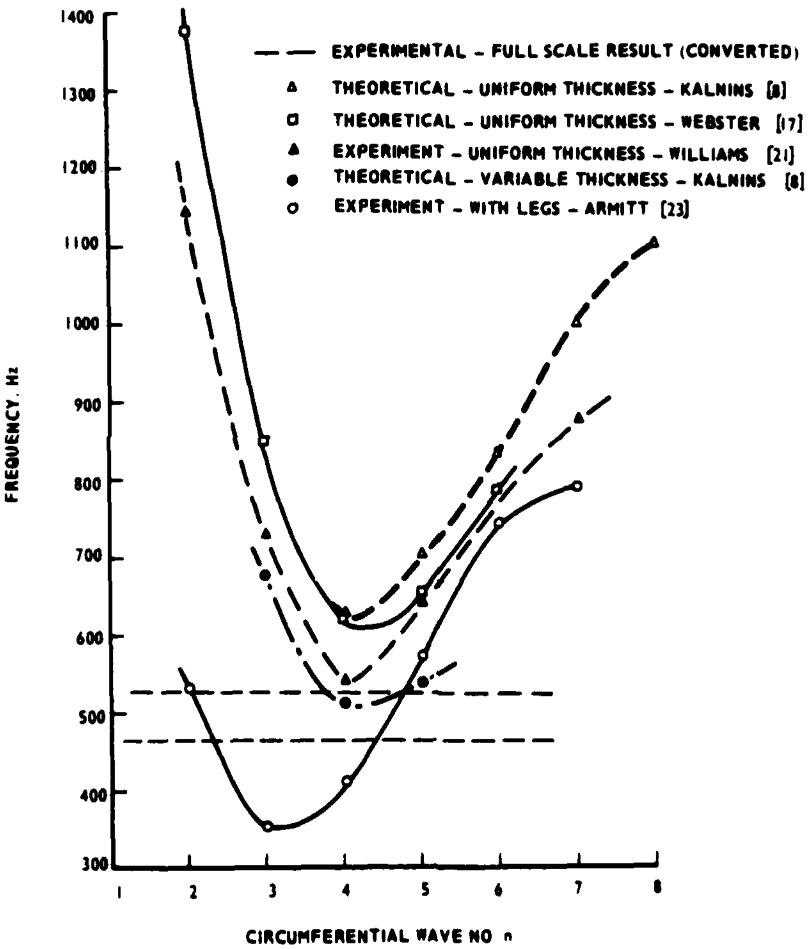
Neal [19] determined experimentally and theoretically the two lowest natural frequencies for a hyperboloidal shell supported by four pairs of inclined column-supports. The second lowest frequency predicted by both techniques agreed to within about 18%. The lowest frequency agreed to within about 1.5%. He again experimentally determined the resonant frequencies of the same shell when supported by 40 pairs of column-supports. (In full-scale cooling towers, the usual practice is to employ a large number of pairs of column-supports; 40 is a typical number.) However, he did not then theoretically analyze the structure. No firm conclusions can be made from the results of Neal's investigation.

Woodman and Severn [20] used a doubly curved shell finite element to analyze an idealized (i.e., constant thickness was assumed and no attempt was made to model the column-supports) model of the Ferrybridge 'C' cooling tower. Note that, because a shell finite element was used, no prior assumption was made that the structure was axisymmetric – a noteworthy departure from the usual practice of using axisymmetric or ring elements. The theoretical results were compared to the experimental results of Williams [21]. Unfortunately very poor agreement was obtained. This might have been due in part to insufficient core-storage of the computer so that the number of elements necessary for satisfactory convergence was not available.

It is of interest to compare some experimental and theoretical results for an idealized cooling tower model. Williams [21] carried out frequency response tests on a 1/576th scale nickel model of a Ferrybridge cooling tower. The model had no column-supports and was of uniform thickness. Theoretical and experimental results are superimposed on those obtained by Williams [21] in the figure: Kalnin [8] used the program SHEL [22] for variable thickness; Webster solved uniform thickness [17] using the program NOTTo2 [24]; Armitt's experimental results [23] were for a model in which the column-supports and variable thickness were accurate.

Note that the base plate used by Armitt for his model was not rigid and probably resulted in lower resonant frequencies -- a harmonic-circumferential-wave number less than four -- than would have occurred with a rigid base. However, subsequent studies indicated that frequencies corresponding to wave numbers greater than four are probably not significantly affected.

Agreement between experimental and theoretical results is generally indifferent. For the relatively simple case with constant thickness and no column-supports, the error at the lowest frequency is about 10%. Moreover, the experimental results for the



Comparison of Natural Frequencies of Ferrybridge 'C' Cooling Tower Model
(1/576th Nickel Model)

model with column-supports [23] are significantly lower than the theoretical values for the idealized cooling towers.

The two lowest resonant frequencies of the full-scale tower were also measured during a perfunctory experimental investigation. The frequencies were converted to the model values by applying the formula

$$F_m = F_f \sqrt{\frac{M_f E_m}{E_f M_m}} \times \text{(scale factor = 576)}$$

where F, M, and E are frequency, mass density, and Young's Modulus, respectively. The subscripts *m* and *f* pertain to the model and full-scale structures. Values of the non-dimensional quantity, Poisson's Ratio, are assumed to be the same for both materials. If these values are dissimilar, however, the error in the converted frequency is small [29]. The converted frequencies are depicted in the figure as two dashed lines, the number of meridional modes m and the number of harmonic circumferential wave numbers n were not measured. All theoretical frequencies are higher than the lower of the two converted frequencies. The conclusion to be drawn from the figure therefore is that little correlation exists between theoretical and experimental values.

In order to establish conclusively that the poor correlation obtained for the Ferrybridge tower is representative of theoretical predictions for the other tower designs, similar results for several other model cooling towers were compiled (see Table 1). The models were made from Devcon B, an epoxy resin with added steel powder, and were 1/250th scale size. The models were carefully made and had column-supports. The computer programs SHEL [22] and NOTTo2 [24] were used to generate the solution. The values in parentheses in Table 1 are the number of harmonic-circumferential-wavelengths (n). Again, there is poor correlation between the experimental and theoretical results. Also, as before, the theoretical resonant frequencies tend to be higher than the experimental results.

Burrough, Jeary, and Winney [25] were among the first workers to instrument a full-scale model in order

Table 1. Experimentally Measured and Theoretically Calculated Resonant Frequencies of Model Cooling Towers with Column-Supports

Model Cooling Tower	Natural Frequency (Hz) Theoretical: Kalnins [8]	Natural Frequency (Hz) Theoretical: Webster [17]	Experiment [23]
Thorpe Marsh	185.3 (3) 112.3 (4) 180.2 (5)	182.9 (3) 151.2 (4) 157.7 (5)	93 (3) 102 (4) 125 (4)
Drakelow 'C'	Not calculated	220.0 (2) 140.5 (3) - 106.7 (4) 131.0 (5)	53 (2) 64 (3) 72 (-) 79 (4) 118 (5)
Hams Hall 'C'	Not calculated	140.1 (3) 101.8 (4) 129.6 (5)	79 (3) 103.5 (4) 150 0 (-)
Skelton Grange 'B'	Not calculated	224 (2) 141.5 (3) 143.4 (4)	56 (2) 66 5 (3)
Ferrybridge 'C'	94.5 (3) 71.0 (4) 74.4 (5)	117.8 (3) 85.9 (4) 93 (5)	49 (3) 57 (4) 80 (5)

The numbers in parentheses indicate the values of n. a dash means the value of n is uncertain to measure structural resonance. They recorded the output of a number of accelerometers placed at strategic positions on the tower surface; power spectral densities were obtained, and the probable and possible resonant frequencies were estimated. These frequencies are given in column three of Table 2. In column two of that table the resonant frequencies of the model have been converted to full-scale values by applying the conversion formula given previously. There are difficulties in comparing the values given in columns two and three because the mode shapes were not available for both the model and full-scale towers. It could also be argued that there is some uncertainty in the material values assumed for the conversion equation.

When the tower was idealized as a uniform shell and the programs SHEL and NOTTo2 were used to calculate the lowest natural frequency, values of 145.8 Hz and 150.6 Hz, respectively, were obtained. These values compare unfavorably with both the value of 66 Hz measured for the model tower which included column-supports, and the value of 0.41 Hz measured for the full-scale structure (see Table 2) which when converted is 44 Hz. Again the theoretical results are higher than the experimental ones.

NON-AXISYMMETRIC MODELING OF COLUMN-SUPPORTS

It has been shown above that theoretical results obtained for idealized towers without column-supports have little relevance if they are intended as a prediction of the behavior of full-scale or realistically modeled structures. The column-supports appear, therefore, to have an important effect on the free-vibration behavior of cooling towers; in addition, attempts to idealize the column-supports as an axisymmetric shell lead to unreliable results. Noteworthy, therefore, are the theoretical methods for static analyses devised by Gould and Seng-Lip [6] and Abu-Sitta [7]; they attempted to incorporate the effects of column-supports on a rational basis.

For dynamic analyses various finite element methods [26, 27, 38, 39] are instructive. In one case [26] a doubly curved shell finite element was used, the effects of column-supports were included by omitting parts of the shell at the base. The cooling tower chosen by Deb Nath [26] for his calculations was the full-scale tower at the Didcot Power Station (England). His values for the natural frequencies are at variance with the experimental values obtained by Winney [28] for the actual full-scale tower.

In another study [38] the column-supports were treated as discrete springs attached to the base of the shell. For technical and economic reasons the number of discrete springs was not made equal to the number of column-supports of the tower analyzed. Good agreement was obtained with the theoretical results reported by Gould, Sen, and Suryoutomo [39]. They treated the column-supports as uniformly distributed springs. In one comparison of calculations [39] with experimental results [19], the theoretical frequencies were found to be 14 and 27% higher (depending on the flexibility assumed for the base) than the lowest natural frequency measured [19]. The significant discrepancy between

Table 2. Comparison of Frequencies for 1/250th Scale Model and Full-Scale Cooling Tower at West Burton

Model Frequency (Hz)		Full Scale Frequency (Hz)
Measured	Converted	Measured
66	0 61	0 41
78	0 72	0 61
103	0.95	0 81
112	1 96	-
128	1 19	0 96
143	1 33	1 06
160	1 48	1 20
180	1 67	1 42
213	1 98	1 58

these experimental and theoretical results cannot be assessed because the experimental mode shapes were not defined.

Resonant frequencies of the Paradise cooling tower (U.S.A.) have been calculated [27]. Two types of finite elements were used: a three-dimensional beam finite element and an orthotrophic quadrilateral flat finite element oriented arbitrarily in three-dimensional space. The beam elements were used to represent the column-supports and the flat elements were used to model the hyperboloidal shell-of-revolution. The resonant frequencies calculated by this method have not been validated bacause experimental results are not available. However, it should be noted that the central processor unit (c.p.u.) time required by the CDC 6500 digital computer used for the analysis was 2124 seconds. The long c.p.u. time is attributable in part to the flat plate used to represent a doubly curved structure. As a result convergence of the element would be expected to be poor. In addition, because the entire tower, including column-supports was analyzed, a large number of degrees of freedom would have been required.

COOLING TOWER AS A ROTATIONALLY PERIODIC STRUCTURE

A method developed recently [29, 30] uses the property of rotational periodicity exhibited by cooling towers to overcome the difficulties encountered by previous workers in the field. The method is described below.

A structure is rotationally periodic when identical segments are symmetrically arrayed about an axis-of-revolution. MacNeal, Harder, and Mason [31] have used this property to simplify the analyses of static stress problems, steady-state heat transfer, and vibration analysis with the finite element Computer program NASTRAN. The method of Thomas [32, 33] is similar except that he [33] employs complex numbers instead of real arithmetic; complex numbers simplify the equation required to define the technique because sine and cosine components of displacement need not be considered separately. Thomas [32] regards any normal mode of vibration as a wave propagating around a structure in which the wave undergoes a phase change ψ between adjacent substructures. When using the method of Thomas in a finite element program, it is necessary only to calculate the mass and stiffness matrices of one representative substructure, even though the natural frequencies and normal mode shapes or other vibratory properties of the entire rotationally periodic structure are to be calculated. The degrees of freedom on one boundary of the substructure, say the left-hand, are constrained; all the displacements have the same amplitude as the corresponding displacements on the right-hand boundary but have the prescribed phase difference of ψ. This can be expressed in complex arithmetic as

$$[U_L] = [U_R] \times \exp(+i\psi)$$

where $[U_L]$ and $[U_R]$ are the complex displacement vectors on the left- and right-hand boundaries, respectively, and $i = \sqrt{-1}$.

From a computational aspect the displacements are treated as undergoing a transformation as, for example, a coordinate transformation. The stiffness matrix of the entire structure is then given by

$$[K] = [T]^T [K_s] [T]$$

where $[K_s]$ is the stiffness matrix of a representative substructure, and $[T]$ is the transformation matrix, and $[\ ]^T$ signifies matrix transposition. The mass matrix of the entire structure is similarly obtained; both matrices can then be used for conventional finite element analyses.

Nelson [29] and Nelson and Thomas [30] have used this technique in the finite element program VACTIL [34] to calculate the natural frequencies and mode shapes of a cooling tower at the Didcot Power Station. For each value of n calculated, the time required on an IBM 370 computer was 39 seconds. The column-supports were explicitly defined by beam elements [36] and the shell-of-revolution by doubly curved shell elements [26]. The computed results were compared with experimental values obtained for both the full-scale and model structures.

The experimentation on the full-scale structure was conducted by Winney [28] over a period of years and, as far as this author is aware, yielded the most complete information reported in the literature heretofore for a large (114 metres tall, minimum diameter of 52 metres) natural draught cooling tower. The tower was vibrated at a resonant frequency by six reciprocating masses (one tonne tracks) attached at equi-distant points on the circumference of the tower (at a height of 15 m). The resonance was sustained by a modified version of the electronic apparatus described in reference [35].

The experimentation on the model cooling tower was conducted [29] on an exact 1/250th scale replica, and resonance was controlled by a system similar to that used by Winney [28].

A summary of results [29, 30] is given in Table 3. Good correlation is obtained between the experimental results for the model structure and the theoretical values. The correlation of the theoretical results with the experimental results for the full-scale structure is not as good as for the model but is generally better than the correlation of results reviewed earlier in this paper. Nelson [29] reports that this is because elasticity in the vertical direction at the base of the full-scale structure (of the order of 10^9 N/m) causes the lower resonant frequencies to fall in value whereas the base of the model cooling tower is sensibly rigid. This view is also supported by Winney [28]. For comparison, results for the Didcot tower from a previous finite element technique [26] representative of methods which assume that column-supports can be modeled by an axisymmetric shell are given in columns 8 and 9. (Note that the frequencies given in [26] are corrected for the more accurate values of the material properties given elsewhere [30].) The resonant frequencies predicted by the axisymmetric method are significantly higher

Table 3. Comparison of Resonant Frequencies and Mode Shapes Obtained Experimentally and Theoretically for the Cooling Tower of Didcot Power Station

1	2	3	4	5	6	7	8	9
Finite Element Method [30]		Experimentation on 1/250th Scale Model [29]			Experimentation on Full-Scale Structure [28]		Axisymmetric Finite Element Method [26]	
Resonant Frequency (Hz)	m, n	Measured Resonant Frequency (Hz)	Converted Frequency (Hz)	Measured m, n	Measured Resonant Frequency (Hz)	Measured m, n	Resonant Frequency (Hz)	m, n
1.16	2, 4	124.5	1.16 (0)*	2, 4	1.08 (−7.5)	2, 4	1.37 [+18.1]†	2, 4
1.24	3, 5	136.6	1.27 (+2.4)	3, 5	1.18 (−4.8)	2, 5	1.45 [+14.2]	2, 5
1.40	2, 3	147.0	1.37 (−2.1)	2, 3	1.30 (−7.1)	2, 3	1.73 [+26.3]	2, 3
1.39	3, 6	156.0	1.45 (+4.3)	3, 6	1.41 (+1.4)	3, 6	1.66 [+14.5]	3, 6
1.63	3, 7	174.0	1.62 (−0.6)	3, 7	1.62 (−0.6)	3, 7	1.84 [+13.6]	3, 7
1.92	2, 8	209.5	1.95 (+1.6)	3, 8	1.98 (+3.1)	2, 8	2.04 [+4.6]	2, 8

* The numbers in parentheses refer to the percentage difference with respect to Column 1

† The numbers in square brackets refer to the percentage difference with respect to Column 4

than the corresponding experimental values, especially for the lower modes, which are of most interest to the engineer. This demonstrates the importance of accurately including the effects of column-supports.

CLOSURE

A review of many of the theoretical techniques used to analyze the free vibration of cooling towers has been presented. It has been observed that, in general, theoretical resonant frequencies are significantly higher than corresponding experimental values. Thus resonant stresses, which are more difficult to calculate accurately than resonant frequencies, would be suspect. Two aspects of many of the theoretical analyses that result in unquantifiable errors are analyzing the model cooling tower as an idealized axisymmetric structure and inaccurate modeling of the discrete nature of the column-supports at the base of the tower.

Accurate representation of the column-supports, however, has been seen to lead to a large number of degrees of freedom that require excessive computer time. The property of rotational periodicity exhibited by a cooling tower has been of value in reducing computer time and results in good agreement between calculated and experimental values.

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BOOK REVIEWS

LARGE GROUND MOVEMENTS AND STRUCTURES

J.D. Geddes, Editor
John Wiley and Sons, Toronto, New York, 1978

Professor Geddes has systematically arranged a large number of papers presented at a conference held in Cardiff. The book is a general survey and contains illustrations of surface and near-surface ground movements that occur as a result of extraction of coal and tunnelling. The effects of such movements on structures are also illustrated. The estimation and measurement of such movements in different soil conditions are emphasized. Mathematical complexities have been avoided insofar as possible. The book is a welcome addition to the technology of large ground movements and structures. The reviewer feels that the book will serve as a valuable guide to both engineers and theoreticians.

S. De
Old Engineering Office
Santiketan
Birbum, W. Bengal
India

FRACTURE OF COMPOSITE MATERIALS

G.C. Sih and V.P. Tamuzs, Editors
Sijthoff & Noordhoff, The Netherlands, 1979

This book contains the proceedings of the first USA-USSR symposium on the fracture of composite materials. The meeting was held at the Hotel Jurmola, Riga, USSR on September 4-7, 1978.

The intent of the symposium was to bring together a small group of experts in the field of fracture of composite materials to 1) review the fundamentals of the subject, 2) discuss the problem areas, and 3) display current developments. The need to share this information with all those currently working in this field was accomplished by publishing the symposium proceedings. The 33 technical papers treat many aspects of theoretical and experimental fracture of composite materials. Both microscopic and macroscopic cracking are addressed. The editors have classified the contents into the following five sections:

- Microfracture
- Statistical and Analytical Methods
- Fracture Analysis
- Failure Analysis
- Experimental Analysis

This book is an excellent general reference for information concerning the fracture of composite materials. It should be stressed that a complete and detailed treatment of all aspects of this field cannot be contained in a single publication. However, if one supplements the material of this book with the information referenced in the various bibliographies, a complete treatment of the subject of fracture of composites is available.

S.E. Benzley
Applied Mechanics Division II
Division 5522
Sandia National Laboratories
Albuquerque, New Mexico 87185

MODERN FORMULAS FOR STATICS AND DYNAMICS

W.D. Pilkey and Pin Yu Chang
McGraw-Hill Book Co., New York, New York, 1978

This book differs from a number of other books of a similar nature in that it describes the use of advanced equations in dynamics and statics. Although directions for writing large computer programs are given, the book does not contain any programs; rather, programs developed by the Structural Members Users Group are referred to. However, the equations needed to write programs for solving statics and dynamics problems are given. The authors use the transfer matrix approach and do not consider the finite element approach.

The book contains 14 chapters and two appendices. Chapter I contains descriptions of beams, plates, shells, and stresses. Modeling of complex structures is also given. Chapter II considers all types of beams -- columns, beams of variable area, thermally loaded beams, and beams on elastic foundations. Equations that are developed include one for shear deformation. Various boundary conditions and the way in which they can be implemented in transfer function matrix equations are discussed. Modeling for both static and dynamic equations, including time-dependent acceleration (transient response), is given, as is the application of Voigt-Kelvin materials. Results of computer solutions to such beam problems as columns and frequency analysis of a drilling platform are presented. The reviewer considers this a well done chapter that the analyst will be able to use. One significant omission is a detailed listing of a simple computer program.

Chapters III and IV contain descriptions of torsional and longitudinal static and dynamic problems and their solutions. The authors derive the necessary equations. Applications of geared systems in torsion and extensional springs in longitudinal are illustrated in computer program output.

Chapter V is concerned with torsion of thin-walled beams, including warping stresses of I beams, angles of twist are derived. Dynamic response to arbitrary loading, including non-proportional damping, is considered.

Chapter VI is a short chapter on rotating shafts; bearing stiffness (isotropic and multi-plane) and shear deformation are covered. Uncoupled equations are considered for isotropic bearings and applied to unbalance response, critical speeds, and transient response. In the reviewers opinion the chapter should have been expanded to include bearings on pedestal loading, different types of bearings and their spring constants, shafts passing through resonance, and subsynchronous torsional response problems in large machines.

Chapters VII and VIII contain short discourses on gridwork and a discussion on discs. This important structural element of turbines and other rotating equipment is considered to be either rotating, applied by external pressure, shrink-fit, or in segments. The complex disc equations -- including static and dynamic response with no damping or proportional damping -- are derived and expressed in transfer matrix form.

Chapters IX and X have to do with thick cylinders and thick spherical shells, various stresses (static and thermal), and complex shapes. Natural frequencies of cylinders are considered.

Chapters XI and XII are concerned with circular and rectangular plates. Many of the formulas are found in books on elasticity, plates, and shells; the authors have derived and stated them in transfer matrix form. Both static and dynamic aspects of complex plates are considered.

Chapters XIII and XIV contain a discussion of thin-walled cylinders and cross-sectional static problems of open-type beam elements. The transfer matrix formulation again is used for natural frequencies of complex cylinders and beams.

In summary, this is an excellent book but some detailed computer programs would have enhanced its value. A short discussion on the relationship between finite elements and transfer matrices should have been included. The reviewer recommends this book to designers and engineers involved in structural design.

H. Saunders
General Electric Company
Schenectady, New York 12345

BOOK REVIEWS: 1980

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SHORT COURSES

DECEMBER

MODAL ANALYSIS, SUBSTRUCTURING AND TESTING

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

BLASTING AND EXPLOSIVES SAFETY TRAINING

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.

VIBRATION AND SHOCK SURVIVABILITY, TESTING, MEASUREMENT, ANALYSIS, AND CALIBRATION

Dates: December 8-12, 1980
Place: Anaheim, California
Dates: February 2-6, 1981
Place: Santa Barbara, California
Dates: March 2-6, 1981
Place: Washington, D.C.
Dates: April 6-10, 1981
Place: Boston, Massachusetts
Dates: May 18-22, 1981
Place: Syosset, New York
Dates: August 24-28, 1981
Place: Santa Barbara, California
Dates: October 5-9, 1981
Place: Bournemouth, England
Objective: Topics to be covered are resonance and fragility phenomena, and environmental vibration and shock measurement and analysis, also vibration and shock environmental testing to prove survivability. This course will concentrate upon equipments and techniques, rather than upon mathematics and theory.

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

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.

FEBRUARY

MACHINERY DATA ACQUISITION

Dates: February 2-6, 1981
June 1-5, 1981
August 3-7, 1981
September 28-October 2, 1981
December 7-11, 1981
Place: Carson City, Nevada
Objective: This seminar is designed for people whose function is to acquire machinery data for dynamic analysis, using specialized instrumentation, and/or that person responsible for interpreting and analyzing the data for the purpose of corrective action on machines. Topics include measurement and analysis parameters, basic instrumentation review, data collection and reduction techniques, fundamental rotor behavior, explanation and symptoms of common machinery malfunctions, including demonstrations and case histories. The week also includes a lab workshop day with hands-on operation of the instrumentation and demonstration units by the participants.

Contact: Marketing Training Department, Bently-Nevada Corporation, P.O. Box 157, Minden, Nevada 89423 - (702) 782-3611, Extension 224.

ROTOR DYNAMICS ENGINEERING

Dates: February 16-18, 1981
Place: Daytona Beach, Florida
Objective: This intensive course has been especially designed for specialists, engineers, and scientists working in industrial and governmental facilities involved with rotor dynamics. This course provides participants with an understanding of the principles of rotor dynamics and the application of these principles to practical problems in rotor dynamics engineering.

Contact: Union College, Office of Graduate Studies, 1 Union Avenue, Schenectady, NY 12308 - (518) 370-6288.

APPLIED VIBRATION ENGINEERING

Dates: February 16-18, 1981
Place: Daytona, Beach, Florida
Objective This intensive course is designed for specialists, engineers and scientists working in industrial, governmental and educational institutions involved with design against vibration or solving of existing vibration problems. This course provides participants with an understanding of the principles

of vibration and the application of these principles to practical problems of vibration reduction.

Contact: Union College, Office of Graduate Studies, 1 Union Avenue, Schenectady, NY 12308 - (518) 370-6288.

MARCH

MACHINE PROTECTION

Dates: March 3-4, 1981
Place: Houston, Texas
Dates: April 22-23, 1981
Place: Chicago, Illinois
Dates: April 28-29, 1981
Place: Buffalo, New York
Dates: May 6-7, 1981
Place: Edmonton, Alberta, Canada
Dates: September 16-17, 1981
Place: New Orleans, Louisiana
Dates: October 20-21, 1980
Place: Houston, Texas
Dates: October 27-28, 1981
Place: Pittsburgh, Pennsylvania
Objective: This is our most basic seminar. It provides an in-depth examination of proximity measurement, probe installation techniques, and monitoring systems including types, functions, and calibration procedures. In addition, Bently-Nevada provides an overview of some of the instrumentation used for vibration analysis including oscilloscopes, scope cameras, and specialized filter instruments. The seminar is designed for those individuals responsible for installation and proper operation of in-place monitoring systems - maintenance technicians, instrument engineers, and operators.

Contact: Marketing Training Deoartment, Bently-Nevada Corporation, P.O. Box 157, Minden, NV 89423 - (702) 782-3611, Extension 224.

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.

MECHANICAL ENGINEERING

Dates: March 30 - April 3, 1981
August 31 - September 4, 1981
Place: Carson City, Nevada
Objective: This is our most comprehensive presentation of rotor dynamics theory, and machinery malfunction descriptions and demonstrations. A guest speaker in the field of rotor dynamics is invited to present the theoretical portion of the seminar. A full day will be spent in a rotor lab workshop allowing individual instruction and operation of the demonstration units. This session is designed for the mechanical engineer who has responsibility for the proper operation of major rotating machinery.

Contact: Marketing Training Department, Bently-Nevada Corporation, P.O. Box 157, Minden, NV 89423 - (702) 782-3611, Extension 224.

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

INSTITUTE OF ENVIRONMENTAL SCIENCES
ANNUAL TECHNICAL MEETING
May 4-7, 1981
Los Angeles Marriott

The interrelated disciplines represented by the Institute of Environmental Sciences is being summarized in the 1981 Annual Technical Meeting theme, "Emerging Environmental Solutions for the Eighties". The four comprehensive seminars being presented for the three days of the meeting will present the progress to date, establish the current state-of-the-art, define interrelationships and project the next decade's technology needs and resources.

The principle issues and concerns of the next decade include electronic and mechanical hardware reliability and acquisition, contamination, energy effects and their associated economics, and environmental regulations.

Electronic and mechanical hardware reliability, acquisition, and life cycle solutions require increased involvement by the environmental science disciplines. This is especially true in government projects and will require new and unique solutions.

Contamination control in aerospace, medicine, and associated disciplines will require re-reassessment, reanalysis of controversial isues and definition of structured technical tasks necessary to resolve the problems of the 80's.

The development of a cohesive energy policy and plan and the associated economic factors is a vital necessity for a progressive technology. Many controversial technical factors are involved in the resolution of these issues.

Ecological and environmental management concepts and programs will require new and unique solutions in the decade of the 80's in the face of competitive social, political and economic forces.

Over fifty percent of the exhibit hall has been reserved. The firms exhibiting are those whose products measure, control, simulate, study or improve the environments, and/or are directly involved in all phases of environmental and non-destructive testing. Firms with products in the contamination control/bioscience and energy-related fields will also be exhibiting. Designated hours for visiting the exhibit floor have been set aside each day.

Topics of interest in the four comprehensive seminars on May 5, 6, and 7 are:

Environmental Stress Impact on Hardware Life Cycle

- Challenge of the 80's Panel
- Specifications and Standards (MIL-STD-810D, -781D, -883B, etc.)
- Environmental Stress Screening
- Successful Test Tailoring
- Combined Environmental Testing
- Environmental Analysis
- Environmental Reliability Testing
- Irwin Vigness Memorial Colloquium (Dr. A.J. Curtis, Hughes Aircraft)
- Environmental Test Procedures
- Environmental Test Management

Environmental Engineering Methods and Technology

- Challenge of the 80's Panel
- Low Cost Vibration Testing
- Reliability Growth
- Model Testing
- Environmental Reliability Honors Colloquium (Cornelius Mandel, Hughes Aircraft)
- Reliability Analysis and Environmental Integration
- Digital Control and Processes
- Instrumentation

For further information, contact Institute of Environmental Sciences, 940 East Northwest Highway, Mt. Prospect, IL 60056 · (312) 255-1561.

ABSTRACT CATEGORIES

MECHANICAL SYSTEMS

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

STRUCTURAL SYSTEMS

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

VEHICLE SYSTEMS

Ground Vehicles
Ships
Aircraft
Missiles and Spacecraft

BIOLOGICAL SYSTEMS

Human
Animal

MECHANICAL COMPONENTS

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

STRUCTURAL COMPONENTS

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

ELECTRIC COMPONENTS

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

DYNAMIC ENVIRONMENT

Acoustic Excitation
Shock Excitation
Vibration Excitation
Thermal Excitation

MECHANICAL PROPERTIES

Damping
Fatigue
Elasticity and Plasticity

EXPERIMENTATION

Measurement and Analysis
Dynamic Tests
Scaling and Modeling
Diagnostics
Balancing
Monitoring

ANALYSIS AND DESIGN

Analogs and Analog Computation
Analytical Methods
Modeling Techniques
Nonlinear Analysis
Numerical Methods
Statistical Methods
Parameter Identification
Mobility/Impedance Methods
Optimization Techniques
Design Techniques
Computer Programs

GENERAL TOPICS

Conference Proceedings
Tutorials and Reviews
Criteria, Standards, and Specifications
Bibliographies
Useful Applications

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. 2652, 2686, 2687, 2689, 2715, 2727, 2728, 2751, 2752, 2753)

80-2586

On Synchronization of Rotating Machines with Alternating Flow Hydraulics (Part 1. Synchronizing Rotating Motion under Limited Power Source)

Y. Tanaka

Mech. Engrg. Research Lab., Hitachi Ltd., Kandatsu-cho, Tsuchiurashi, Ibaraki, Japan, Bull. JSME, 23 (180), pp 970-976 (June 1980) 10 figs, 1 table, 8 refs

Key Words: Rotating structures, Synchronous motors, Periodic response

Synchronization of rotating machines connected by alternating flow hydraulics is discussed. Taking account of the interaction between driving and driven machines, synchronization phenomena are analyzed by the averaging method and the synchronizing phase angles are derived. The stability of the steady-state solution is investigated and the influence of initial conditions on the steady-state rotating motion is considered on the phase plane; critical domain is discussed.

80-2587

The Long Period Testing of Rotor Systems

T.K. Ziberkas and A. Jurkauskas

Kaunas Antanas Snieckus Polytechnical Inst., Kaunas, Lithuania, Vibrotechnika, 5 (29), pp 49-55 (1977) 6 figs, 2 refs, Kaunas A. Snieckus Politechnical Institute, Kaunas, Lithuanian SSR, 1979
(In Russian)

Key Words: Rotors (machine elements), Rotor-bearing systems, Dynamic tests

The results of long period rotor system testing are presented in this paper. The operating conditions of a rotor system are described and parameters taken. Conclusions evaluating the efficiency of a bearing unit are given.

80-2588

Vibration of a Shaft Passing through a Critical Speed (4th Report: Effect of Gyroscopic Moment)

S. Yanabe

Tokyo Inst. of Tech., Meguro-ku, Tokyo. Japan, Bull. JSME, 23 (180), pp 945-952 (June 1980) 6 figs, 5 tables, 13 refs

Key Words: Shafts (machine elements), Critical speed

Effects of the gyroscopic moment on the nonstationary vibration which occurs when a rotor passes through its critical speed at a uniform acceleration rate are analyzed. Formulas for the imaginary acceleration rate and maximum amplitude are derived by considering both the nonstationary vibration of a single-degree-of-freedom system and the change of the natural frequency of the gyroscopic system. Estimated maximum amplitudes are compared with numerical ones.

RECIPROCATING MACHINES

80-2589

Surface Acoustical Intensity Measurements on a Diesel Engine

M.C. McGary and M.J. Crocker

NASA Langley Res. Ctr., Langley Station, VA, Rept. No. NASA-TM-81807, 18 pp (Apr 1980), 99th ASA Mtg., Atlanta, Apr 21-25. 1980
N80-25103

Key Words: Diesel engines, Noise source identification

The use of surface intensity measurements as an alternative to the conventional selective wrapping technique of noise source identification and ranking on diesel engines is investigated. Results are compared by plotting sound power level against frequency and noise source rankings for the two methods.

POWER TRANSMISSION SYSTEMS

80-2590

The Optimization of Free-Loop Cassettes Used for Tape Drive Mechanisms

P. Varanauskas

Kaunas Antanas Snieckus Polytechnical Inst., Kaunas, Lithuania, Vibrotechnika, 5 (29), pp 57-62 (1977)

3 figs, 5 refs, Kaunas A. Snieckus Politechnical Institute, Kaunas, Lithuanian SSR, 1979
(In Russian)

Key Words: Tape drives, Optimization

The changes of free loops moving in a cassette are investigated. Formulas defining the relationship of cassette shape to free loop mechanisms and motion parameters are given.

METAL WORKING AND FORMING

80-2591
Dynamic Stiffness of Machine Tool Feed Driving System (1st Report. Theoretical Analysis of the Damping Capacity of Slideway)
S. Shiozaki, Y. Furukawa, and M. Mizukane
Faculty of Engrg., Tokyo Metropolitan Univ., Tokyo, Japan, Bull. JSME, 23 (180), pp 991-996 (June 1980) 7 figs, 7 refs

Key Words: Machine tools, Coulomb friction, Viscous damping, Dynamic stiffness

The theory that Coulomb friction acting on a slideway of machine tool has the ability to damp a fluctuating external force, thus consuming the same amount of energy with the friction during one period of vibration, is investigated. It is shown that the dynamic stiffness of a feed driving system attached with a hydrodynamic slideway, which usually possesses Coulomb friction, can be theoretically estimated if the corresponding equivalent damping is considered by the present theory.

80-2592
Dynamic Stiffness of Machine Tool Feed Drive System (2nd Report. Experimental Evaluation of the Damping Capacity of Slideway)
M. Mizukane, Y. Furukawa, and S. Shiozake
Faculty of Engrg., Tokyo Metropolitan Univ., Tokyo, Japan, Bull. JSME, 23 (180), pp 997-1002 (June 1980) 13 figs, 4 refs

Key Words: Machine tools, Coulomb friction, Viscous damping, Dynamic stiffness

A feed driving model facilitated with a hydrodynamic, half-floating, or hydrostatic slideway is prepared and its dynamic stiffness measured under various conditions. Results of the experiment are examined.

80-2593
A Fundamental Relationship between Force Waveform and the Sound Radiated from a Power Press during Blanking or Piercing
H.A. Evensen
Dept. of Mech. Engrg. and Engrg. Mechanics, Michigan Technological Univ., Houghton, MI 49931, J. Sound Vib., 68 (3), pp 451-463 (Feb 8, 1980) 4 figs, 14 refs

Key Words: Presses, Metal working, Noise generation

A relationship between an equivalent continuous noise level received near a machine structure and the derivatives of its transient excitation history is derived from fundamental principles. Data from a multi-parameter study of power press tooling is used to test this relationship.

MATERIALS HANDLING EQUIPMENT

80-2594
Vibrational Characteristics of Cordon-Trained Grape Vines
M. Loghavi
Ph.D. Thesis, Univ. of California, 281 pp (1979)
UM 8016768

Key Words: Grape vines, Dynamic properties, Vibration response, Agricultural machinery, Vibratory techniques

An investigation of the physical properties of grape vines was undertaken as the first part of this study. The investigation included the measurement of modulus of elasticity, modulus of rigidity, specific mass and damping coefficient. Regression equations between the cane, cordon and trunk bending stiffness, torsional rigidity, modulus of elasticity and shear modulus and average specimen diameter were determined. In the second part of the study, field experiments were conducted to investigate the vibrational characteristics of Grenache vines trained as bilateral cordons. Finally, the vibrational response of the vines were simulated by considering a physical model and formulating the governing equations of motion of the cordons assuming only lateral and twisting modes. A computer program was developed to solve the system of differential equations of motion.

STRUCTURAL SYSTEMS

BRIDGES

80-2595

Vehicle Braking on Highway Bridges

R.K. Gupta and R.W. Traill-Nash
The Papua New Guinea Univ. of Tech., Lae, Papua, New Guinea, ASCE J. Engr. Mech. Div., 106 (EM4), pp 641-658 (Aug 1980) 12 figs, 8 refs

Key Words: Bridges, Braking effects, Interaction: vehicle-structure

Highway bridges are idealized as beams as well as orthotropic plates. A standard HS-20-44 highway vehicle is represented by a planar, two axle, sprung mass system with frictional device. The response equations are derived in terms of the natural modal coordinates of the bridge and of displacement coordinates of the vehicle. The bridge dynamic loading due to vehicle braking is investigated for symmetric as well as eccentric loading of vehicle.

BUILDINGS

(Also see Nos. 2744, 2747)

80-2596

An Ultimate Approach to Cumulative Seismic Damage

A. Baratta
Istituto di Scienza delle Costruzioni, Facolta di Ingegneria, Universita di Napoli, Meccanica, 14 (2), pp 79-89 (June 1979) 13 figs, 8 refs

Key Words: Buildings, Seismic design, Earthquake damage

An investigation into the seismic reliability of structures during earthquakes is presented. Analysis of behavior of structures under the decisive quake is stressed, and the possibility to derive safety statements by inspecting the way the structure collapses is proven with regard to a simple structural pattern.

80-2597

A Model of Audio-Frequency Vibration of Buildings

J. Lubliner
Dept. of Civil Engrg., Univ. of California, Berkeley, CA 94720, J. Sound Vib., 68 (3), pp 335-340 (Feb 8, 1980) 6 refs

Key Words: Buildings, Audio-frequencies, High frequency excitation, Acoustic excitation

A model is proposed wherein audio-frequency vibrations in buildings are transmitted by column motion in the fixed-fixed mode. Transmission and attenuation depend on the relative tuning of neighboring story columns.

80-2598

Structural Building Response Review: Seismic Safety Margins Research Program. Volume I.

J.J. Healey, S.T. Wu, and M. Murga
Lawrence Livermore Lab., California Univ., Livermore, CA, Rept. No. NUREG/CR-1432-V-1, 189 pp (May 1980)

Key Words: Buildings, Seismic response

Structural modeling including methods of discretization, basic modeling approaches and decoupling are described. Various methods of linear and nonlinear structural dynamic analysis, numerical methods, damping, etc. are given. A discussion of the nonlinearity as it relates to nuclear plant structures is presented. The subject of combining seismic and nonseismic load effects with particular reference to the state-of-the-art in this area as related to the probabilistic methodology is treated. A summary of the various sources of uncertainty in seismic dynamic analysis together with a discussion of the sources of data available to quantitatively define these uncertainties is presented.

80-2599

Structural Building Response Review: Seismic Safety Margins Research Program. Volume II

A.K. Singh, T.I. Hsu, and T.P. Khatua
Lawrence Livermore Lab., California Univ., Livermore, CA, Rept. No. NURLG-CR-1423-V-2, 239 pp (May 1980)

Key Words: Buildings, Seismic analysis, Interaction: soil-structure, Nuclear power plants

This report describes the structural response analysis method, including the structural model, soil-structure-interaction as it relates to structural models, methods for seismic structural analysis, numerical integration methods, methods for non-seismic response analysis approaches to combine various responses, structural damping values, nonlinear response, uncertainties in structural properties, and structural response analysis using random properties. The report presents the state-of-the-art in these areas for nuclear power plants.

80-2600

Investigation of the Effect of 3-D Parametric Earthquake Motions on Stability of Elastic and Inelastic Building Systems. Report No. 1

F.Y. Cheng and P. Kitipitayangkul

Dept. of Civil Engrg., Missouri Univ., Rolla, MO, Rept. No. CIVIL ENGINEERING STUDY-79-10; NSF/RA-790399, 396 pp (Aug 1979)

PB80-176936

Key Words: Buildings, Seismic excitation, Computer programs

The effect of interacting, three-dimensional ground motions on the response behavior of elastic and inelastic building systems is investigated. A computer program has been comprehensively developed for achieving efficiency in both computation and data preparation. A total of 26 numerical examples have been studied for various low-rise and high-rise building systems, which show that an interacting ground motion can significantly increase internal forces, nodal displacements, ductilities, and seismic input and dissipated energy.

80-2601

Prediction of Earthquake Resistance of Structures

P.C.Wang

Polytechnic Inst. of New York, Brooklyn, NY, Rept. No. NSF/TA-800013, 200 pp (Jan 1980)

PB80-170731

Key Words: Buildings, Seismic response

The prediction of structural resistance to earthquakes provides the focus of this report. Particular attention is paid to developing an upper bound or critical ground excitation for a structure of major importance, so that a high level of confidence in the prediction of structural resistance may be achieved.

80-2602

Tall Building Response to Earthquake Excitations

J.N. Yang, Y.K. Lin, and S. Sae-Ung

George Washington Univ., Washington, D.C., ASCE J. Engr. Mech. Div., 106 (EM4), pp 801-817 (Aug 1980) 5 figs, 20 refs

Key Words: Buildings, Earthquake response

Under external excitations, a multistory building structure responds in both translation and torsion. The two types of motion are normally coupled and importance of this coupling effect is explored using a transfer matrix formulation. An eight-story building with a moderate degree of eccentricity is used as a numerical example.

FOUNDATIONS

(Also see Nos. 2630, 2631, 2632)

80-2603

Thread Friction on a Vibrating Support

A. Abromaitis, L. Valkunas, and S. Girsovicius

Puntukas, PKB, Vilnius, Lithuania, Vibrotechnika, 5 (29), pp 129-135 (1977), 5 figs, 6 refs, Kaunas A. Snieckus Politechnical Institute, Kaunas, Lithuanian SSR, 1979

(In Russian)

Key Words: Supports, Vibrating foundations, Friction damping

The problem of thread friction on a high-frequency vibrating support is considered. The thread elasticity and viscosity are taken into account. The methods used in this experimental investigation are described.

80-2604

Doubly-Asymptotic Boundary-Element Analysis of Nonlinear Soil-Structure Interaction

P.G. Underwood and T.L. Geers

Palo Alto Research Lab., Lockheed Missiles and Space Co., Inc., Palo Alto, CA, Rept. No. LMSC/D673964, DNA-4953F, AD-E300 725, 69 pp (June 1979)

AD-A083 330/1

Key Words: Interaction: soil-structure, Finite element technique, Nonlinear theories

A doubly-asymptotic, boundary-element treatment of a surrounding nonlinear soil medium for dynamic soil-structure interaction analysis is described. Linear soil-structure interaction is reduced to a surface relationship that is asymptotically exact at both high and low frequencies. Nonlinear soil-structure interaction is treated similarly, except a volume contribution is added in the volume; a quasi-static and quasi-dynamic (axisymmetric) problem for which finite-element solutions have been obtained for comparison.

HARBORS AND DAMS

80-2605
On the Damping of Non-Resonant Wave Agitation in Small Craft Harbours
D.A.Y. Smith
Ph.D. Thesis, Queen's Univ. at Kingston, Canada (1980)

Key Words: Harbors, Water waves, Damping

The effect of damping on non-resonant wave agitation has been studied, with particular emphasis on problems and conditions associated with small craft harbors. The experimental and theoretical results have been compared, and good agreement between the two has been shown.

POWER PLANTS

(Also see Nos. 2599, 2647, 2653)

80-2606
Seismic Review Table
M. Subudhi, M. Reich, B. Koplik, and J. Lane
Brookhaven National Lab., Upton, NY, Rept. No. NUREG/CR-1429, 300 pp (May 1980)

Key Words: Nuclear power plants, Seismic analysis, Seismic design

The Seismic Review Table is a summary of engineering design parameters that were employed in the seismic analysis and design of nuclear power plants. The table covers 71 reactors licensed to operate by the U.S.N.R.C. The goal of the Seismic Review Table is to provide a reference of the available information relevant to the seismic design of currently licensed nuclear power plants.

80-2607
Methods and Benefits of Experimental Seismic Evaluation of Nuclear Power Plants
P. Ibanez, G. Howard, C. Smith, W. Gundy, and W. Walton
Lawrence Livermore Lab., California Univ., Livermore, CA, Rept. No. NUREG/CR-1443, 125 pp (Apr 1980)

Key Words: Nuclear power plants, Seismic design, Vibration tests, Testing techniques, Test equipment and instrumentation, Natural frequencies, Mode shapes, Vibration damping

This study reviews experimental techniques, instrumentation requirements, safety considerations, and benefits of performing vibration tests on nuclear power plant containments and internal components. The emphasis is on testing to improve seismic structural models. Techniques for identification of resonant frequencies, damping, and mode shapes are discussed. The benefits of testing with regard to increased and more accurate computer models are outlined. A test plan, schedule, and budget are presented for a typical PWR nuclear power plant.

80-2608
Verifying Seismic Design of Nuclear Reactors by Testing
B. Barclay, J.A. Malthan, S.F. Masri, and F.B. Safford
Lawrence Livermore Lab., California Univ., Livermore, CA, Rept. No. NUREG/CR-1442, 168 pp (Apr 1980)

Key Words: Nuclear power plants, Seismic design, Testing techniques

The purpose of the study is to develop a program plan to provide assurance by physical demonstration that nuclear power plants are earthquake resistant and to allow nuclear power plant operators to decide whether tests should be conducted on their facilities, specify the tests that should be performed, and estimate the cost of the effort to complete the recommended test program.

VEHICLE SYSTEMS

GROUND VEHICLES

80-2609
Statistical Estimation of Road Traffic Noise in an Arbitrary Sound Propagation Environment by Use of Stratonovich's Theory for a Random Points System

M. Ohta, S. Yamaguchi, and A. Ikuta
Dept. of Electrical Engrg., Hiroshima Univ., Hiroshima, Japan, J. Sound Vib., 69 (2), pp 275-284 (Mar 22, 1980) 1 fig, 13 refs

Key Words: Traffic noise, Statistical analysis, Stochastic processes

This paper is devoted to considering the relationships between the multi-dimensional correlation properties of sound intensity and the higher order information on the flow of vehicles by use of Stratonovich's stochastic theory for a random points system. The relationships between the theoretical results and those of well-known previous studies are discussed for several lower order moments.

80-2610
Post-Test Blast Response Analyses of DICE THROW Vehicles
K.R. Wetmore
Kaman Avidyne, Burlington, MA, Rept. No. KA-TR-150; ARBRL-CR-00413, 125 pp (Jan 1980)
AD-A083 436/6

Key Words: Trucks, Blast response, Computer programs

Results of a blast response study of select truck configurations fielded in the DICE THROW test are summarized. Using the TRUCK computer code, the response time-histories of four different Army wheeled vehicle systems exposed to both blast overpressure and dynamic pressure loadings were obtained. Important motions of the total systems subsequent to blast wave interception, particularly vehicle overturning, are plotted.

80-2611
Whirl and Critical Speeds of Flywheel-Container Systems Aboard Vehicles
G. Genta and M. Gola
Istituto alla Motorizzazione, Politecnico di Torino, Torino, Italy, Meccanica, 14 (1), pp 55-61 (Mar 1979) 7 figs, 9 refs

Key Words: Whirling, Critical speed, Mountings, Flywheels, Ground vehicles

Container-flywheel systems for road vehicles can be mounted in a variety of ways on the vehicle's body, thus allowing large or small displacements. In the case of steady precession kinematic conditions are obtained for both large and small displacements. Dynamic analysis in the small displacement case is then tested against a complete non-linear simulation model, previously used for studies on flywheel bus dynamics. Whirling and critical speeds are obtained and discussed.

AIRCRAFT

(Also see Nos. 2623, 2624, 2627, 2628, 2642, 2699)

80-2612
On the Growth Rate of Bending Induced Edge Cracks in Panels Excited by Convected Random Pressure Fields
K.P. Byrne
School of Mechanical and Industrial Engrg., Univ. of New South Wales, Kensington, New South Wales 2033, Australia, J. Sound Vib., 68 (2), pp 161-171 (Jan 22, 1980) 9 figs, 8 refs

Key Words: Aircraft, Acoustic excitation, Fatigue life

The emphasis of the work described in this paper is on devising a method of predicting the growth rate of an edge crack in a panel which is excited by a convected random pressure field.

80-2613
Analytical Study of Interior Noise Control by Fuselage Design Techniques on High-Speed, Propeller-Driven Aircraft (Final Report, July 1978 - Dec 1979)
J.D. Revell, F.J. Balena, and L.R. Koval
Lockheed-California Co., Burbank, CA, Rept. No. NASA-CR-159222, 174 pp (Apr 4, 1980)
N80-25105

Key Words: Aircraft noise, Propeller noise, Noise reduction

Acoustical treatment mass penalties required to achieve an interior noise level of 80 dBA for high speed, fuel efficient propfan-powered aircraft are determined. The prediction method used is based on theory developed for the outer shell dynamics, and a modified approach for add-on noise control element performance. The present synthesis of these methods is supported by experimental data. Three different sized aircraft are studied, including a wide body, a narrow body and a business sized aircraft.

80-2614

Interior Noise Control Prediction Study for High-Speed Propeller-Driven Aircraft

D.C. Rennison, J.F. Wilby, A.H. Marsh, and E.G. Wilby

Bolt, Beranek and Newman, Inc., Canoga Park, CA, Rept. No. NASA-CR-159200, 307 pp (Sept 1979)
N80-25102

Key Words: Aircraft noise, Interior noise, Noise prediction, Noise reduction

An analytical model was developed to predict the noise levels inside propeller-driven aircraft during cruise at M = 0.8. The model was applied to three study aircraft with fuselages of different size in order to determine the noise reductions required to achieve the goal of an A-weighted sound level which does not exceed 80 dB. The model was then used to determine noise control methods which could achieve the required noise reductions.

80-2615

Radiation in a Wall Jet Flow Environment

R. Ramakrishnan

Joint Inst. for Advancement of Flight Sciences, NASA Langley Res. Ctr., Hampton, VA 23665, J. Sound Vib., 68 (3), pp 389-405 (Feb 8, 1980) 5 figs, 2 tables, 20 refs

Key Words: Aircraft noise, Noise reduction, Acoustic liners

An analytical study of sound propagation through a wall jet flow with compliant walls is carried out. The prime objective of this study is to evaluate the influences of flow convection and refraction due to non-uniform mean flow on sound radiation. Another major aim is to calculate the nature of acoustic attenuation attributable to finite wall admittances. A two-dimensional model is used in the analysis.

80-2616

Analyses of Pressure Oscillations in an Open Cavity

W.L. Hankey and J.S. Shang

Air Force Flight Dynamics Lab., Wright-Patterson Air Force Base, OH, AIAA J., 18 (8), pp 892-898 (Aug 1980) 15 figs, 1 table, 18 refs

Key Words: Aircraft, Self-excited vibration, Cavity resonators

The purpose of this study is to obtain numerical solutions of the Navier-Stokes equations for an open cavity in order to provide a new tool for the analysis of pressure oscillations.

80-2617

Maximum Likelihood Method for Estimating Airplane Stability and Control Parameters from Flight Data in Frequency Domain

V. Klein

NASA Langley Res. Ctr., Langley Station, VA, Rept. No. NASA-TP-1637, 60 pp (May 1980)
N80-24323

Key Words: Aircraft, Parameter identification technique, Frequency domain method

A frequency domain maximum likelihood method is developed for the estimation of airplane stability and control parameters from measured data. The model of an airplane is represented by a discrete-type steady state Kalman filter with time variables replaced by their Fourier series expansions. The likelihood function of innovations is formulated, and by its maximization with respect to unknown parameters the estimation algorithm is obtained. This algorithm is then simplified to the output error estimation method with the data in the form of transformed time histories, freqency response curves, or spectral and cross-spectral densities.

80-2618

Flutter Analysis of an Airplane with Multiple Structural Nonlinearities in the Control System

E.J. Breitbach

NASA Langley Res. Ctr., Langley Station, VA, Rept. No. NASA-TP-1620, 39 pp (Mar 1980)
N80-24324

Key Words: Aircraft, Flutter, Nonlinear response, Equivalent linearization method

It is demonstrated how the equivalent linearization approach can be extended to rather complicated systems with multiple sets of strongly interacting, concentrated nonlinearities. An airplane with nonlinear control characteristics is used as an example.

80-2619

The Design, Testing and Evaluation of the MIT Individual-Blade-Control System as Applied to Gust Alleviation for Helicopters

R.M. Mckillip, Jr.

Aeroelastic and Structures Res. Lab., Massachusetts Inst. of Tech., Cambridge, MA, Rept. No. NASA-CR-152352, 92 pp (Feb 1980)
N80-22357

Key Words: Helicopter rotors, Rotary wings, Active control, Wind induced excitation

A type of active control for helicopters was designed and tested on a four foot diameter model rotor. A single blade was individually controlled in pitch in the rotating frame over a wide range of frequencies by electromechanical means. By utilizing a tip mounted accelerometer as a sensor in the feedback path, significant reductions in blade flapping response to gust were achieved at the gust excitation frequency as well as at super and subharmonics of rotor speed.

MISSILES AND SPACECRAFT

(Also see No. 2750)

80-2620

Dynamics of Tethered Satellites, Two Alternative Concepts for Retrieval

E. Allais and S. Bergamaschi

Settore Spazio, Aeritalia, Torino, Meccanica, 14 (2), pp 103-111 (June 1979) 14 figs, 6 refs

Key Words: Spacecraft, Satellites, Space shuttles, Vibration damping

The dynamics of a satellite connected to the space shuttle by means of a tether during its retrieval is studied. Two methods of recovery are given.

80-2621

Spacecraft Structural Acoustic Studies: The Development of a Practical Prediction Technique for Noise Induced Structural Vibration and Sound Transmission

R.J. Cummins and W. Cooper

British Aerospace Aircraft Group, Bristol, UK, Rept. No. EAS/B44-7/0712, ESA-CR(P)01264, 200 pp (June 1979)

N80-22052

Key Words: Spacecraft, Noise-induced excitation, Vibration response, Sound transmission, Statistical energy analysis, Computer programs

A prediction method was developed for noise induced structural vibration and sound transmission based on the concepts of statistical energy analysis (SEA). A general statistical energy program was written in FORTRAN ANS language which is capable of solving problems modeled by the SEA techniques. An experimental program was also performed in order to establish necessary SEA parameters for a range of typical spacecraft structural components.

80-2622

Dynamics of Rotationally Periodic Large Space Structures

T.J. McDaniel and K.J. Chang

Dept. of Aerospace Engrg., Iowa State Univ., Ames, IA 50010, J. Sound Vib., 68 (3), pp 351-368 (Feb 8, 1980) 4 figs, 2 tables, 24 refs

Key Words: Spacecraft, Periodic structures, Transfer matrix method, Frequency response

A finite element transfer matrix method employed to eliminate internal degrees of freedom from the basic unit of a rotationally periodic space structure is analyzed. Eigenfunctions of the resulting periodic unit transfer matrix are used to obtain frequency responses of the complete structure without increasing the analysis variables. Interpolation procedures are developed which significantly reduce the required computations, the dimension of the transfer matrix, and the number of eigenvalues/eigenvectors extractions required in a given frequency range.

BIOLOGICAL SYSTEMS

HUMAN

(See Nos. 2688, 2756)

MECHANICAL COMPONENTS

ABSORBERS AND ISOLATORS

(Also see Nos. 2693, 2719)

80-2623

Antiresonant Rotor Isolation for Vibration Reduction

R.A. Desjardins and W.E. Hooper

Upper Controls & Vibration Design, Boeing Vertol Co., Philadelphia, PA, J. Amer. Helicopter Soc., 25 (3), pp 46-55 (July 1980) 19 figs, 13 refs

Key Words: Isolators, Vibration isolators, Helicopter vibration

Continuing development of an improved rotor isolation system to minimize helicopter vibration is presented. Based on flight test experience gained with anti-resonant rotor isolation systems designed for the BO-105 and the company-owned Model 179 helicopters, a completely new and simplified design having reduced weight was completed. The rationale and analysis leading to the design, and the final arrangement are presented in detail together with flight test data acquired with the dynamically similar system installed on the Model 179.

80-2624

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, 73 pp (1979) Engl. transl. of "Untersuchung zu einen activen Schwingungsisolationssystem fur Hubschrauber bei starrer und elastischer Zellenmodelieurung" DLR-IB-552-78-6 Brunswick, W. Germany (June 1978)

Key Words: Vibration isolation, Active isolation, Helicopter rotors

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.

80-2625

Evaluation of the Practical Aspects of Vibration Reduction Using Structural Optimization Techniques

H.W. Hanson and N.J. Calapodas

Bell Helicopter Textron, Fort Worth, TX, J. Amer. Helicopter Soc., 25 (3), pp 37-45 (July 1980) 15 figs, 2 tables, 6 refs

Key Words: Vibration reduction, Helicopters, Stiffness coefficients, Optimization

The results of a practical evaluation of two structural optimization techniques for vibration reduction, the Vincent Circle method and the forced response strain energy method, are discussed. Initial comparison studies of the two methods based on stiffness parameter variations were conducted using an elastic line mathematical model of the AH-1G helicopter. The forced response strain energy method was applied to a large complex builtup NASTRAN AH-1G model. The Vincent Circle method was further evaluated for mass tuning, damping, and dynamic absorber parameters using the elastic line model.

80-2626

Filled Rubber Materials System: Application to Echo Absorption in Waterfilled Tanks

R.D. Corsaro, J.D. Klunder, and J. Jarzynski

Naval Res. Lab., Washington, D.C. 20375, J. Acoust Soc. Amer., 68 (2), pp 655-664 (Aug 1980) 9 figs, 4 tables, 14 refs

Key Words: Foam rubber, Acoustic absorption, Tanks (containers), Anechoic chambers

A materials system for forming rubber composites with selectable acoustic properties is described. The sound speed, density, and attenuation coefficient for more than 100 samples containing various concentrations and types of fillers were measured. These data were then reduced to determine the best fit coefficients in a set of descriptive equations. Thereafter these equations could be used to calculate the filler concentrations needed to form composites with specific required properties.

80-2627

Decoupler Pylon. Wing/Store Flutter Suppressor

W.A. Reed, III

NASA Langley Res. Ctr., Langley Station, VA, PAT-APPL-6-135 057, 18 pp (Mar 1980)

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

A device for suspending a store from a support such as an aircraft wing is described. It comprises soft-spring means whereby the store pitch mode is decoupled from support modes and a low frequency active control mechanism which maintains store alignment. In the described embodiment, a pneumatic suspension system both isolates the store in pitch and, under conditions of changing mean load, aligns the store with the wing to which it is attached. 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.

80-2628

Effect of a Flexibly Mounted Store on the Flutter Speed of a Wing

H L Runyan

Joint Inst. for Advancement of Flight Sciences, Hampton, VA, Rept. No. NASA-CR-159245, 25 pp (Apr 1980)

N80-22356

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

A passive system proposed for increasing the flutter speed of a wing with heavy concentrated weights involves the concept of mounting the store on a pitch pivot having a very low pitch stiffness relative to the wing stiffness. This concept was investigated utilizing a two dimensional approach involving 4 degrees of freedom. A second more complete analysis was developed utilizing a three-dimensional structure. Details of the analysis are included.

80-2629

Angle Dependence of the Impedance of a Porous Layer

C. Klein and A. Cops

Laboratorium voor Akoestiek en Warmtegeleiding, Departement Natuurkunde, K.U.-Leuven, 3030 Heverlee, Belgium, Acustica, 44 (4), pp 258-264 (Apr 1980) 6 figs, 2 tables, 8 refs

Key Words: Foam rubber, Acoustic impedance

A free field method is described to measure the specific acoustic impedance of polyurethane foam layers as a function of the angle of incidence of the sound wave. An approximate spherical wave theory, which is believed to be correct up to angles of incidence of about 60°, is used for the calculations. In a plane wave approximation, the characteristic impedance and the propagation constant of the material are calculated. These values are then used in a plane wave theory which calculates the specific acoustic impedance as a function of the angle of incidence.

80-2630

Vibrational Power Flow from Machines into Built-up Structures, Part III: Power Flow through Isolation Systems

H.G.D. Goyder and R.G. White

Inst. of Sound and Vib. Res., Univ. of Southampton, Southampton S09 5NH, UK, J. Sound Vib., 68 (1), pp 97-117 (Jan 8, 1980) 16 figs, 2 tables, 8 refs

Key Words: Vibration isolation, Machinery vibration, Machine foundations, Beams, Plates

The power flowing through the isolators and into the supporting foundation of a machine is examined by approximating the driving point frequency response function of the foundation. One and two stage isolation of machines with internal force or velocity sources is considered. Two stage isolation is superior to single stage isolation in reducing power flow in those circumstances where the excitation spectra do not cover the two resonances of the system.

80-2631

Vibrational Power Flow from Machines into Built-up Structures, Part II: Wave Propagation and Power Flow in Beam-Stiffened Plates

H.G.D. Goyder and R.G. White

Inst. of Sound and Vib. Res., Univ. of Southampton, Southampton S09 5NH, UK, J. Sound Vib., 68 (1), pp 77-96 (Jan 8, 1980) 9 figs, 7 refs

Key Words: Vibration isolation, Machinery vibration, Machine foundations, Beams, Plates

Wave propagation and power flow due to force and torque (moment) excitation is studied at the driving point and in the far field of an infinite plate with a single line-stiffener. Such a structure excited by forces or torques applied to the beam behaves like an uncoupled beam at the driving point. In the far field, power transmitted by flexural waves in the beam is radiated into the plate while power transmitted by torsional waves in the beam is not radiated. The plate carries a cylindrical wave with a strong directivity.

80-2632

Vibrational Power Flow from Machines into Built-up Structures, Part I: Introduction and Approximate Analyses of Beam and Plate-Like Foundations

H.G.D. Goyder and R.G. White

Inst. of Sound and Vib. Res., Univ. of Southampton, Southampton S09 5NH, UK, J. Sound Vib., 68 (1), pp 59-75 (Jan 8, 1980) 2 figs, 1 table, 12 refs

Key Words: Vibration isolation, Machinery vibration, Machine foundations, Beams, Plates

An introduction to power flow analysis techniques and a study of the simplification of practical structural analysis by use of the frequency response characteristics of an equivalent infinite structure is presented. Beams and plates with force and torque excitation are studied and the resulting near and far field power flow mechanisms are examined. Principal results, which are in the form of very simple formulae, are tabulated.

SPRINGS

80-2633

Fatigue Strength of Steel Coned Disc Springs

Engineering Sciences Data Unit, Ltd., London, UK, Rept. No. ISBN-0-85679-282-9, 16 pp (1980)
ESDU-80004

Key Words: Springs, Disk springs, Fatigue life, Crack detection

Basic fatigue data is provided on which to assess the endurance of steel coned disc springs and to estimate the location of failure within a stack and the point on each spring at which a fatigue crack is likely to initiate. The results of the research may be applied to springs for valves, forging dies, machine tools, pneumatic equipment, and testing apparatus.

80-2634

Design of Laminated Torsion Bar Springs

J.A. Gentiluomo

Watervliet Arsenal, NY, Rept. No. WVT-PP-1, 24 pp (Feb 1980)
AD-A083 449/9

Key Words: Springs, Torsion bars, Layered materials, Design techniques

An analytical approach to the design of torsion leaf spring packs for use in cannon breech mechanisms, vehicle suspensions, etc. is provided. The design procedure presents an expeditious simple method for determining spring pack dimensions when parameters such as total required torque, spring pack angle of twist, free length of leaf spring, maximum tensile working stress, and maximum torsional working stress are known.

BLADES

80-2635

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

R.L. Barger

NASA Langley Res. Ctr., Hampton, VA, Rept. No. NASA-TP-1660, L-13388, 18 pp (May 1980)
N80-22265

Key Words: Blades, Propeller blades, Noise generation

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.

BEARINGS

(Also see No. 2751)

80-2636

Influence of the Gas-Film Inertia Forces on the Dynamic Characteristics of Externally Pressurized, Gas Lubricated Journal Bearings, Part II: Analyses of Whirl Instability and Plane Vibration

A. Mori, K. Aoyama, and H. Mori

Faculty of Tech., Kyoto Univ., Kyoto, Japan, Bull. JSME, 23 (180), pp 953-960 (June 1980) 21 figs, 1 table, 6 refs

Key Words: Bearings, Journal bearings, Whirling

Influences of the gas-film inertia forces on the whirl instability and on the plane vibration in externally pressurized, gas lubricated journal bearings are analyzed. Analytical results agree well with the experimental results, and conclusions are given.

80-2637

On the Spring Characteristics of a Ball Bearing (Extreme Characteristics with Many Balls)

H. Tamura and Y. Tsuda

Faculty of Engrg., Kyushu Univ., Higashi-Ku, Fukuoka, Japan, Bull. JSME, 23 (180), pp 961-968 (June 1980) 6 figs, 2 tables, 17 refs

Key Words: Bearings, Ball bearings, Spring constants

A theoretical analysis of the radial spring characteristics of a ball bearing is presented, based on the studies by Perret/Meldau. Numerical examples of the motion of inner ring and the differential stiffness are shown.

80-2638

A Simple Way to Estimate Bearing Stiffness

E.P. Gargiulo, Jr.

E.I. DuPont de Nemours & Co., Wilmington, DE, Mach. Des., 52 (17), pp 107-110 (July 24, 1980) 2 figs, 2 tables

Key Words: Rotating structures, Bearings, Stiffness coefficients

High-speed rotating machinery must be subjected to careful dynamic analysis to ensure against potentially destructive vibration. Values of bearing stiffness required for this analysis normally must be found from expensive tests or complex calculations. A simple new method provides approximate values for studies that do not demand utmost accuracy.

80-2639

Definition of Axial Preload-Clearances in Ball Bearing Supports by Experimental Measurements

N. Lebedev

Vibrotechnika, 5 (29), pp 141-150 (1977), 5 figs, 4 refs, Kaunas A. Snieckus Politechnical Institute, Kaunas, Lithuanian SSR, 1979

(In Russian)

Key Words: Bearings, Ball bearings, Clearance effects

A method to determine preload or clearance in ball bearing supports by experimental measurements of axial forces is examined. The method is based on Herz's contact theory.

80-2640

Case Instabilities in a 42 mm ED/20 mm Id Angular Contact Bearing

K.T. Stevens and M.J. Todd

European Space Tribology Lab., National Center of Tribology, Risley, UK, Rept. No. ESA-CR(P)-1255, 31 pp (May 1979)

N80-21763

Key Words: Bearings, Dynamic tests

Spin tests were conducted on a series of angular contact, inner race separable bearings with phenolic cages using a variety of space approved lubricants. Three types of cage instability were observed in ED20 bearings.

GEARS

80-2641

Load-Carrying Capacity of the $H_B \approx 340$ (Hardened and Tempered) Gears. 3rd Report. Influences of Difference in Hardness and Roughness on Surface Durability

T. Nakanishi, T. Ueno, Y. Ariura, Y. Miyamoto, and H. Murata

Faculty of Engrg., Kyushu Univ., Fukuoka, Japan, Bull. JSME, 23 (180), pp 1010-1015 (June 1980) 15 figs, 5 tables, 4 refs

Key Words: Gears, Surface roughness, Fatigue life

The influences of difference in hardness of mating gears and their roughness on surface durability is investigated using hobbed gears and rollers of various roughness.

80-2642

Analysis of Vibratory Excitation of Gear Systems as a Contributor to Aircraft Interior Noise

W.D. Mark

Bolt, Beranek and Newman, Inc., Cambridge, MA, Rept. No. NASA-CR-159088, 97 pp (Feb 1979)

N80-25100

Key Words: Gear boxes, Gears, Spur gears, Helical gears, Gear vibration, Gear noise, Frequency domain method, Aircraft noise, Interior noise

Application of the transfer function approach to predict the resulting interior noise contribution requires gearbox vibration sources and paths to be characterized in the frequency domain. Tooth-face deviations from perfect involute surfaces were represented in terms of Legendre polynomials which may be directly interpreted in terms of tooth-spacing errors, mean and random deviations associated with involute slope and fullness, lead mismatch and crowning, and analogous higher-order components. The contributions of these components to the spectrum of the static transmission error is discussed and illustrated using a set of measurements made on a pair of helicopter spur gears. The general methodology presented is applicable to both spur and helical gears.

COUPLINGS

80-2643

A Special Coupling on the Basis of a Rotating Fluid

L. Zubavicius, A.P. Kavolelis, and B. Spruogis

Vilnius Civil Engrg. Inst., Vilnius, Lithuania 232600, Vibrotechnika, 5 (29), pp 23-34 (1977), 12 figs, 2 refs, Kaunas A. Snieckus Politechnical Institute, Kaunas, Lithuanian SSR, 1979

(In Russian)

Key Words: Couplings, Vibration control

The coupling investigated is a special highly sensitive antivibrational connection of rotary objects. The main analytic dependencies for engineering calculation (torque, stiffness, frequencies, etc.) are presented. Graphical representation of these dependencies is also given and specific features of the coupling are shown.

FASTENERS

(Also see No. 2676)

80-2644

The Dynamics of High-Pressure Flange Connections of Tubings

J. Dulevicius and S. Sakalauskas

Kaunas Antanas Snieckus Polytechnical Inst., Kaunas, Lithuania, Vibrotechnika, 5 (29), pp 79-87 (1977), 7 figs, 3 refs, Kaunas A. Snieckus Politechnical Institute, Kaunas, Lithuanian SSR, 1979

(In Russian)

Key Words: Tubes, Joints (junctions)

The differential equations describing longitudinal free vibrations of flange connections with joined tubes are presented and solved. The solution results of frequency equations are presented in graphic form. The investigation results obtained allow the use of resonance frequencies of flange connections to estimate the effect of dynamic loads on flange connections sealing.

SEALS

80-2645

A Rapidly Converging Theoretical Solution of the Elastohydrodynamic Problem for Rectangular Rubber Seals

L.E.C. Ruskell

Royal Aircraft Establishment, Farnborough, Hampshire, UK, J. Mech. Engr. Sci., 22 (1), pp 9-16 (Feb 1980) 5 figs, 1 table, 15 refs

Key Words: Seals (stoppers), Elastomeric seals, Elastohydrodynamic properties

A theoretical approach is described which overcomes the problems of convergence previously associated with obtaining solutions of the elastohydrodynamic equations for a reciprocating, rectangular section rubber seal. Convergence of this method is extremely rapid. Results are presented which illustrate that it is suitable both for instrokes and outstrokes at realistic sealed pressures. Experimental measurements of pressure distribution are presented for comparison.

80-2646

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

I. Etsion

NASA Lewis Res. Ctr., Cleveland, OH, Rept. No. NASA-TM-81490, 25 pp (Apr 1980)

N80-22701

Key Words: Seals (stoppers)

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.

The random vibration of a beam impacting a spring-like stop is discussed. The mean square response and the frequency of impacts are obtained by an equivalent linearization. Reasonable agreement is obtained between these results and the results for an equivalent non-linear single-degree-of-freedom system.

STRUCTURAL COMPONENTS

BARS AND RODS

80-2647

Turbulence and Rod Vibrations in an Annular Region with Upstream Disturbances

T.M. Mulcahy, T.T. Yeh, and A.J. Miskevics
Components Tech. Div., Argonne National Lab., Argonne, IL 60439, J. Sound Vib., 69 (1), pp 59-69 (Mar 8, 1980) 5 figs, 3 tables, 10 refs

Key Words: Rods, Fluid-induced excitation, Nuclear reactor components, Turbulence

Disturbances in nominally parallel flow are produced by the use of grids upstream of a flexible rod in an annular region. The turbulence decay in two annular regions and the vibrations of the same rod are measured for a wide range of flow velocities, grid configurations, and hydraulic diameters typical of those found in nuclear reactors. The creation and characterization of the upstream flow disturbances as a test parameter are the unique contributions of this study.

BEAMS

(Also see Nos. 2630, 2631, 2632, 2716)

80-2648

Random Vibration of a Beam Impacting Stops

H.G. Davies
Dept. of Mech. Engrg., Univ. of New Brunswick, Fredericton, E3B 5A3, Canada, J. Sound Vib., 68 (4), pp 479-487 (Feb 22, 1980) 5 figs, 12 refs

Key Words: Beams, Random excitation, Mean square response, Frequencies, Equivalent linearization method

80-2649

The Lateral Vibration of Slightly Bent Slender Beams Subject to Prescribed Axial End Displacement

S.M. Dickinson
Faculty of Engrg. Science, The Univ. of Western Ontario, London, Ontario N6A 5B9, Canada, J. Sound Vib., 68 (4), pp 507-514 (Feb 22, 1980) 10 figs, 1 table, 4 refs

Key Words: Beams, Initial deformation effects, Axial excitation, Natural frequencies, Flexural vibrations, Heat exchangers, Tubes

A simple analysis is presented for the prediction of the induced axial loads in initially slightly bent slender beams subject to prescribed axial end displacement. The effect upon the natural frequencies of flexural vibration of the beams is then determined. A simply supported beam and a fully clamped beam are considered and it is assumed that the initial deflection is of the same form as the first critical buckling mode for the straight beam. It is shown that the effect of relatively slight initial lack of straightness upon the induced axial load and bending natural frequencies is very significant.

80-2650

Natural Frequencies for Out-of-Plane Vibrations of Continuous Curved Beams

T.M. Wang, R.H. Nettleton, and B. Keita
Dept. of Civil Engrg., Univ. of New Hampshire, Durham, New Hampshire 03824, J. Sound Vib., 68 (3), pp 427-436 (Feb 8, 1980) 3 figs, 10 refs

Key Words: Beams, Curved beams, Natural frequencies

An analytic technique is presented for the determination of natural frequencies of continuous curved beams vibrating out of their initial plane of curvature. An example of a two-span circular curved beam is given to show the effect of the central angle of the arc upon the natural frequencies of the beam.

80-2651
Further Results on Instability of the Motion of a Beam of Periodically Varying Length
J. Zajaczkowski and G. Yamada
Lodz Technical Univ., Lodz, Zwirki 36, Poland, J. Sound Vib., 68 (2), pp 173-180 (Jan 22, 1980) 8 figs, 3 refs

Key Words: Beams, Variable material properties, Axial excitation

The parametric instability of the motion of a beam of periodically varying length is analyzed. The instability regions are found and plotted. The study shows that the way in which the beam is driven has an essential effect on the stability of its motion.

80-2652
Effect of Angle of Attack on the Stability of a Rotating Non-Uniform Cantilever with a Tip Mass Subjected to Dissipative and Non-Conservative Forces
R.C. Kar
Dept. of Mech. Engrg., Indian Inst. of Tech., Kharagpur - 721302, India, J. Sound Vib., 68 (2), pp 249-258 (Jan 22, 1980) 9 figs, 8 refs

Key Words: Flutter, Beams, Cantilever beams, Variable cross section, Rotating structures, External damping, Follower forces

The influence of angle of attack on the stability of a rotating viscoelastic tapered cantilever beam of rectangular cross-section carrying a tip mass and subjected to a circulatory force at its free end is investigated. The effect of external damping is included in the study. The non-self-adjoint boundary value problem is formulated and an appropriate adjoint boundary value problem is introduced. Approximate values of the critical flutter load are calculated on the basis of an adjoint variational principle for several values of geometric and material parameters of the system. The results are presented through a series of graphs.

80-2653
Natural Frequencies and Stresses for Beams with External Rotational Restraints
K.F.H. Dresig and M. Labes
Forsch. Ingenieurwesen, 46 (3), pp 88-93 (1980) 14 figs, 4 refs

Key Words: Beams, Natural frequencies, Cables (ropes), Springs, Nuclear power plants

Safety related cable tray systems in nuclear power plants must be designed to withstand vibrational effects due to external events. It is also necessary to consider the rotational stiffness effects on the system natural frequency provided by the attachment of cable trays to their support beams. This effect is modeled by using either distributed or discrete rotational springs. Differential equations are developed and solved which reflect the response of the rotationally restrained beam when subjected to frequency dependent loads.

80-2654
A Cantilever Beam Chattering Against a Stop
C.C. Lo
Bell Telephone Labs., Inc., Columbus, OH 43213, J. Sound Vib., 69 (2), pp 245-255 (Mar 22, 1980) 8 figs, 21 refs

Key Words: Beams, Cantilever beams, Chatter, Bernoulli-Euler method

Contact chatter or bounding of a cantilever beam with the free end pressed against a stop was studied. The problem was treated according to the Bernoulli-Euler beam theory and the resulting integral equation was solved by the small time increment technique. Deflections, contact force and chatter were calculated. Deflections were measured photographically by using a multiflash strobe light and the chatter was measured with an oscilloscope. An approximate method was developed by using kinetic energies based on the beam theory and contact open or closure times based on an equivalent mass-spring system.

80-2655
The Effects of Fibre Orientation on Free Vibrations of Composite Beams
K.K. Teh and C.C. Huang
Dept. of Mech. Engrg., The Univ. of Western Australia, Nedlands, Western Australia 6009, J. Sound Vib., 69 (2), pp 327-337 (Mar 22, 1980) 11 figs, 8 refs

Key Words: Beams, Composite structures, Fiber composites, Mode shapes

The torsion-flexure coupling effect of generally orthotropic beams, dependent on reinforcing fibre orientation and mode order, is studied. At higher ranks of vibration, this coupling effect is principally contributed by the twisting moment

induced by bending. The influence of fibre orientation on normal mode shapes is more significant for small values of fibre orientation.

FRAMES AND ARCHES

80-2656
Effect of Axial Force on Framework Dynamics
B.A. Ovunc
Dept. of Civil Engrg., Univ. of Southwestern Louisiana, Lafayette, LA, Computers Struc., 11 (5), pp 389-395 (May 1980) 14 figs, 23 refs

Key Words: Frames, Axial excitation, Forced vibration, Dynamic buckling, Computer programs, Modal analysis

The effect of member axial forces on the free and forced vibration of frameworks is investigated. Forced vibration of the frameworks is determined by means of modal analysis. A set of single beams, a three story and a sixteen story frame are considered as example problems to illustrate the effect of the member axial force on the vibration. The buckling modes of these beams and frames are investigated.

MEMBRANES, FILMS, AND WEBS

80-2657
Approximations to the Admittances and Free Wavenumbers of Fluid-Loaded Panels
D.G. Crighton
Dept. of Applied Mathematical Studies, Univ. of Leeds, Leeds LS2 9JT, UK, J. Sound Vib., 68 (1), pp 15-33 (Jan 8, 1980) 11 refs

Key Words: Membranes, Panels, Fluid-induced excitation, Mechanical admittance

The approximate evaluation of free wavenumbers and line transfer and line drive admittances of a fluid-loaded membrane is studied. The physical mechanisms dominating each approximation are identified as are the physical implications of the approximations.

PANELS
(Also see No. 2657)

80-2658
Noise Transmission through Stiffened Panels
M. Slazak
Ph.D. Thesis, Columbia Univ., 103 pp (1980)
UM 8017472

Key Words: Panels, Noise transmission, Panel-cavity response

An analytical study is presented to predict low frequency noise transmission through stiffened panels into cavity backed enclosures. Noise transmission is determined by solving the acoustic wave equation for the interior noise field and stiffened panel equations for vibrations of the stiffened panel. The dynamic behavior of the panel is determined by the transfer matrix procedure. Also presented is a transfer matrix development for stiffened sandwich panels. Results include comparisons between theory and experiment, noise transmission due to boundary layer turbulence and noise transmission through the sidewall of an aircraft.

80-2659
The Stability of Cantilever Panels in Uniform Incompressible Flow
L.K. Shayo
Dept. of Mathematics, Univ. of Dar es Salaam, Dar es Salaam, Tanzania, J. Sound Vib., 68 (3), pp 341-350 (Feb 8, 1980) 1 fig, 3 tables, 6 refs

Key Words: Panels, Cantilever plates, Fluid-induced excitation

The stability of large aspect ratio cantilever panels in uniform incompressible flow is studied by employing linearized plate and potential flow theories together with asymptotic expressions for the generalized pressures.

PLATES
(Also see Nos. 2630, 2631, 2632, 2659)

80-2660
Instability of a Periodically Moving Plate
J. Zajaczkowski and G. Yamada
Lodz Technical Univ., Lodz, Zwirki 36, Poland, J. Sound Vib., 68 (2), pp 181-186 (Jan 22, 1980) 2 figs, 1 table, 4 refs

Key Words: Plates, Rectangular plates, Variable material properties, Axial excitation

The parametric instability of the in-plane motion of a rectangular plate of periodically varying length is investigated. The boundaries of the instability regions are found and plotted.

80-2661

An Exact, Closed Form Solution for the Flexural Vibration of a Thin Annular Plate Having a Parabolic Thickness Variation

T.A. Lenox and H.D. Conway

Dept. of Theoretical and Applied Mechanics, Cornell Univ., Ithaca, NY 14853, J. Sound Vib., 68 (2), pp 231-239 (Jan 22, 1980) 4 figs, 3 tables, 12 refs

Key Words: Plates, Variable cross section, Flexural vibrations

An exact, closed form solution is obtained for the transverse vibrations, with nodal diameters and circles, of a thin annular plate having a parabolic thickness variation. Representative numerical values for the frequency parameter and typical mode shapes are presented for three different combinations of simple boundary conditions. The corresponding exact solution for an aeolotropic annular plate of the same geometry is also presented.

80-2662

An Experimental Study of Flow-Generated Waves on a Flexible Surface

R.J. Hansen, D.L. Hunston, C.C. Ni, and M.M. Reischman

Naval Res. Lab., Washington, D.C. 20375, J. Sound Vib., 68 (3), pp 317-334 (Feb 8, 1980) 15 figs, 3 tables, 16 refs

Key Words: Plates, Fluid-induced excitation

An experimental study of the generation of waves on an elastic surface by a turbulent boundary layer is discussed. Experiments were conducted primarily in a flat plate (two dimensional) geometry, with some companion rotating disk experiments (three dimensional) also performed. Three distinct types of surface waves were identified in the flat plate studies.

80-2663

Response of Composite Plates to Blast Loading

A. Rajamani and R. Prabhakaran

Bharat Heavy Electricals, Hyderabad, India, Exptl. Mech., 20 (7), pp 245-250 (July 1980) 3 figs, 5 tables, 25 refs

Key Words: Plates, Composite materials, Blast response

The transient response of composite plates, with and without central circular holes, to blast loading is studied. The modal-analysis approach is used in the computation of numerical results. To verify the theoretical results, experiments are conducted on aluminum and unidirectionally reinforced E-glass-epoxy plates, using a shock tube as the loading device. The experimental peak dynamic strains are compared with the theoretical values. A comparison of dynamic-amplification factors, defined as the ratio of the peak dynamic strains to the static strains, has been made between the isotropic and the composite plates.

80-2664

Transverse Vibrations of Plates with Stepped Thickness over a Concentric Circular Region

R.H. Gutierrez, P.A.A. Laura, and R.O. Grossi

Inst. of Applied Mechanics, Puerto Belgrano Naval Base, 8111 Argentina, J. Sound Vib., 69 (2), pp 285-295 (Mar 22, 1980) 4 figs, 6 tables, 12 refs

Key Words: Plates, Rectangular plates, Circular plates, Flexural vibration, Variable cross section, Fundamental frequency, Ritz method

Determination of the fundamental frequency of vibration of rectangular, regular polygonal, and circular plates with stepped thickness over a concentric, circular subdomain of the plates is examined. Problems are solved in a unified fashion by adopting simple polynomial co-ordinate functions and making use of the Ritz method to generate the frequency determinant.

80-2665

Large Amplitude Axisymmetric Vibrations of Orthotropic Circular Plates Elastically Restrained Against Rotation

G.V. Rao and K.K. Raju

Structural Engrg. Div., Vikram Sarabhai Space Centre, Trivandrum-695022, India, J. Sound Vib., 69 (2), pp 175-180 (Mar 22, 1980) 8 tables, 8 refs

Key Words: Plates, Orthotropism, Elastically restrained edges, Finite element technique, Large amplitudes

A finite element formulation is employed to obtain the linear and non-linear frequencies of orthotropic circular plates with elastically restrained edges. Results are presented in the form of linear frequency parameters and ratios of non-linear to linear periods for several values of the spring constants, orthotropy parameter and central deflections.

80-2666

Response of Plates with Unconstrained Layer Damping Treatment to Random Acoustic Excitation, Part II: Response Evaluation

C.V. Ramachandra Reddy, N. Ganesan, B.V.A. Rao, and S. Narayanan

ISRO Satellite Centre, Bangalore-58, India, J. Sound Vib., 69 (1), pp 45-57 (Mar 8, 1980) 7 figs, 7 tables, 15 refs

Key Words: Plates, Layered damping, Acoustic excitation, Spectral energy distribution techniques, Harmonic analysis

Theoretical and experimental investigations on the response of a plate with unconstrained layer damping treatment to random acoustic excitation are carried out. The theoretical response evaluation consists of determining the power spectral density of the acceleration response of the layered plate by the use of generalized harmonic analysis under a specific random acoustic excitation, with use being made of modal frequencies and associated loss factors estimated. A study was made on the contribution of cross coupling terms of the acceleration response for the two boundary conditions investigated.

80-2667

Vibration of a Plate with Straight Line Boundaries

K. Nagaya

Dept. of Mech. Engrg., Yamagata Univ., Yonezawa, Japan, J. Sound Vib., 68 (1), pp 35-43 (Jan 8, 1980) 5 figs, 4 tables, 18 refs

Key Words: Plates, Vibration response, Numerical analysis

A method for solving vibration problems of an elastic thin solid plate with a boundary consisting of straight lines is examined. The exact solution of equation of motion is utilized and the boundary conditions along the straight line boundaries are satisfied by means of the Fourier expansion method. Numerical calculations are carried out for clamped or simply supported trapezoidal and rhombic plates.

80-2668

Internal Field of an Insonified Elastic Plate

A. Freedman and G.G. Swinerd

65 Mount Pleasant Ave., Weymouth, Dorset DT3 5JF, UK, J. Sound Vib., 68 (4), pp 515-552 (Feb 22, 1980) 18 figs, 21 refs

Key Words: Plates, Submerged structures, Acoustic excitation

The displacement field within an infinite, fluid-loaded elastic plate insonified by a plane wave at arbitrary incidence angle is examined. For a water-immersed steel plate which is 0·55 shear wavelengths thick extensive graphical data are presented showing the evolution of the displacement field with variation of incidence angle from very close to normal incidence to very close to grazing incidence.

80-2669

Upper and Lower Bounds for Frequencies of Clamped Rhombical Plates

J.R. Kuttler and V.G. Sigillito

Applied Physics Lab., The Johns Hopkins Univ., Laurel, MD 20810, J. Sound Vib., 68 (4), pp 597-607 (Feb 22, 1980) 4 figs, 1 table, 11 refs

Key Words: Plates, Natural frequencies

Upper and lower bounds are given for the lowest frequencies of vibration of clamped rhombical plates. These bounds were obtained by using a recently developed method which allows the use of trial functions which do not need to satisfy any boundary conditions.

80-2670

Response of Plates with Unconstrained Layer Damping Treatment to Random Acoustic Excitation. Part I: Damping and Frequency Evaluations

C.V. Ramachandra Reddy, N. Ganesan, B.V.A. Rao, and S. Narayanan

ISRO Satellite Centre, Bangalore-58, India, J. Sound Vib., 69 (1), pp 35-43 (Mar 8, 1980) 6 figs, 4 tables, 11 refs

Key Words: Plates, Layered damping, Acoustic excitation

For theoretical evaluation of the response of a structure under random acoustic excitation a complete understanding is required of the various modes of vibration and the modal damping associated with each mode. In order to evaluate these parameters for plates with unconstrained layer damping treatment, some of the theoretical approaches applicable are used. Experimentally observed model frequencies and associated loss factors are compared with those estimated by different theories for all edges simply supported and all edges clamped boundaries, after accounting for the damping at sup-

ports. The modes of vibration used in the theoretical analysis for these boundaries are compared with those observed in the experiments.

SHELLS

80-2671

Optimum Design of Stiffened Cylindrical Shells with Natural Frequency Constraints

S.S. Rao and E.S. Reddy

Dept. of Mech. Engrg., Indian Inst. of Tech., Kanpur-208016, India, Computers Struc., 12 (2), pp 211-219 (Aug 1980) 1 fig, 6 tables, 25 refs

Key Words: Shells, Cylindrical shells, Stiffened shells, Minimum weight design, Natural frequencies

The design optimization of axially loaded, simply supported stiffened cylindrical shells for minimum mass is considered. The design variables are thickness of shell wall, thicknesses and depths of rings and stringers, number/spacing of rings and stringers. Natural frequency, local and overall buckling strengths and direct stress constraints are considered in the design problems.

RINGS

(See No. 2716)

PIPES AND TUBES

(Also see Nos 2644, 2649)

80-2672

A Method for the Analysis of Seismic Reliability of Lifeline Systems

J. Mohammadi

Ph.D. Thesis, Univ. of Illinois at Urbana-Champaign, 118 pp (1980)

UM 8018190

Key Words: Pipelines, Life line systems, Seismic response

Methods for assessing the seismic safety of a lifeline system, such as a water distribution system, an oil pipeline system, or a transportation network, are developed and introduced with part of the study being devoted to the development of a relation between the earthquake intensity and the distance.

80-2673

Surface Displacements Accompanying the Propagation of Acoustic Waves within an Underground Pipe

A.N. Jette and J.G. Parker

Applied Physics Lab., The Johns Hopkins Univ., Laurel, MD 20810, J. Sound Vib., 69 (2), pp 265-274 (Mar 22, 1980) 7 figs, 13 refs

Key Words: Pipes (tubes), Underground structures, Elastic waves, Acoustic excitation

Theoretical expressions for surface displacements accompanying the propagation of acoustic waves in a buried gas-filled pipe are derived.

80-2674

The Proximity of Coincidence and Acoustic Cut-Off Frequencies in Relation to Acoustic Radiation from Pipes with Disturbed Internal Turbulent Flow

M.K. Bull and M.P. Norton

Dept. of Mech. Engrg., The Univ. of Adelaide, Adelaide, South Australia, J. Sound Vib., 69 (1), pp 1-11 (Mar 8, 1980) 6 figs, 16 refs

Key Words: Pipes (tubes), Joints (junctions), Pipe joints, Fluid-induced excitation

Spectral measurements showing the effects of various pipe fittings (radiused bends, mitred bends, and gate and butterfly valves) on wall pressure fluctuations, wall acceleration, and acoustic radiation due to turbulent air flow in a pipe are presented.

80-2675

Measurement of Nonlinear Reflection of N-Wave at the Open End of a Circular Pipe

T. Nakamura, A. Nakamura, and R. Takeuchi

Inst. of Scientific and Industrial Research, Osaka Univ., Yamadakami, Suita, Osaka, Japan, Acustica, 44 (4), pp 323-329 (Apr 1980) 13 figs, 11 refs

Key Words: Pipes (tubes), Shock wave reflection

The measurements of reflection of N-wave at the open end of a circular pipe with baffle were made for analysis of nonlinearity of energy reflection dependent upon shock amplitude.

80-2676
The Investigation of Transverse Vibrations of Tubes with Flange Connection
J. Dulevicius and S. Sakalauskas
Kaunas Antanas Snieckus Polytechnical Inst., Kaunas, Lithuania, Vibrotechnika, 5 (29), pp 89-97 (1977), 5 figs, 2 refs, Kaunas A. Snieckus Politechnical Institute, Kaunas, Lithuanian SSR, 1979
(In Russian)

Key Words: Pipes (tubes), Flexural vibration, Joints (junctions)

The investigation of transverse free vibrations of tubes with flange connection are carried out and the results of the obtained frequency equation solution are presented.

80-2677
Evaluation of the Dynamic Stress Component in Pipes by Identification Method
J. Dulevicius, V. Kaminskas, and P. Ziliukas
Kaunas Antanas Snieckus Polytechnical Inst., Kaunas, Lithuania, Vibrotechnika, 5 (29), pp 171-178 (1977), 2 figs, 6 refs, Kaunas A. Snieckus Politechnical Institute, Kaunas, Lithuanian SSR, 1979
(In Russian)

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

The possibility of evaluating the alternating stress component in a pipe wall by fluid pressure pulse measurements is shown. The mathematical model of the problem solved and experimental results are presented.

80-2678
Identification Technique of Standard Elements for High-Pressure Lines
V. Volkov, L. Dulevicius, and V. Kaminskas
Kaunas Antanas Snieckus Polytechnical Inst., Kaunas, Lithuania, Vibrotechnika, 5 (29), pp 161-170 (1977), 3 figs, 8 refs, Kaunas A. Snieckus Politechnical Institute, Kaunas, Lithuanian SSR, 1979
(In Russian)

Key Words: Pipelines, Parameter identification technique

The main problems arising from the identification of standard elements for pipeline systems are considered. A number of dynamic models for standard elements are suggested and selection of the meaningful parameters of the proposed models, as well as quantitative estimate of the degree to which the built models are adequate, is discussed.

DUCTS

80-2679
Transient Acoustic Wave Propagation in an Epstein Duct
C.H. Wilcox
Dept. of Mathematics, Utah Univ., Salt Lake City, UT, Rept. No. TR-36, 50 pp (Nov 1979)
AD-A083 484/6

Key Words: Ducts, Elastic waves, Wave propagation, Sound waves

Transient acoustic wave propagation is analyzed for the case of an unlimited plane-stratified fluid having constant density and sound speed.

80-2680
The Acoustic Characteristics of Duct Bends
A. Cabelli
Div. of Mech. Engrg., Commonwealth Scientific and Industrial Res. Org., Melbourne, Australia, J. Sound Vib., 68 (3), pp 369-388 (Feb 8, 1980) 14 figs, 2 tables, 12 refs

Key Words: Ducts, Curved pipes, Acoustic properties

The acoustic characteristics of a duct system are studied. The system consists of a curved bend joined to two straight sections of rigid duct. Solutions of the relevant two-dimensional equations are obtained by numerical methods for a range of bend geometries. The results agree closely with experimentally obtained data.

80-2681
Higher Order Mode Effects in Circular Ducts and Expansion Chambers
L.J. Eriksson
Corporate Res Dept., Nelson Industries, Inc., Box

428, Stoughton, WI 53589, J. Acoust. Soc. Amer., 68 (2), pp 545-550 (Aug 1980) 7 figs, 25 refs

Key Words: *Ducts, Elastic waves, Noise reduction*

The theory of higher order modes in circular ducts is reviewed and applied to expansion chambers. A specific approach, analogous to that used in rectangular ducts, is recommended that has geometric clarity and elegance. The cutoff frequencies for these various modes are discussed with respect to propagation in an expansion chamber. Incomplete and misleading statements in the literature concerning the calculation of cutoff frequencies are reviewed. Higher order mode propagation through an expansion chamber is analyzed for various inlet and outlet locations, and experimental results presented. The interaction between plane wave and higher order mode effects is discussed.

80-2682

Characterization of Acoustic Disturbances in Linearly Sheared Flows

S.P. Loutsoyannis

Joint Inst. for Aeronautics and Acoustics, Dept. of Aeronautics and Astronautics, Stanford Univ., Stanford, CA 94305, J. Sound Vib., 68 (2), pp 187-202 (Jan 22, 1980) 4 figs, 1 table, 19 refs

Key Words: Ducts, Rectangular ducts, Sound waves, Wave propagation, Sound propagation

The equation describing plane wave propagation, stability, or rectangular duct mode characteristics in a compressible inviscid linearly sheared parallel flow, is shown to be reducible to Whittaker's equation. The exact solutions in terms of Whittaker functions are used to obtain a number of known results of plane wave propagation and stability in linearly sheared flows as limiting cases in which the speed of sound goes to infinity or the shear layer thickness, or wave number, goes to zero. The usefulness of the exact solutions is discussed in connection with the problems of plane wave propagation and stability of a finite thickness shear layer with a linear velocity profile.

80-2683

The Finite Element Duct Eigenvalue Problem. An Improved Formulation with Hermitian Elements and No-Flow Condensation

R.J. Astley and W. Eversman

Dept. of Mech. Engrg., Univ. of Canterbury, Christchurch, New Zealand, J. Sound Vib., 69 (1), pp 13-25 (Mar 8, 1980) 3 figs, 6 tables, 9 refs

Key Words: Ducts, Linings, Eigenvalue problems, Finite element technique

Hermitian elements are used in a finite element solution for the eigenvalue problem in lined ducts with flow. These elements give significantly greater accuracy for reduced dimensionality when compared with Lagrangian elements. Results are presented for two dimensional and axisymmetric ducts. In the axisymmetric case good resolution is obtained even for high order, high frequency modes by the use of continuously graded meshes.

BUILDING COMPONENTS

80-2684

Architectural Design of Building Components for Earthquakes

G.M. McCue, A. Skaff, and J.W. Boyce

MBT Associates, San Francisco, CA, Rept. No. NSF/RA-780690, 234 pp (1978)

PB80-173768

Key Words: Building components, Seismic design

Review of the dynamic principles governing site and building response provides the basis for a conceptual model of building and component interaction during earthquakes. This conceptual model consists of: a four-part Dynamic Model, which describes the various elements of a building, their interactive relationships during earthquakes, and the effect of their interaction on overall building response; and the Dynamic Environment, which describes the nature of the seismic motions that a component will be subjected to in a particular location of a building. Two studies illustrate the design of building components according to the principles of the model.

ELECTRIC COMPONENTS

MOTORS

80-2685

The Vibration Study of Precise High-Speed Small-Size Electric Motors

V.V. Zdanavicius, R. Krancikas, K. Ragulskis, and S. Tichonov
Kaunas Antanas Snieckus Polytechnical Inst., Kaunas, Lithuania, Vibrotechnika, 5 (29), pp 63-70 (1977), 8 figs, 5 refs, Kaunas A. Snieckus Politechnical Institute, Kaunas, Lithuanian SSR, 1979
(In Russian)

Key Words: Motors, Vibration response

The relation of precise high-speed small-size electric motor vibration level to rotor rotation speed, environment temperature and radial-thrust bearing axial tightening is discussed.

DYNAMIC ENVIRONMENT

ACOUSTIC EXCITATION

(Also see Nos. 2589, 2597, 2609, 2613, 2614, 2615, 2616, 2626, 2629, 2635, 2658, 2666, 2668, 2670, 2682, 2756)

80-2686
Forward Acoustic Performance of a Shock-Swallowing High-Tip-Speed Fan (Qf-13)
J.G. Lucas, R.P. Woodward, and M.J. Mackinnon
NASA Lewis Res. Ctr., Cleveland, OH, Rept. No. NASA-TP-1668, L-202, 20 pp (May 1980)
N80-23100

Key Words: Fans, Noise generation

Forward noise and overall aerodynamic performance data are presented for a high-tip-speed fan having rotor blade airfoils designed to alter the conventional leading-edge bow shocks to weak, oblique shocks which are swallowed within the interblade channels.

80-2687
Effects of Inflow Distortion Profiles on Fan Tone Noise
H. Kobayashi and J.F. Groeneweg
NASA Lewis Res. Ctr., Cleveland, OH, AIAA J., 18 (8), pp 899-906 (Aug 1980) 12 figs, 1 table, 12 refs

Key Words: Fans, Fan noise

Calculations of the fan tone acoustic power and modal structure generated by complex distortions in axial inflow velocity are presented. The model used treats the rotor as a rotating three-dimensional cascade and calculates the acoustic field from the distortion-produced dipole distribution on the blades including non-compact source effects. Radial and circumferential distortion shapes are synthesized from Fourier-Bessel components representing individual distortion modes. The relation between individual distortion modes and the generated acoustic modes is examined for particular distortion cases.

80-2688
Highway Noise Barrier Perceived Benefit
D.N. May and M.M. Osman
Acoustics Office, Ministry of Transportation and Communications, 1201 Wilson Ave., Downsview, Ontario M3M 1J8, Canada, J. Sound Vib., 70 (2), pp 153-165 (May 22, 1980) 2 figs, 26 refs

Key Words: Noise barriers, Human response

A laboratory experiment was performed in which 82 subjects judged the benefit of a noise barrier by listening to tape recordings of before-barrier and after-barrier traffic noise. These perceived benefit judgments were related by regression analysis to the barrier attenuation, the before-barrier traffic sound level, and a music background level, all of which were varied over the course of the experiment. Prediction equations were developed for barrier benefit in terms of these sound levels, their purpose being to provide a model for barrier benefit that can be used in barrier site selection and design. An unexpected finding was that barrier benefit was highest when before-barrier sound levels were lowest, i.e., subjects preferred a noise barrier that solved a moderate noise problem over an equally-attenuating barrier that only partially solved a more severe noise problem.

80-2689
Some Calculated Effects of Non-Uniform Inflow on the Radiated Noise of a Large Wind Turbine
G.C. Greene and H.H. Hubbard
NASA Langley Res. Ctr., Langley Station, VA, Rept

No. NASA-TM-81813, 14 pp (May 1980)
N80-25104

Key Words: Wind turbines, Noise prediction

Far field computations were performed for a large wind turbine to evaluate the effects of non-uniform aerodynamic loading over the rotor disk. A modified version of the Farassat/Nystrom propeller noise prediction program was applied to account for the variations in loading due to inflow interruption by the upstream support tower.

80-2690

Mode Conversion and Resonance Scattering of Elastic Waves from a Cylindrical, Fluid-Filled Cavity

S.G. Solomon
Ph.D. Thesis, The Catholic Univ. of America, 97 pp (1980)
UM 8018456

Key Words: Cavities, Cavity resonance, Fluid-filled containers, Elastic waves, Wave scattering

Mode conversion and scattering of compressional and shear waves from cylindrical cavities are studied by performing partial wave expansions of the incident and scattered fields. A mathematical analysis, supported by extensive numerical calculations, shows that each partial wave spectrum consists of a smooth background identical to that of an empty cavity and a series of resonance terms associated with the eigenvibrations of the cavity's fluid interior. Resonance scattering of elastic waves is shown to occur when circumferential waves are excited in the fluid interior of the cavity.

80-2691

Acoustic Wave Scattering by a Finite Elastic Cylinder in Water

J. Su, V.V. Varadan, and V.K. Varadan
Wave Propagation Group, Dept. of Engrg. Mechanics, The Ohio State University, Columbus, OH 43210, J. Acoust. Soc. Amer., 68 (2), pp 686-691 (Aug 1980) 8 figs, 1 table, 9 refs

Key Words: Underwater sound, Acoustic scattering, Circular cylinders

Numerical results are obtained for a finite circular elastic cylinder with spherical end caps using Waterman's *T*-matrix method. This method is applied to elastic scatterers that have a discontinuity in the first derivative of the normal to the surface. This makes the problem numerically difficult and is a good test of the effectiveness of the *T*-matrix method. The frequency dependence of the backscattering cross section is presented for a cylinder whose overall length is twice its diameter. Results are compared with experiments showing excellent agreement.

80-2692

Scattering of Acoustic Waves by Layered Elastic and Viscoelastic Obstacles in Water

B. Peterson, V.V. Varadan, and V.K. Varadan
Wave Propagation Group, Dept. of Engrg. Mechanics, The Ohio State Univ., Columbus, OH 43210, J. Acoust. Soc. Amer., 68 (2), pp 673-685 (Aug 1980) 30 figs, 1 table, 11 refs

Key Words: Underwater sound, Acoustic scattering, Layered materials, Elastic properties, Viscoelastic properties

A *T*-matrix formalism is presented for a multilayered three-dimensional scatterer of arbitrary shape immersed in a fluid, to study the scattering of acoustic waves. Explicit expressions for the *T*-matrix of two- and three-layered scatterers are presented.

80-2693

The Optimum Weight of Highway Noise Barriers

D.N. May
Acoustics Office, Ministry of Transportation and Communications, 1201 Wilson Ave., Downsview, Ontario M3M 1J8, Canada, J. Sound Vib., 68 (1), pp 1-13 (Jan 8, 1980) 14 figs, 10 refs

Key Words: Optimum design, Noise barriers

The relative importance of the two major sound paths between a highway and receivers when a noise barrier is interposed was studied. The overall insertion loss of the barrier is represented in terms of barrier height and barrier surface mass density. A procedure is developed for choosing barrier surface mass density to provide the most noise reduction at least cost.

80-2694

Pressures Inside a Room Subjected to Simulated Sonic Booms

N.N. Wahba, I.I. Glass, and R.C. Tennyson

Inst. for Aerospace Studies, University of Toronto, Downsview, Ontario, Canada, J. Sound Vib., 68 (2), pp 259-279 (Jan 22, 1980) 23 figs, 1 table, 19 refs

Key Words: Sonic boom, Rooms, Simulation, Test facilities

The pressure variations inside a room of plaster-wood construction subjected to sonic boom loadings were investigated both analytically and experimentally to study the problems of dynamic structural response. The room overpressures in some cases were found to be twice as great as that in the incident sonic boom. The analysis and experimental data can be useful in assessing structural damage caused by supersonic aircraft overflights.

80-2695

Broad-Band Active Sound Absorption in a Duct Carrying Uniformly Flowing Fluid

M. Berengier and A. Roure

Laboratoire de Mecanique et d'Acoustique, Centre National de la Recherche Scientifique, 13274 Marseille Cedex 2, France, J. Sound Vib., 68 (3), pp 437-449 (Feb 8, 1980) 9 figs, 12 refs

Key Words: Waveguide analysis, Acoustic absorption, Modal analysis

Use of the modal theory permits precise expression of the acoustic field and the acoustic pressure generated by a real source mounted on a hard-walled waveguide. With these results it is possible to express characteristics of different absorbing systems formed by several independent sources.

80-2696

Diffraction of a Spherical Wave by Different Models of Ground: Approximate Formulas

D. Habault

Laboratoire de Mecanique et d'Acoustique, Centre National de la Recherche Scientifique, 13274 Marseille Cedex 2, France, J. Sound Vib., 68 (3), pp 413-425 (Feb 8, 1980) 3 figs, 18 refs

Key Words: Wave diffraction, Elastic waves, Sound waves

The diffraction of a spherical wave by different models of ground has been studied previously and an exact solution of each problem given. Approximations of these solutions are presented in this paper and numerical examples are shown.

80-2697

On Calculation of Sound Fields Around Three Dimensional Objects by Integral Equation Methods

T. Terai

Dept. of Architectural Engrg., Kyoto Univ., Yoshida Hon-machi, Sakyoku, Kyoto, 606 Japan, J. Sound Vib., 69 (1), pp 71-100 (Mar 8, 1980) 18 figs, 2 tables, 35 refs

Key Words: Acoustic scattering, Integral equations, Numerical analysis

The use of integral equation methods in numerical calculations of exterior sound fields around scattering objects is analyzed. The objects investigated are a rigid body with edges and vertices, a rigid plate, and an absorbing body. For each case integral equation solutions are developed and the numerical results are found to agree with measurements.

80-2698

Noise Suppression Due to Annulus Shaping of Conventional Coaxial Nozzle

U. Vonglahn and J. Goodykoontz

Lewis Research Center, NASA, Cleveland, OH, Rept No. NASA-TM-81461, 19 pp (1980)

N80-22047

Key Words: Nozzles, Noise generation, Noise reduction, Geometric effects

A method which shows that increasing the annulus width of a conventional coaxial nozzle with constant bypass velocity will lower the noise level is described. The method entails modifying a concentric coaxial nozzle to provide an eccentric outer stream annulus while maintaining approximately the same through flow as that for the original concentric bypass nozzle. Acoustical tests to determine the noise generating characteristics of the nozzle over a range of flow conditions are described.

80-2699

V/STOL Rotary Propulsor Noise Prediction Model Update and Evaluation

B. Magliozzi

Systems Res. and Dev. Service, Hamilton Standard, Windsor Locks, CT, Rept No. AD-A082616, FAA

RD-79-107, 237 pp (Dec 1979)
N80-25106

Key Words: Propeller noise, Noise measurement

A literature review was conducted to identify and evaluate high quality noise measurements of propeller, variable pitch fan, fixed pitch fan, helicopter, lift fan, core engine, and jet noise 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.

80-2700

A Comparison Between an Existing Propeller Noise Theory and Wind Tunnel Data

J.H. Dittmar

NASA Lewis Res. Ctr., Cleveland, OH Rept. No. NASA-TM-81519; E-464, 41 pp (May 1980)
N80-25101

Key Words: Propeller noise, Noise prediction, Noise measurement, Wind tunnel tests

The noise of three supersonic helical tip speed propellers was compared with the noise predicted by an existing noise theory. Comparisons of the peak blade passage tones showed fairly good agreement between theory and experiment at the lowest helical tip Mach numbers tested, while at higher numbers, the theory predicted higher noise levels than measured.

80-2701

A Note on Sound Radiation from Distributed Sources

H. Levine

Joint Inst. for Aeronautics and Acoustics, Dept. of Aeronautics and Astronautics, Stanford Univ., Stanford, CA 94305, J. Sound Vib., 68 (2), pp 203-207 (Jan 22, 1980) 2 refs

Key Words: Sound propagation

The power output from a normally vibrating strip radiator is expressed in alternative general forms, one of these being chosen to refine and correct some particular estimates given by Heckl for different numerical ratios of strip width to wave length. An exact and explicit calculation is effected for sinusoidal velocity profiles when the strip width equals an integer number of half wave lengths.

SHOCK EXCITATION

(Also see Nos. 2596, 2600, 2601, 2610, 2675, 2684, 2747, 2756)

80-2702

Computer Calculation of Mechanisms Involving Intermittent Motions

B. Noble and H.S. Hung

Mathematics Res. Ctr., Wisconsin Univ., Madison, WI, Rept. No. MRC-TSR-2026, 43 pp (Dec 1979)
AD-A083 809/4

Key Words: Mechanisms, Intermittent motion, Computer aided techniques

A simple computational approach to the analysis of dynamical systems involving intermittent motion in which the velocities involved can be discontinuous due to impulsive forces, impact, mass capture, and mass release is presented. To illustrate the simplicity of the approach, the method is applied to a dynamical system of ten masses considered by Ehle. The computer code and numerical results are included.

80-2703

Preliminary Study of a Test Procedure for Obtaining Step Wave Loadings on Structures at Deep Submergence

J.P. Wright, M.L. Baron, and F.L. DiMaggio

Weidlinger Associates, New York, NY, Rept. No. DNA-4933T, AD-E300 724, 102 pp (Apr 1979)
AD-A083 347/5

Key Words: Submerged structures, Fluid-filled containers, Shock waves

The development of a possible technique for obtaining step wave loading on deeply submerged structures is investigated. This report presents a preliminary study of the response of a submerged fluid-filled ring subjected to a transverse step wave. The external fluid is represented by using the plane wave approximation. The ring and internal fluid equations are replaced by finite difference approximations using central differences in space and time. Details of the numerical method, and the results of six calculations are given.

VIBRATION EXCITATION

(Also see Nos. 2607, 2608, 2619, 2625, 2731, 2740, 2746)

80-2704

Oscillations in One Dimensional System with Elastoplastic Connection

V. Veteris, B. Kucinskas, V. Ragulskiene, and K. Ragulskis
Kaunas Antanas Snieckus Polytechnical Inst., Kaunas, Lithuania, Vibrotechnika, 5 (29), pp 179-183 (1977), 5 figs, 3 refs, Kaunas A. Snieckus Politechnical Institute, Kaunas, Lithuanian SSR, 1979
(In Russian)

Key Words: One degree of freedom systems, Elastoplastic properties

A quasi-static model of mechanical breakdown is studied. The operating member is a two-mass system moved by external force in a rectilinear way. The breakdown process with and without foreign vibrations is investigated. Regions of stability and existence as well as dynamic characteristics of the set-up break-down processes are defined.

80-2705

Measurement of the Separation and Half-Width of the Components of Close Doublets in High-Q Systems

T. Charnley, V. Mohanan, and R. Perrin
Dept. of Physics, Loughborough Univ. of Tech., Loughborough LE11, 3TU, UK, J. Sound Vib., 68 (4), pp 609-619 (Feb 22, 1980) 9 figs, 3 tables, 3 refs

Key Words: Normal modes, Mode shapes, Bodies of revolution, Measurement techniques

Various methods for measuring the separation and half-width of the components of a close doublet in a high-Q system are discussed. An expression is derived for the shape of the velocity response curve of such a doublet seen at an equal amplitude point. From simple measurements on this curve it is possible to evaluate the separation and half-width of the components even in cases where the separation is too small for the beating-decay method to be used.

80-2706

Response of Infinite Periodic Structures

R.C. Engels
Dept. of Engrg. Science and Mechanics, Virginia Polytechnic Inst. and State Univ., Blacksburg, VA 24061, J. Sound Vib., 69 (2), pp 181-197 (Mar 22, 1980) 9 figs, 6 refs

Key Words: Periodic structures, Harmonic excitation

The response of infinite and semi-infinite periodic structures to harmonic loads is investigated. The method developed requires the eigenvalues of the transfer matrix of a typical substructure. The algorithm is capable of analyzing an infinite periodic structure with the same computational effort necessary to analyze a single substructure. The solution is given in terms of known boundary conditions and no eigenvectors of the transfer matrix are required. Several examples are included.

80-2707

Random Excitation of a Vibratory System with Autoparametric Interaction

J.W. Roberts
Dept. of Mech. Engrg., Univ. of Edinburgh, Edinburgh EH9 3JL, Scotland, J. Sound Vib., 69 (1), pp 101-116 (Mar 8, 1980) 7 figs, 13 refs

Key Words: Random excitation, Coupled response, Parametric excitation

The broad band random excitation of a two degree of freedom vibratory system with non-linear coupling of autoparametric type is studied. A general equation for the evolution of the moments of any order of the response co-ordinates is derived by using stochastic calculus and found to represent an infinite hierarchy set. Consideration is given to the determination of the mean square stability boundary for unimodal response with no transverse motion of the coupled system. Two approximate solutions are obtained. Results are also obtained from an investigation of the response regions of a laboratory model excited from a random noise generator.

80-2708

Response of a Dynamic System to Flow-Induced Load

P.T.D. Spanos and T.W. Chen
Dept. of Aerospace Engrg. and Engrg. Mechanics, The Univ. of Texas at Austin, Austin, TX 78712,

Intl. J. Nonlin. Mech., 15 (2), pp 115-126 (1980) 9 figs, 12 refs

Key Words: Flow-induced excitation, Viscous damping

An approximate analytical method is used to study *in-line* vibrations of a linear system induced by oscillatory flow. The hydrodynamic drag force is accounted for by an equivalent viscous dashpot. The obtained equivalent linear system is used to determine the amplitude and the phase of the oscillatory component, and the offset component of the steady-state periodic response of the linear system. Several parametric studies are presented and discussed in detail. Particular attention is given to the magnitude of the effective viscous damping.

80-2709

A General Substructure Synthesis Method for the Dynamic Simulation of Complex Structures

A.L. Hale and L. Meirovitch

Dept. of Engrg. Science and Mechanics, Virginia Polytechnic Inst. and State Univ., Blacksburg, VA 24061, J. Sound Vib., 69 (2), pp 309-326 (Mar 22, 1980) 1 fig, 3 tables, 12 refs

Key Words: Eigenvalue problems, Natural frequencies, Mode shapes, Substructuring methods

A general substructure synthesis method is developed for the dynamic analysis of complex flexible structures. The motion of each substructure is represented by a given number of substructure admissible functions. The otherwise disjointed substructures are connected together to form a whole structure by imposing approximate geometric compatibility conditions by means of the method of weighted residuals. The behavior of the estimated eigenvalues obtained by the substructure synthesis method can be ascertained by means of a bracketing theorem.

80-2710

Nonlinear Analysis of Liquid Motion in a Container Subjected to Forced Pitching Oscillation

T. Nakayama and K. Washizu

Dept. of Aeronautics, Univ. of Tokyo, Hongo 7-3-1, Bunkyo-ku, Tokyo, Japan, Intl. J. Numer. Methods Engr., 15 (8), pp 1207-1220 (Aug 1980) 12 figs, 9 refs

Key Words: Containers (tanks), Fluid-filled containers, Periodic excitation, Nonlinear theories

A nonlinear analysis is carried out for the motion of the inviscid, incompressible fluid in a two-dimensional, rigid, open container which is subjected to forced sinusoidal pitching oscillation. The problem is defined as a nonlinear initial-boundary value problem by the use of a governing differential equation and boundary conditions. The problem is then formulated in the form of a pseudo-variational principle. The finite element method and finite difference method are used spacewise and timewise, respectively. Numerical results are compared with solutions of the linear theory and experimental data. The difference between linear and nonlinear analysis is indicated.

80-2711

Harmonic Wave Propagation in an Infinite Viscoelastic Medium with a Period Array of Cylindrical Elastic Fibers

T.C. Ma, R.A. Scott, and W.H. Yang

Dept. of Mech. Engrg. and Applied Mechanics, Univ. of Michigan, Ann Arbor, MI 48109, J. Sound Vib., 69 (2), pp 257-264 (Mar 22, 1980) 4 figs, 1 table, 14 refs

Key Words: Wave propagation, Harmonic waves, Fiber composites, Viscoelastic media, Finite element technique, Galerkin method

The propagation of plane harmonic waves in an infinite isotropic medium in which a doubly periodic array of cylindrical fibers is embedded is studied. A finite element method based on Galerkin's technique is employed, which leads to a non-linear eigenvalue problem. An iterative scheme is used to obtain two modes of dispersion, for both real and imaginary wave numbers, for a specific composite.

80-2712

Combination Resonance of Parametrically Excited Coupled Second Order Systems with Non-Linear Damping

V. Mukhopadhyay

Dept. of Aeronautical Engrg., Indian Inst. of Tech., Kharagpur-721302, India, J. Sound Vib., 69 (2), pp 297-307 (Mar 22, 1980) 5 figs, 9 refs

Key Words: Parametric excitation, Nonlinear damping

The parametrically excited oscillation of two coupled second order systems with non-linear damping is investigated. Through an asymptotic analysis simple formulas are obtained

for evaluating the steady state amplitudes in the first instability region and the non-dimensional solution surfaces are plotted. The theoretical results are examined.

80-2713
Forced Oscillations of Nonlinear Hamiltonian Systems, II
I. Ekeland
Mathematics Res. Ctr., Wisconsin Univ., Madison, WI, Rept. No. MRC-TSR-2030, 26 pp (Dec 1979)
AD-A083 812/8

Key Words: Forced vibration, Nonlinear systems

A study is reported of periodic solutions of the nonlinear Hamiltonian system with n degrees of freedom, the Hamiltonian H being convex and super quadratic in both variables, and the forcing terms being T-periodic with mean value zero.

80-2714
A Model for a Two Dimensional Distributed Resonator
J.F.W. Bell, J.Y.F. Chen, G.K. Steel, and S.A.C. Sanders
Dept. of Electrical and Electronic Engrg., Univ. of Aston in Birmingham, Gosta Green, Birmingham, UK, J. Sound Vib., 68 (1), pp 45-58 (Jan 8, 1980) 7 figs, 3 tables, 8 refs

Key Words: Resonators, Mathematical models

In many distributed resonators the low order mode frequencies are sufficiently separated to permit satisfactory modeling in terms of only the single mode being used. It can be represented mechanically by mass, stiffness and energy loss by dissipation and coupling. This article is concerned with the extension of this model to higher, more complex modes.

MECHANICAL PROPERTIES

DAMPING

(Also see No. 2670, 2712)

80-2715
Stability of Machine Units with Quadratic Hysteresis
V. Loginov and G. Strahow
Vibrotechnika, 5 (29), pp 121-127 (1977), 6 figs, 4 refs, Kaunas A. Snieckus Politechnical Institute, Kaunas, Lithuanian SSR, 1979
(In Russian)

Key Words: Rotating structures, Hysteretic damping, Quadratic damping

A static and dynamic stability problem of circulatory system with structural damping is developed. A high frictional force intensity effect on the stability is revealed.

80-2716
More on Finite Element Modeling of Damped Composite Systems
Y.P. Lu and G.C. Everstine
David W. Taylor Naval Ship Res. and Dev. Ctr., Bethesda, MD 20084, J. Sound Vib., 69 (2), pp 199-205 (Mar 22, 1980) 4 figs, 20 refs

Key Words: Composite structures, Viscoelastic damping, Viscoelastic-core containing media, Sandwich structures, Beams, Rings, Finite element technique

Finite element procedures are developed and verified for layered beams and rings having either continuously or discontinuously constrained viscoelastic damping layers. The two configurations considered are a three-layered sandwich beam or ring (closed curved beam) consisting of two thin elastic layers with a viscoelastic core in between, and a damped composite made of a thin-walled elastic structure having a finite number of mass segments or elastic segments adhered to it by a viscoelastic material.

80-2717
Quenching the Oscillations of Vibroimpact System by Dynamic Damper
K. Ragulskis and G. Ulinskaite
Kaunas Antanas Snieckus Polytechnical Inst., Kaunas, Lithuania, Vibrotechnika, 5 (29), pp 137-140 (1977), 2 figs, 3 refs, Kaunas A. Snieckus Politechnical Institute, Kaunas, Lithuanian SSR, 1979
(In Russian)

Key Words: Damping, Resonant frequencies

In an effort to reduce resonance oscillations the dynamic linear damper is joined to symmetric vibroimpact system.

The method of harmonic linearization shows that the amplitude of steady oscillations can be substantially reduced.

80-2718

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: Dampers, Elastomeric dampers, Hydraulic dampers, Power transmission systems

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.

80-2719

Effect of Damping on Impact Response of a Two Degrees of Freedom System

M.S. Hundal

Dept. of Mech. Engrg., The Univ. of Vermont, Burlington, VT 05405, J. Sound Vib., 68 (3), pp 407-412 (Feb 8, 1980) 5 figs, 1 table, 4 refs

Key Words: Damping, Shock absorbers, Two degree of freedom systems, Optimum design, Shock resistant design

The impact response of a system consisting of a main mass on which a critical element of much smaller mass is mounted, is analyzed. Equations of motion are non-dimensionalized and a closed form solution obtained. System parameters are the two damping ratios and the frequency ratio. Maximum values of the non-dimensional acceleration of the critical element and the product of its acceleration and displacement are computed. Results are presented in a form to permit optimum design of the system.

FATIGUE

(Also see Nos. 2612, 2633, 2754)

80-2720

Fatigue Crack Propagation in Aluminum Alloy Sheet Materials under Maneuver Spectrum and Constant Amplitude Loading

R.J.H. Wanhill

Structures and Materials Div., National Aerospace Lab., Amsterdam, Netherlands, Rept. No. NLR-MP-78025-U, 25 pp (June 1978)

N80-22749

Key Words: Fatigue tests, Crack propagation

Aluminum alloy sheets were compared for fatigue crack propagation resistance under maneuver conditions and constant amplitude loading. Results of stress levels, crack growth rate, delta k value, and fracture toughness for each alloy are presented.

EXPERIMENTATION

MEASUREMENT AND ANALYSIS

(Also see Nos. 2757, 2758)

80-2721

Noncontacting Method for Measuring Angular Deflection

E.L. Bryant

Langley Research Center, Langley Station, VA, U.S. PATENT-4 189 234, 4 pp (Feb 1980)

Key Words: Measuring instruments

An apparatus is described for indicating the instantaneous angular deflection of an object about a selected axis without mechanical contact with the object.

80-2722

On Choice Filter Number When Signal Reproducing

A. Bozko and J. Puzko

Kharkov Institut problem mashinostroeniya, AN USSR, Vibrotechnika 5 (29), pp 107-112 (1977), 4 figs, 2 refs, Kaunas A. Snieckus Politechnical Institute, Kaunas, Lithuanian SSR, 1979
(In Russian)

Key Words: Spectral energy distribution techniques, Band-pass filters

The problem of quantifying stepchoice for frequency axis is discussed; the algorithm for filter number definition when reproducing spectral density of process by synthesizer is received. The error estimation of spectral density reproduction is made. The design formulas are derived and example is given.

80-2723
A Digital Low Frequency Spectrum Analyzer, Using a Programmable Pocket Calculator
W.P. Spruit
Dept. of Electrical Engrg., Technische Hogeschool, Eindhoven, Netherlands, Rept. No. TH-78-E-85, ISBN-90-6144-085-8, 37 pp (June 1978)
N80-25015

Key Words: Spectrum analyzers, Noise measurement, Measuring instruments

A measuring instrument utilizing Texas Instruments calculators is described. An application as a digital noise measuring system is discussed in detail. Results concerning sine-wave and noisy input signals are presented.

DIAGNOSTICS

80-2724
Defect Location in Structures by a Vibration Technique
P. Cawley
Dept. of Mech. Engrg., Bristol Univ., UK, 127 pp (Nov 1978)
N80-21797

Key Words: Diagnostic techniques, Nondestructive tests, Vibratory techniques, Natural frequencies

A vibration technique for non-destructively assessing the integrity of structures using measurements of changes in the lower structural natural frequencies, made at a single point in the structure, in conjunction with a dynamic analysis of the system to detect, locate and quantify damage was developed. *A program was developed which provides the location* of the damage site and estimation of damage severity from the results of the dynamic analysis and the changes in the structural natural frequencies.

80-2725
Detection of Damage Structures from Changes in Their Dynamic (Modal) Properties - A Survey
M. Richardson
Lawrence Livermore Labs., California Univ., Livermore, CA, Rept. No. UCRL-15103, 282 pp (Apr 1980)
NUREG-CR-1431

Key Words: Diagnostic techniques, Modal tests

The stated object of this study was to survey the technical literature and interview selected experts in the fields of dynamic testing and analysis to determine the state-of-the-art of the relationship between physical damage to a structure and changes in its dynamic (modal) properties.

80-2726
Small Portable Analyzer Diagnostic Equipment (SPADE) - Advance Development Prototype Report
D.B. Board
SKF Industries, Inc., King of Prussia, PA, Rept. No. SKF-AL99Q016, USAAVRADCOM-TR-80-F-3, 115 pp (Sept 1979)
AD-A083 652/8

Key Words: Diagnostic equipment, Aircraft, Bearings, Computer-aided techniques

The SPADE is an advanced development prototype of an off board aircraft bearing diagnostic equipment. The SPADE works on the shock pulse principle, which measures the *kinetic impact and frictional energy within the tested component*, independent of background vibration. The SPADE provides a highly accurate and trendable measurement of bearing condition that is independent of non-defect related background vibrations caused by the elastic motions of structures, rotors, gears, and shafts.

ANALYSIS AND DESIGN

80-2727

On the Application of Feeding Support with Gas Lubrication for Micro-Turbomachines

G. Zavialov, A. Koisin, and V. Lesukov
Nauchno-issledovatelskii i konstruktorskii institut mikrokriogennoi tekhniki, Omsk, USSR, Vibrotechnika, 5 (29), pp 43-48 (1977), 2 figs, 9 refs, Kaunas A. Snieckus Politechnical Institute, Kaunas, Lithuanian SSR, 1979
(In Russian)

Key Words: Bearings, Gas bearings, Balancing techniques

The main type of bearings with gas-lubrication are analyzed. A feeding support as a gas-bearing is selected for micro-turbomachines. The stationary flat flow of compressed lubricant in the clearance of cylindrical bearing is investigated at arbitrary shaft position and sleeve position in the area of the central position. The expression of lubricating layer is obtained, and balance conditions are deduced. Conclusion is made on the possibility of balance position stabilization by applying the feeding supports.

80-2728

A Theoretical Introduction to the Development of a Unified Approach to Flexible Rotor Balancing

A.G. Parkinson, M.S. Darlow, and A.J. Smalley
Dept. of Mech. Engrg., University College London, London WC1E 7JE, UK, J. Sound Vib., 68 (4), pp 489-506 (Feb 22, 1980) 3 figs, 1 table, 13 refs

Key Words: Balancing techniques, Rotors (machine elements), Flexible rotors, Shafts

Several successful methods for balancing flexible rotating shafts have been developed in recent years, whose relative merits have been the subject of much debate and argument. These methods can be separated into two seemingly distinct groups which can be concisely identified as modal balancing and influence coefficient techniques. In practice many of the differences are more apparent rather than real and the time has arrived for an attempt to reconcile the differences and hopefully to synthesize a method which includes the best features of both methods. This paper reviews the theoretical basis for this program.

ANALYTICAL METHODS

80-2729

Equivalent Linearization for Systems Subjected to Non-Stationary Random Excitation

W.D. Iwan and A.B. Mason Jr
California Inst. of Tech., Pasadena, CA 91125, Intl. J. Nonlin. Mech., 15 (2), pp 71-82 (1980) 5 figs, 15 refs

Key Words: Random excitation, Equivalent linearization method

The method of equivalent linearization is applied to the general problem of the response of non-linear discrete systems to non-stationary random excitation. Conditions for minimum equation difference are determined which do not depend explicitly on time but only on the instantaneous statistics of the response process. Using the equivalent linear parameters, a deterministic non-linear ordinary differential equation for the covariance matrix is derived. An example is given of a damped Duffing oscillator subjected to modulated white noise.

80-2730

Methods for Determining Undamped Normal Modes and Transfer Functions from Receptance Measurements

D.R. Gaukroger and J.C. Copley
Royal Aircraft Establishment, Farnborough, UK, Rept. No. RAE-TR-79071; RAE-Struct-BF/B/0793; BR70158, 35 pp (June 1979)

Key Words: Receptance method, Normal modes, Transfer functions

Possible approaches to the determination of the dynamic characteristics of a system from receptance measurements are considered. The particular characteristics of interest are transfer functions for which no direct measurements are available and their undamped normal modes. A simple example using calculated receptances which are degraded with random errors indicates the degree of accuracy which might be expected from various methods of analysis.

80-2731

Time-Domain Finite-Element Solutions for Single-Degree-of-Freedom Systems with Time-Dependent Parameters

J.E.T. Penny and G.F. Howard

Univ. of Aston in Birmingham, Gosta Green, Birmingham, UK, J. Mech. Engr. Sci., 22 (1), pp 29-33 (Feb 1980) 2 tables, 15 refs

Key Words: Finite element technique, Single degree of freedom systems, Time domain method

The motion of systems in which mass, damping, and stiffness properties are known functions of time is described in terms of time-domain finite elements. The response of such systems to external forces is determined by generating matrices, the coefficients of which are functions of the varying parameters. The original differential equations are then replaced by sets of linear algebraic equations which are solved numerically. Examples of the use of the method are given.

80-2732

The Commonality of Earthquake and Wind Analysis

P.J. Cevallos-Candau

Ph.D. Thesis, Univ. of Illinois at Urbana-Champaign, 209 pp (1980)

UM 8017919

Key Words: Modal analysis, Wind-induced excitation, Seismic excitation, Earthquakes

The development of a basis for generating response spectra for wind loading, which in turn would permit the use of modal analysis techniques for wind analysis in a manner similar to that employed for earthquake engineering is investigated. Random vibration techniques were applied for developing response spectra for wind loading. Several illustrative examples are presented to demonstrate the common application of modal analysis and response spectrum techniques for evaluating the effects of wind and earthquake excitation. The primary purpose of this research study is to investigate the common features of general dynamic analysis procedures employed for evaluating the effects of wind and earthquake excitation.

80-2733

Condensing Loaded Points for Transients by Substructuring

T.G. Butler

NASA Goddard Space Flight Ctr., Greenbelt, MD, In: Eighth NASTRAN User's Colloq., pp 79-100 (May 1980)

N80-24654

Key Words: Computer programs, Substructuring methods

A technique for condensing dynamic loading points is described. The method was applied to substructure transient solutions and found to be very effective.

MODELING TECHNIQUES

(Also see No. 2741)

80-2734

Methods and Application of Structural Modelling from Measured Structural Frequency Response Data

H.G.D. Goyder

Inst. of Sound and Vib. Res., Univ. of Southampton, Southampton S09 5NH, UK, J. Sound Vib., 68 (2), pp 209-230 (Jan 22, 1980) 11 figs, 18 refs

Key Words: Mathematical models, Frequency response method

By modeling two separate components of a structure from measured data it is possible to obtain an estimate of the subsequent motion and power flow through the two components when coupled. A critical examination is made of the use of mathematical modeling for the determination of mass and stiffness distribution and for the prediction of the response of coupled structures.

NONLINEAR ANALYSIS

80-2735

Energy Minimization Versus Pseudo Force Technique for Nonlinear Structural Analysis

M.P. Kamat and R.J. Hayduk

Virginia Polytechnic Inst. and State Univ., Blacksburg, VA 24061, Computers Struc., 11 (5), pp 403-409 (May 1980) 4 figs, 47 refs

Key Words: Nonlinear analysis, Minimization technique, Pseudo force technique

The effectiveness of using minimization techniques for the solution of nonlinear structural analysis problems is discussed and demonstrated by comparison with the conventional pseudo force technique. The comparison involves nonlinear problems with a relatively few degrees of freedom. A survey of the state-of-the-art of algorithms for unconstrained minimization reveals that extension of the technique to large scale nonlinear systems is possible.

NUMERICAL METHODS

(Also see Nos. 2667, 2697)

80-2736

Determination of the Inhomogeneous Structure of a Medium from Its Plane Wave Reflection Response, Part 1: A Numerical Analysis of the Direct Problem

S.M. Candel, F. Defillipi, and A. Launay
Ecole Centrale des Arts et Manufactures, 92290 Chatenay-Malabry, France, J. Sound Vib., 68 (4), pp 571-582 (Feb 22, 1980) 6 figs, 12 refs

Key Words: Numerical analysis, Wave propagation, Wave diffraction

A numerical analysis of wave propagation in one dimensional inhomogeneous media is presented. The aim is to provide a natural and physical basis for the solution of the inverse scattering problem in one dimension.

80-2737

Determination of the Inhomogeneous Structure of a Medium from Its Plane Wave Reflection Response, Part II. A Numerical Approximation

S.M. Candel, F. Defillipi, and A. Launay
Ecole Centrale des Arts et Manufactures, 92290 Chatenay-Malabry, France, J. Sound Vib., 68 (4), pp 583-595 (Feb 22, 1980) 5 figs, 14 refs

Key Words: Numerical analysis, Wave propagation, Wave diffraction

A standard one dimensional inverse scattering problem -- given the reflection response of an unknown inhomogeneous medium for plane waves under normal or oblique incidence, determine its sound speed and density structures – is investigated. The problem is solved by means of a simple numerical technique which involves only fast Fourier transform operations and numerical integration of ordinary differential equations.

80-2738

A Direct Construction of First Integrals for Certain Non-Linear Dynamical Systems

W. Sarlet and L.Y. Bahar
Instituut voor Theoretische Mechanica Rijksuniversiteit Gent, Krijgslaan 271-S9, B-9000 Gent, Belgium, Intl. J. Nonlin. Mech., 15 (2), pp 133-146 (1980) 35 refs

Key Words: Integration, Differential equations, Equations of motion, Dynamic systems, Nonlinear systems

A direct, constructive approach to the problem of finding first integrals of certain non-linear, second order ordinary differential equations is presented. The idea is motivated by the construction of the energy integral for the equations of motion of the corresponding conservative systems. The approach reveals some interesting features when it is specialized to the case of linear equations. A two-dimensional example is considered by extending the methodology developed for scalar equations to their vector counterparts.

STATISTICAL METHODS

(Also see No. 2609)

80-2739

Demonstration of a Stochastic Analysis Technique for Nonlinear Dynamical Systems

C.J. Henry
Davidson Lab., Stevens Inst. of Tech., Hoboken, NJ, Rept. No. SIT-DL-79-9-2033, 52 pp (Sept 1979) AD-A083 629/6

Key Words: Stochastic processes, Nonlinear systems

In order to demonstrate a promising technique, the control gain for a nonlinear, first order system with limited control and with random input, required to obtain a limited range of state with given likelihood is evaluated. The results are discussed and elaborated in order to indicate the significance of this promising technique.

80-2740

Analytic Theory of Extrema, II: Application to Non-Linear Oscillators

V. Seshadri, B.J. West, and K. Lindenberg
Dept. of Chemistry, Univ. of California, San Diego, LaJolla, CA 92093, J. Sound Vib., 68 (4), pp 553-570 (Feb 22, 1980) 3 figs, 28 refs

Key Words: Oscillators, Damped structures, Statistical analysis, Extremum principles

A simple method is applied that yields analytic results for the mean first passage time and the mean extreme value of Fokker-Planck processes in the asymptotic regime. The extremal properties of lightly damped linear and non-linear oscillators excited by white noise are studied. The agreement of the results of this theory with previous calculations is excellent.

PARAMETER IDENTIFICATION

(Also see Nos. 2617, 2678, 2734)

80-2741

Identification of Mechanical Multimass Systems (Identifikation mechanischer Mehrkorpersysteme)

R.G. Schwarz

Fortschritt-Berichte der VDI-Zt., Series 8, No. 30, 188 pp, 22 figs, 7 tables (1980). Summary in VDI-Z 122 (11), p 430 (June 1980)

(In German)

Key Words: Time-domain method, Multi degree of freedom systems, System identification techniques

A time domain method is presented for the identification of mechanical multimass systems. The method requires only a minimum of a priori information and the measurement of the deflections only. The method is tested on a four degree of freedom and 36 parameter system. The simulation confirms the theory, as do the experimental results.

80-2742

Parameter Identification in a Class of Nonlinear Systems

P.K. Pal

Ph.D. Thesis, The Univ. of Connecticut, 158 pp (1979)

UM 801704

Key Words: Parameter identification technique, Nonlinear systems

The problems considered in this work are the development of algorithms for the on line identification of the parameters in a class of discrete time nonlinear systems disturbed by white noise. The class consists of those systems in which parameters enter linearly into the state equations while state variables and inputs, if they are perfectly measurable, enter in arbitrary nonlinear form.

80-2743

Determination of Dynamic Structural Stresses from Experimental and Modal Analyses

M.A. Tucchio

Ph.D. Thesis, The Univ., of Connecticut, 107 pp (1980)

UM 8017065

Key Words: Parameter identification technique, Accelerometers, Beams, Frames, Modal analysis

A methodology to determine the dynamic stresses in a structure from a few measured accelerations is presented. It is shown that while the technique is theoretically correct, it is subject to experimental limitations due to inaccuracies in current accelerometer technology. The theory of the method is developed and checked both analytically and experimentally.

COMPUTER PROGRAMS

(Also see No. 2733)

80-2744

INRESB-3D: A Computer Program for Inelastic Analysis of Reinforced-Concrete Steel Buildings Subjected to 3-Dimensional Ground Motions

F.Y. Cheng and P. Kitipitayangkul

Dept. of Civil Engrg., Missouri Univ., Rolla, MO, Rept. No. CIVIL ENGINEERING STUDY 79-11, NSF/RA-790400, 104 pp (Aug 1979)

PB80-176944

Key Words: Computer programs, Buildings, Reinforced concrete, Seismic excitation

This report is a user's guide for the computer program, INRESB-3D, for analyzing elastic and inelastic building systems subjected to the simultaneous input of static loads and multicomponent earthquake motions, which can be applied in any direction of the structural plane. The report includes the program list, a description of the program, instructions for data preparation, and a guide to modify the program's capacity.

80-2745

A Generalized Coupling Technique for the Dynamic Analysis of Structural Systems

A. Berman

Kaman Aerospace Corp., Bloomfield, CT, J. Amer. Helicopter Soc., 25 (3), pp 22-28 (July 1980) 7 figs, 6 refs

Key Words: Computer programs, Coupled systems, Helicopters

A technique is described which allows the performance of dynamic and aeroelastic analyses on an arbitrarily coupled system of independently modeled components. Each component may contain periodic, nonlinear, and nonanalytic effects. Applications to helicopter analyses are discussed. The architecture of a computer program which implements this technique is illustrated.

80-2746

Small Vibrations in Lever Mechanisms

H. Dresing and B. Fiedler

Visshaya technicheskaya shkola Karl-Marks Stadta, E. Germany, Vibrotechnika, 5 (29), pp 99-105 (1977), 3 figs, 9 refs, Kaunas A. Snieckus Politechnical Institute, Kaunas, Lithuanian SSR, 1979 (In Russian)

Key Words: Mechanisms, Self-excited vibrations, Forced vibrations, Computer programs

The automatic solution of problems on the dynamics of mechanism with an additional degree of freedom is made for the determination of self-vibration frequencies, the estimation of forced vibrations, resonance use and stability. The program formed is the extension of the next part of the system of KOGEOP program. It will be applied for the solution of practical dynamics problems on high-speed lever devices for the industrial enterprises in German Democratic Republic.

80-2747

A Computer Program for Three Dimensional Analysis of Buildings

J.L. Humar and J.U. Khandoker

Dept. of Civil Engrg., Carleton Univ., Ottawa, Canada, Computers Struc., 11 (5), pp 369-387 (May 1980) 5 figs, 8 refs

Key Words: Computer programs, Buildings, Earthquake response, Seismic response

A special purpose computer program for the linear three dimensional analyses of building structures for gravity, lateral and earthquake loads is presented. Three dimensional frequencies and mode shapes are evaluated and a response spectrum approach is used for the dynamic analysis. A front-end processor accepts input data in a conversational mode and in free format. Data input is speeded up by taking advantage of the repetitive nature of frame dimensions, member sizes and loadings.

80-2748

Applications of NASTRAN in Gust Response Analysis at Northrop

A.K. Singh

In: NASA Goddard Space Flight Ctr., Eighth NASTRAN User's Colloq., pp 165-188 (May 1980) N80-24658

Key Words: Computer programs, NASTRAN (computer program), Aircraft, Wind-induced excitation

A comprehensive gust response analysis was performed on a complete model of an airplane using the NASTRAN aeroelastic package. The analysis investigated random response to atmospheric turbulence and transient response to a discrete gust, including control system dynamics in both cases.

80-2749

Steady State Solutions to Dynamically Loaded Periodic Structures

A.J. Kalinowski

Naval Underwater Systems Ctr., New London, CT, In: NASA Goddard Space Flight Ctr., Eighth NASTRAN User's Colloq., pp 131-164 (May 1980) N80-24657

Key Words: Computer programs, NASTRAN (computer programs), Periodic structures

The general problem of solving for the steady state dynamic response of a general elastic periodic structure subject to a phase difference loading of the type encountered in traveling wave propagation problems is studied. Two types of structural configurations are considered. Final results are recovered as with any ordinary rigid format-8 solution, except that the results are only printed for the typical periodic segment of the structure. A simple demonstration problem having a known exact solution is used to illustrate the implementation of the procedure.

80-2750
Normal Mode Analysis of the IUS/TDRS Payload in a Payload Canister/Transporter Environment
K.A. Meyer
Planning Res. Corp., Kennedy Space Ctr., FL, In NASA Goddard Space Flight Ctr., Eighth NASTRAN User's Colloq., pp 113-129 (May 1980)
N80-24656

Key Words: Computer programs, NASTRAN (Computer programs), Satellites, Transportation effects, Normal modes

Special modeling techniques are developed to simulate an accurate mathematical model of the transporter/canister/payload system during ground transport of the Inertial Upper Stage/Tracking and Data Relay Satellite payload. The three finite element models are merged into one model and used along with the NASTRAN normal mode analysis. Deficiencies as well as recommendations for improving the NASTRAN program are discussed.

GENERAL TOPICS

CONFERENCE PROCEEDINGS

80-2751
Proceedings of the Conference on the Stability and Dynamic Response of Rotors with Squeeze Film Bearings, 8-10 May 79
Dept. of Mech. and Aerospace Engrg., Virginia Univ., Charlottesville, VA, Rept. No. ARO-16660.1-E, 266 pp (1979)
AD-A083 098/4

Key Words: Bearings, Squeeze film bearings, Rotors (machine elements), Proceedings

Presentations made at the Conference on the Stability and Dynamic Response of Rotors with Squeeze Film Bearings are reported. The purpose of the conference was to assemble experts on squeeze film bearings to assess the current state of the art squeeze film bearing technology and to determine future research requirements.

TUTORIALS AND REVIEWS

80-2752
Modeling of Fluid Transients in Machines, Part II: Advanced Considerations
R. Singh
Dept. of Mech. Engrg., Ohio State Univ., 206 W. 18th Ave., Columbus, OH 43210, Shock Vib. Dig., 12 (7), pp 11-17 (July 1980) 140 refs

Key Words: Reviews, Turbomachinery, Mathematical models

A state-of-the-art literature review with emphasis on advanced mathematical modeling considerations is presented. Modeling of turbomachinery and positive displacement machinery, dynamic coupling of machines, transient behavior of machinery systems and installations, multi-dimensional transients, two-phase flow, interaction between wave propagation and fluid flow modes, and experimental modeling methods are discussed.

80-2753
Stability Problems of Rotor Systems
T. Iwatsubo
Faculty of Engrg., Kobe Univ., Rokko, Nada, Kobe, Japan, Shock Vib. Dig., 12 (7), pp 3-8 (July 1980) 65 refs

Key Words: Reviews, Rotors (machine elements), Rotating structures

Literature published in 1978 and 1979 on instability in rotor systems is reviewed. Included are instability due to internal damping, dry friction, bearing forces, fluid forces, parametric excitation, torsional and torsional lateral vibrations, and asymmetric elements.

80-2754
Fatigue of Fiber-Reinforced Plastics. A Literature Survey
C. Lundemo
Structures Dept., Aeronautical Research Inst. of Sweden, Stockholm, Sweden, Rept. No. FFA TN AU-1499, 46 pp (Aug 1979)
N80-21550

Key Words: Reviews, Plastics, Layered materials, Fatigue life

A review of constant amplitude fatigue of fiber reinforced plastic laminates taken from recent literature is presented. An inventory of test methods and choice of failure criteria is made. Suggestions for further fatigue testing, leading to better understanding of the fatigue life of wind turbine blades are included.

80-2755

A Survey on Non-Linear Oscillations

D.P. Atherton and H.T. Dorrah

Electrical Engrg. Dept., Univ. of New Brunswick, Fredericton, N.B., Canada, Intl. J. Control, 31 (6), pp 1041-1105 (June 1980) 14 figs, 578 refs

Key Words: Reviews, Nonlinear response, Lumped parameter method

A comprehensive review of work in the field of non-linear oscillations is presented. A brief discussion of second-order systems is followed by a presentation of exact criteria, approximate analytical methods and computational techniques for limit cycles in single variable systems. Multivariable systems are covered from an analogous viewpoint which allows the reader to clearly identify both how single variable methods have been extended and the possibilities for further research. Several applications of the theories in various fields of engineering and science are discussed and indicate the broad interest in non-linear oscillatory phenomena. A detailed bibliography on the subject is provided.

CRITERIA, STANDARDS, AND SPECIFICATIONS

80-2756

Standardization of Dynamic Vibration Evaluation and its Correlation to the Stevens Power Functions (Zur Vereinheitlichung der dynamischen Schwingungsbewertung und ihrer Zuordnung zu den Stevensschen Powerfunktionen)

F.J. Meister

VDI Z, 122 (11), pp 439-443 (June 1980) 2 figs, 6 table, 26 refs

(In German)

Key Words: Standards and codes, Acoustic excitation, Vibration excitation, Human response

Vibration and sound sensitivity are correlated by means of Stevens power functions. The scale elements, sone and pal, are correlated to each other and the relationship of the so-called K-value of the proposed standard VDI 2057 to the pal scale is sought. Even the dependency of vibration excitation of the human body on the duration of excitation can be simulated by the time dependency of acoustic excitation, which was obtained for three excitation steps. These are compared with the ISO and Soviet standard proposals.

BIBLIOGRAPHIES

80-2757

Applications of Holography. 1979 - April, 1980 (Citations from the NTIS Data Base)

B. Carrigan

NTIS, Springfield, VA, 65 pp (May 1980)

PB80-81-674

Key Words: Bibliographies, Holography, Nondestructive tests, Vibration measurement

The bibliography covers studies on the applications of holography in such areas as photographing high-speed particles, nondestructive testing of material defects, strain analysis, microscopy, interferometry, vibration measurement, and medical diagnosis.

80-2758

Applications of Holography 1975 - 1978 (Citations from the NTIS Data Base)

B. Carrigan

NTIS, Springfield, VA, 254 pp (May 1980)

PB80-810666

Key Words: Bibliographies, Holography, Nondestructive tests, Vibration measurement

The bibliography covers studies on the applications of holography in such areas as photographing high-speed particles, nondestructive testing of material defects, strain analysis, microscopy, interferometry, vibration measurement, and medical diagnosis.

80-2759
Study of Vibrational Wiring Process of Ferrite Cores in Electronic Computer Main Memory

J. Gecevicius and A. Fedaravicius
Kaunas Antanas Snieckus Polytechnical Inst., Kaunas, Lithuania, Vibrotechnika, 5 (29), pp 151-159 (1977), 8 figs, 4 refs, Kaunas A. Snieckus Politechnical Institute, Kaunas, Lithuanian SSR, 1979
(In Russian)

Key Words: Computer storage devices, Magnetic cores

A method for mechanical wiring of a coordinate conductor through ferrite cores in the main memory of a computer has been examined and suggested for application. A new technique of driving a coordinate conductor has been found, thus considerably reducing the resistance force to the motion of wire in the cores.

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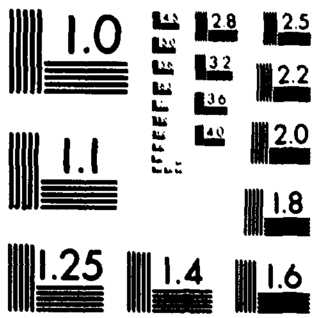

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560	431	372	603	224	475	516	467	158	509
880	671	602	1763	344	605	536	537	608	609
1070	931	1572	2223	604	1355	606	607	738	1149
1150	1151	1902	2233	2014	1835	876	1657	938	1659
1330	1331	2192	2333	2034	2205	2336	2127	1148	1779
1660	1901	2332	2583	2204	2335		2277	1658	1899
1780	2211	1782	2633	2224			2337	1828	2059
1900	1781	2612		2334				2418	2209
1940	2221			2454				2528	2259
2060	2241			2754				2538	
2210	2261								
2260	2331								
	2641								

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			1583	1574	1355	2386	2487	1428	1689
				1584	1425	2546	2537	1928	2149
				2554	1695			2128	
					1785			2148	
					2255				

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2360				1204	505	1696			
					895	2336			
					2315	2536			
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		1632							

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240	521	552	313	514	765	196	317	158	909
260	551	1112	343	654	775	226	517	458	1069
910	641	1142	573	1064	825	596	797	498	1079
960	871	1332	653	1194	965	766	957	608	1329
1080	1041	1372	913	1454	1065	1026	1137	728	1359
1590	1711	1622	1193	1584	1195	1056	1607	1518	1649
1710	1771	1712	2083	2074	1205	1376	1887	1708	1769
2050	2471	1982	2293	2094	1375	1646	2217	2098	2069
	2711	2082	2503	2264	1845	1926	2517	2288	2179
	2731	2422	2683	2314	1975	2006	2567	2368	
				2364	2075	2186		2568	
				2604	2265	2316		2578	
					2665	2486			
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			1443						

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	1751								

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170	71	1592	1573	84	75	796	2477	1258	19
330	1051	2052	2283	104	315	1066		1658	1059
540	1591		2493	324		1856		2078	2649
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2750									2749

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20	1071	1062	1373	4	75	1026	107	98	539
330	1531	1142	1843	314	95	1696	697	328	1029
1240	1611	1332	2503	434	555	2536	817	998	1069
1410	2671	1372	2653	1144	2075		1047	1048	1329
1890		1402		1204	2085		1067	1608	1509
2650		2142		2494	2275		1307		1649
		2312		2724	2315		1777		1749
		2382					1847		2579
							2387		2649
							2607		2669
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1120	851	1122	273	844	1805	2036	567	2688	879
2200	1121	1822	2693		2105				1119
		2302							1729
									1819
									2189
									2299

Noise Control
use Noise Reduction

Noise Generation

130	131	132	33	174	125	126	1487	68	669
490	691	962	113	814	855	276	2047	748	689
690	1111	992	133	834	1045	456	2187	1478	989
750	1391	1392	1273	1234	1245	676	2257	1488	1289
910	1491	1552	1353	2374	1255	856		1528	1479
1000	1501	2202	1493		1995	1756		1728	
1230	1701		1993		2635	2686		1988	
1390	2101		2443					2298	
1640	2521		2593					2698	
1880									
2020									
2190									
2520									

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	2621				2235				

Noise Measurement

850	621	482	273	1264	945	456	567	618	619
2520	761	612	483	2214	1885	616	2137	888	1679
2700	771	1002	793	2444	2445	1806	2227	1638	2339
	881	1802	1543			2446	2447	1808	2449
		1912	2103					2138	2539
		2432	2723					2188	2699

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use Sound Level Meters

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930	961	902	1293	274	2575	276	127	2218	489
1390	1001	1992		814		2576	1977	2448	999
2700	1541			1544			2217		1109
				2374					1219
				2614					1979
									2449
									2689

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200	131	482	13	54	35	546	17	18	9
290	291	682	373	294	115	566	47	338	39
420	681	692	693	464	135	756	277	658	199
430	741	742	743	744	515	1526	337	688	599
740	781	792	793	754	675	1736	457	788	659
790	1261	932	853	944	1085	1756	677	1478	739
1260	1501	1102	1323	1044	1165	2296	757	1728	789
1380	1991	1302	1383	1164	1245	2396	947	1758	939
1490	2021	1522	1523	1264	1495		1117	1808	1119
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940	411	202	413	1974	1225	396	657	1228	1729
2580	941	412	923	2174	1735	1226	937	1738	1739
	1731	942	943	2584	1975	1736	1227	1978	
	2581	1732	1733	2754	2175	1976	1737		
		2582	1973		2375	2176	1977		
		2752	2583		2755				
			2753						

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280	461	42	1973	2024		66		498	
460	2211	462						1788	

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		1622	1483	1104	2125	2716		1858	1839
					2505				

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	1591	1062	1373	2164				1608	
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	2471		313					1658	1049
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		2192							1829

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use Antifriction Bearings

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	1911		693		45			1668	

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700									

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			1983					948	

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									2039

Rotary Wings

	2251	2232	1813	2474		126		2458	2619
			2033			2386			
			2233						

Rotating Structures

330	1981	1252	663	4	665	2586	417	1408	819
960		1482	1253	414	2505		1587	2638	959
2380		2652	1373	1174	2715				1369
			1433	1254					1939
			1463	1434					2039
			1703	1694					
			2753	2184					

Rotational Response

							2197		

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Rotatory Inertia Effects

	121		1843		825	816	797	1848	1609
	551				1375				1849
	1071				1595				1859
	1861				2115				
	2471								

Rotor Bearing Systems

1250	1251	2	1033	784	1985	306	307	1748	309
1480		1752	2383	1034		416	517	2478	1239
1750		2182				956	957		1249
2480						1176	1177		2179
						2056	2587		

Rotor Blades

1330	71	1022		304	305			1178	1029
2050	211	1572		1574				2468	
	1331			2374					
	1811								

Rotor Blades (Rotary Wings)
use Rotary Wings

Rotor-Induced Vibration

300		2242		1554					

Rotors (Machine Elements)

630	951	952	3	124	125	126	177	178	219
950	961	962	123	214	415	176	217	218	949
960	1041	1242	213	414	665	526	1257	538	959
1240	1241	1482	953	664	955	666	1447	958	1239
1330	1331	1982	1243	904	1035	806	1937	1938	1309
1480	1481	2182	1433	954	1245	1176	2057	2458	1409
1750	1751		1983	1174	1445	1246	2347	2558	1749
2010	2181		2183	1244	1755	1446	2387	2728	2559
2040	2521		2753	1654	2055	1756	2587		
2180	2751			1734	2385	1986			
2390				2384		2386			

Rubber
use Elastomers

Rules (Instructions)

		662			425				

Runge-Kutta Method

				664	405				

-S-

Safety (Nuclear Reactors)

2510									

Safety Belts
use Seat Belts

Safety Restraint Systems

270	451	452	1563	1784	445		447	448	449
450	1561	1562	1783				1707		1519
	1741	1742							1799

Sand

390	861	362						1118	259
									389

Sandwich Laminates
use Sandwich Structures

Sandwich Panels
use Panels
Sandwich Structures

Sandwich Structures

		412		314		2716	937		
		1592							

Satellite Antennas
use Spacecraft Antennas

Satellites

2620			1003	1004					
2750									

Saws

	691	692				2476	1727		
	1311						2477		

Scaling

2450	901	902			2555	626			999
	1431								1929

Screws

					1835				

Seals (Stoppers)

1370					2645	2646	1587	1368	1369

Seat Belts

270	991	1742	1783						

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Vibrating Foundations
2012 233 727 2009
2603

Vibrating Structures
610 132 1283 324 565 316 1237 1138 1319
1282 1423 2114 1997 1238
2117

Vibration Absorbers
use Vibration Absorption (Equipment)

Vibration Absorption (Equipment)
1321 1316 1317
1496

Vibration Analyzers
890 1931 1413 2539
2160

Vibration Control
50 781 932 13 964 1165 1166 997 668 599
200 1141 1312 1383 1224 2375 1286 1287 1738 789
1260 1991 1633 1254 2625 1496 1367 1758 1239
2240 1773 1264 2066 1457 2088 1279
2350 2243 1944 2216 1897
2643 2194 2226
2324 2246
2326

Vibration Dampers
1405 1407 298 1019
418
598
1318

Vibration Damping
1100 2231 82 373 1895 596 427 308 879
2620 2322 1323 2315 1406 557 2328 2329
1733 2325 1777
1753 2607
2273

Vibration Effects
1009

Vibration Excitation
1140 1012 493 494 1045 2756 1367 718 719
1312 593 1014 2007 1039
1313 1314 2239
1333

Vibration Frequencies
2079

Vibration Generation
1730 1391 2257

Vibration Isolation
2320 681 2242 1023 2464 785 776 2247 2038 2469
2630 941 2462 2624 2465 2467 2328
2041 2632 2468
2631

Vibration Isolators
500 411 782 13 784 595 2466 777 1319
1020 781 1322 2623
1320 1231
2040

Vibration Measurement
610 661 182 2313 164 2135 166 2227 888 1909
1580 2141 2472 2543 2084 1156 2757 2058 2019
2201 2134 1776 2758 2539
2544 2136
2186
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Vibration Reduction
use Vibration Control

Vibration Resonance
use Natural Frequencies

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910 1061 1502 403 2594 1515 656 1857 308
1140 1361 1063 2115 956 2667 458
1590 1651 1733 2285 2118
2120 2621 1863 2385
2370 2053 2685
2500 2273

Vibration Response Spectra
2561

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Water Towers

		722							

Water Waves

	241	32	1513		2215	1516		738	639
	401				2605			908	979
	1781							1778	1529
								2018	1779
									2369
									2439

Wave Attenuation

							357		859

Wave Diffraction

	341		1113	1634	1635	2696	1677	348	159
			1883			2736	2737	2338	349
			2303						629
									2099
									2369

Wave Energy

						1516			

Wave Equation

		142							

Waveguide Analysis

	91			1904	2695		1117	638	

Wave Number
use Frequency

Wave Propagation

640	1871	1952	1903	1664	335	146	637	148	559
1180	2711	2112	2093	1904		346	1387	578	639
		2152		2094		356	1717	908	1839
		2682				1976	2737	1388	2679
						2516		1878	
						2736		1978	

Wave Reflection

2490				564			147		

Wave Scattering

2690						866			

Weapons Systems

		1202				896			

Wear

		1132		1364				628	

Weighted Residual Technique

				1964					

Welded Joints

	2261			344				2418	
	2331								

Wheel Shimmy

						1826			

Wheels

1670					795	886	377		
					1825	1326			

Wheelsets

				284	285				1789

Whirling

1480	1	1752	2253	874		426	417	1338	
	951	2042		2044		666	667	1348	
	1481					2636			
	2611								

Wind-Induced Excitation

20	721	232	433	934	695	1306	477	968	1619
560	1431	972	763	1704	1505	1746	1407	1618	2619
720	1621	1052	973	2224	1535	1986	1967	1688	
1620	1781	1502	1143		1745	2226		2228	
1870	2241	2222			2005			2748	
2030	2411	2732			2225				
2240					2485				

Wind Tunnel Tests

50	51	1502	1143	74	1535	1166	767	988	1539
490	1331	1532	1303	1224	1545	1256	1547	1158	
1520	1431	2232	1543	1694	1915	1686	1687	1808	
1620	2551	2352		1794					
2450				1914					
2700									

Wind Tunnels

		2552	173	1164					2549
			1163						

Wind Turbines

2250	2251	2252			2185	1986			2689
2520						2186			

Windows

	1381				845	2296			

Wing Stores

50	2451	1532			1655		767	998	1539
2230		2452					2627	2628	2229

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PERIODICALS SCANNED

PUBLICATION AND ADDRESS	ABBREVIATION
ACTA MECHANICA Springer-Verlag New York, Inc. 175 Fifth Ave. New York, NY 10010	Acta Mech.
ACUSTICA S. Hirzel Verlag, Postfach 347 D-700 Stuttgart 1 W. Germany	Acustica
AERONAUTICAL JOURNAL Royal Aeronautical Society 4 Hamilton Place London W1V 0BQ, UK	Aeronaut. J.
AERONAUTICAL QUARTERLY Royal Aeronautical Society 4 Hamilton Place London W1V 0BQ, UK	Aeronaut. Quart.
AIAA JOURNAL American Institute of Aeronautics and Astronautics 1290 Avenue of the Americas New York, NY 10019	AIAA J.
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AMERICAN SOCIETY OF LUBRICATING ENGINEERS, TRANSACTIONS Academic Press 111 Fifth Ave. New York, NY 10019	ASLE, Trans.
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JOURNAL OF APPLIED MECHANICS	J. Appl. Mech., Trans. ASME
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JOURNAL OF MECHANICAL DESIGN	J. Mech. Des., Trans. ASME
JOURNAL OF PRESSURE VESSEL TECHNOLOGY	J. Pressure Vessel Tech., Trans. ASME
APPLIED ACOUSTICS Applied Science Publishers, Ltd. Ripple Road, Barking Essex, UK	Appl. Acoust.
APPLIED MATHEMATICAL MODELING IPC House 32 High St., Guildford Surrey GU1 3EW, UK	Appl. Math. Modeling
ARCHIVES OF ACOUSTICS Polish Academy of Sciences Committee on Acoustics Polish Acoustical Society	Arch. Acoust.
ARCHIVES OF MECHANICS (ARCHIWUM MECHANIKI STOSOWANEJ) Export and Import Enterprise Ruch UL, Wronia 23, Warsaw, Poland	Arch. Mech.
ASTRONAUTICS AND AERONAUTICS AIAA EDP 1290 Avenue of the Americas New York, NY 10019	Astronaut. & Aeronaut.
AUTOMOBILTECHNISCHE ZEITSCHRIFT Franckh'sche Verlagshandlung Abteilung Technik 7000 Stuttgart 1 Pfizerstrasse 5-7 W. Germany	Automobiltech. Z.

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AUTOMOTIVE ENGINEER (SAE) Society of Automotive Engineers, Inc. 400 Commonwealth Drive Warrendale, PA 15096	Auto. Engr. (SAE)
AUTOMOTIVE ENGINEER (UK) P.O. Box 24, Northgate Ave. Bury St., Edmunds Suffolk IP21 GBW, UK	Auto. Engr. (UK)
BALL BEARING JOURNAL (English Edition) SKF (U.K.) Ltd. Luton, Bedfordshire LU3 1JF, UK	Ball Bearing J.
BROWN BOVERI REVIEW Brown Boveri and Co., Ltd. CH-5401, Baden, Switzerland	Brown Boveri Rev.
BULLETIN DE L'ACADEMIE POLONAISE DES SCIENCES, SERIES DES SCIENCES TECHNIQUES Ars Polona-Ruch 7 Krokowskie Przedmiescie, Poland	Bull. Acad. Polon. Sci., Ser. Sci. Tech.
BULLETIN OF JAPAN SOCIETY OF MECHANICAL ENGINEERS Japan Society of Mechanical Engineers Sanshin Hokusei Bldg. H-9 Yoyogi 2-chome Shibuya-ku Tokyo 151, Japan	Bull. JSME
BULLETIN OF SEISMOLOGICAL SOCIETY OF AMERICA Bruce A. Bolt Box 826 Berkeley, CA 94705	Bull. Seismol. Soc. Amer.
CIVIL ENGINEERING (NEW YORK) ASCE Publications Office 345 E. 47th St. New York, NY 10017	Civ. Engr. (N.Y.)
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DESIGN NEWS Cahners Publishing Co., Inc. 221 Columbus Ave. Boston, MA 02116	Des. News
DIESEL AND GAS TURBINE PROGRESS Diesel Engines, Inc. P.O. Box 7406 Milwaukee, WI 53213	Diesel Gas Turbine Prog.
ENGINEERING MATERIALS AND DESIGN IPC Industrial Press Ltd. 33-40 Bowling Green Lane London EC1R, UK	Engr. Matl. Des.
EXPERIMENTAL MECHANICS Society for Experimental Stress Analysis 21 Bridge Sq., P.O. Box 277 Westport, CT 06880	Exptl. Mech.
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HEATING/PIPING/AIR CONDITIONING Circulation Dept. 614 Superior Ave. West Cleveland, OH 44113	Heating/ Piping/ Air Cond.
HYDRAULICS AND PNEUMATICS Penton/IPC, Inc. 614 Superior Ave., West Cleveland, OH 44113	Hydraulics & Pneumatics
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IBM JOURNAL OF RESEARCH AND DEVELOPMENT International Business Machines Corp. Armonk, NY 10504	IBM J. Res. Dev.
INDUSTRIAL RESEARCH Dun-Donnelley Publishing Corp. 222 S. Riverside Plaza Chicago, IL 60606	Indus. Res.
INGENIEUR-ARCHIV Springer-Verlag New York, Inc. 175 Fifth Ave. New York, NY 10010	Ing. Arch.
INSTITUTE OF MARINE ENGINEERS, TECHNICAL REPORTS The Memorial Building 76 Mark Lane London EC3R 7IN, UK	Inst. Mar. Engr., T.R.
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INSTITUTION OF MECHANICAL ENGINEERS, (LONDON), PROCEEDINGS Institution of Mechanical Engineers 1 Birdcage Walk, Westminster, London SW1, UK	Instn. Mech. Engr. Proc.
INSTRUMENT SOCIETY OF AMERICA, TRANSACTIONS Instrument Society of America 400 Stanwix St. Pittsburgh, PA 15222	ISA Trans.
INTERNATIONAL JOURNAL OF CONTROL Taylor and Francis Ltd. 10-14 Macklin St. London WC2B 5NF, UK	Intl. J. Control
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ISRAEL JOURNAL OF TECHNOLOGY Weizmann Science Press of Israel Box 801 Jerusalem, Israel	Israel J. Tech.
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JOURNAL OF MECHANICAL ENGINEERING SCIENCE Institution of Mechanical Engineers 1 Birdcage Walk, Westminster London SW1 H9, UK	J. Mech. Engr. Sci.
JOURNAL OF THE MECHANICS AND PHYSICS OF SOLIDS Pergamon Press, Inc. Maxwell House, Fairview Park Elmsford, NY 10523	J. Mech. Phys. Solids
JOURNAL OF PHYSICS E. (SCIENTIFIC INSTRUMENTS) American Institute of Physics 335 East 45th St. New York, NY 10017	J. Phys. E. (Sci. Instr.)
JOURNAL OF SHIP RESEARCH Society of Naval Architects and Marine Engineers 20th and Northhampton Sts. Easton, PA 18042	J. Ship Res.
JOURNAL OF SOUND AND VIBRATION Academic Press 111 Fifth Ave. New York, NY 10019	J. Sound Vib.

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JOURNAL OF SPACECRAFT AND ROCKETS American Institute of Aeronautics and Astronautics 1290 Avenue of the Americas New York, NY 10019	J. Spacecraft Rockets
JOURNAL OF TESTING AND EVALUATION (ASTM) American Society for Testing and Materials 1916 Race St. Philadelphia, PA 19103	J. Test Eval. (ASTM)
KONSTRUKTION Spring Verlag 3133 Connecticut Ave., N.W. Suite 712 Washington, D.C. 20008	Konstruktion
LUBRICATION ENGINEERING American Society of Lubrication Engineers 838 Busse Highway Park Ridge, IL 60068	Lubric. Engr.
MACHINE DESIGN Penton Publishing Co. Penton Bldg. Cleveland, OH 44113	Mach. Des.
MASCHINENBAUTECHNIK VEB Verlag Technik Oranienburger Str. 13/14 102 Berlin, E. Germany	Maschinenbautechnik
MECCANICA Pergamon Press, Inc. Maxwell House, Fairview Park Elmsford, NY 10523	Meccanica
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MECHANICS RESEARCH AND COMMUNICATIONS Pergamon Press, Inc. Maxwell House, Fairview Park Elmsford, NY 10523	Mech. Res. Comm.
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NAVAL ENGINEERS JOURNAL American Society of Naval Engineers, Inc. Suite 507, Continental Bldg. 1012 - 14th St., N.W. Washington, D.C. 20005	Naval Engr. J.
NOISE CONTROL VIBRATION ISOLATION Trade and Technical Press Ltd. Crown House, Morden Surrey SM4 5EW, UK	Noise Control Vib. Isolation
NOISE CONTROL ENGINEERING P.O. Box 3206, Arlington Branch Poughkeepsie, NY 12603	Noise Control Engr.
NORTHEAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS, TRANSACTIONS Bolbec Hall Newcastle upon Tyne 1, UK	NE Coast Instn. Engrs. Shipbldrs., Trans.
NUCLEAR ENGINEERING AND DESIGN North Holland Publishing Co. P.O. Box 3489 Amsterdam, The Netherlands	Nucl. Engr. Des.
OIL AND GAS JOURNAL The Petroleum Publishing Co. 211 S. Cheyenne Tulsa, OK 74101	Oil Gas J.
PACKAGE ENGINEERING 5 S. Wabash Ave. Chicago, IL 60603	Package Engr.
PLANT ENGINEERING 1301 S. Grove Avenue Barrington, IL 60010	Plant Engr.
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QUARTERLY JOURNAL OF MECHANICS AND APPLIED MATHEMATICS Wm. Dawson & Sons, Ltd. Cannon House Folkestone, Kent, UK	Quart. J. Mech. Appl. Math.
REVUE ROUMAINE DES SCIENCES TECHNIQUES, SERIE DE MÉCANIQUE APPLIQUEE Editions De L'Academie De La Republique Socialiste de Roumaine 3 Bis Str., Gutenberg, Bucurest, Romania	Rev Roumaine Sci. Tech., Mecanique
REVIEW OF SCIENTIFIC INSTRUMENTS American Institute of Physics 335 East 45th St. New York, NY 10017	Rev. Scientific Instr.
SAE PREPRINTS Society of Automotive Engineers Two Pennsylvania Plaza New York, NY 10001	SAE Prepr.

PUBLICATION AND ADDRESS	ABBREVIATION
SIAM JOURNAL ON APPLIED MATHEMATICS Society for Industrial and Applied Mathematics 33 S. 17th St. Philadelphia, PA 19103	SIAM J. Appl. Math.
SIAM JOURNAL ON NUMERICAL ANALYSIS Society for Industrial and Applied Mathematics 33 S. 17th St. Philadelphia, PA 19103	SIAM J. Numer. Anal.
S/V, SOUND AND VIBRATION Acoustic Publications, Inc. 27101 E. Oviat Rd. Bay Village, OH 44140	S/V, Sound Vib.
TECHNISCHES MESSEN - ATM R. Oldenburg Verlag GmbH Rosenheimer Str. 145 8 Munchen 80, W. Germany	Techn. Messen-ATM
TURBOMACHINERY INTERNATIONAL Turbomachinery Publications, Inc. 22 South Smith St. Norwalk, CT 06855	Turbomach. Intl.
VDI ZEITSCHRIFT Verein Deutscher Ingenieur GmbH Postfach 1139, Graf-Recke Str. 84 4 Düsseldorf 1, Germany	VDI Z.
VDI FORSCHUNGSHEFT Verein Deutscher Ingenieur GmbH Postfach 1139, Graf-Recke Str. 84 4 Düsseldorf 1, Germany	VDI Forsch.
VEHICLE SYSTEMS DYNAMICS Swets and Zeitlinger N.V. 347 B. Herreweg Lisse, The Netherlands	Vehicle Syst. Dyn.
WAVE MOTION North Holland Publishing Co. P.O. Box 211 1000 AE Amsterdam The Netherlands	Wave Motion
WEAR Elsevier Sequoia S.A. P.O. Box 851 1001 Lausanne 1, Switzerland	Wear
ZEITSCHRIFT FÜR ANGEWANDTE MATHEMATIK UND MECHANIK Akademie Verlag GmbH Liepziger Str. 3-4 108 Berlin, Germany	Z. angew. Math. Mech.
ZEITSCHRIFT FÜR FLUGWISSENSCHAFTEN DFVLR D-3300 Braunschweig Flughafen, Postfach 3267 W. Germany	Z. Flugwiss

SECONDARY PUBLICATIONS SCANNED

PUBLICATION AND ADDRESS	ABBREVIATION
GOVERNMENT REPORTS ANNOUNCEMENTS & INDEX NTIS U.S. Dept. of Commerce Springfield, VA 22161	GRA
SCIENTIFIC AND TECHNICAL AEROSPACE REPORTS Superintendent of Documents U.S. Government Printing Office Washington, D.C. 20402	STAR
DISSERTATION ABSTRACTS INTERNATIONAL University Microfilms Ann Arbor, MI 48106	DA

ANNUAL PROCEEDINGS SCANNED

PUBLICATION AND ADDRESS	ABBREVIATION
INSTITUTE OF ENVIRONMENTAL SCIENCES, ANNUAL PROCEEDINGS Institute of Environmental Sciences 940 E. Northwest Highway Mt. Prospect, IL 60056	Inst. Environ.
INTERNATIONAL CONGRESS ON ACOUSTICS, ANNUAL PROCEEDINGS	Intl. Cong. Acoust., Proc.
THE SHOCK AND VIBRATION BULLETIN, UNITED STATES NAVAL RESEARCH LABORATORIES, ANNUAL PROCEEDINGS Shock and Vibration Information Center Naval Research Lab., Code 5804 Washington, D.C. 20375	Shock Vib Bull., U.S. Naval Res. Lab., Proc.

CALENDAR

DECEMBER 1980

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	
AGMA:	American Gear Manufacturers Association 1330 Mass. Ave., N.W. Washington, D.C.	
AHS:	American Helicopter Society 1325 18 St. N.W. Washington, D.C. 20036	
AIAA:	American Institute of Aeronautics and Astronautics, 1290 Sixth Ave. New York, NY 10019	
AIChE:	American Institute of Chemical Engineers 345 E. 47th St. New York, NY 10017	
AREA:	American Railway Engineering Association 59 E. Van Buren St. Chicago, IL 60605	
ARPA:	Advanced Research Projects Agency	
ASA:	Acoustical Society of America 335 E. 45th St. New York, NY 10017	
ASCE:	American Society of Civil Engineers 345 E. 45th St. New York, NY 10017	
ASME:	American Society of Mechanical Engineers 345 E. 45th St. New York, NY 10017	
ASNT:	American Society for Nondestructive Testing 914 Chicago Ave. Evanston, IL 60202	
ASQC:	American Society for Quality Control 161 W. Wisconsin Ave. Milwaukee, WI 53203	
ASTM:	American Society for Testing and Materials 1916 Race St. Philadelphia, PA 19103	
CCCAM:	Chairman, c/o Dept. ME, Univ. Toronto, Toronto 5, Ontario, Canada	
ICF:	International Congress on Fracture Tohoku Univ. Sendai, Japan	
IEEE:	Institute of Electrical and Electronics Engineers 345 E. 47th St. New York, NY 10017	
IES:	Institute of Environmental Sciences 940 E. Northwest Highway Mt. Prospect, IL 60056	
IFToMM:	International Federation for Theory of Machines and Mechanisms U.S. Council for TMM c/o Univ. Mass., Dept. ME Amherst, MA 01002	
INCE:	Institute of Noise Control Engineering P.O. Box 3206, Arlington Branch Poughkeepsie, NY 12603	
ISA:	Instrument Society of America 400 Stanwix St. Pittsburgh, PA 15222	
ONR:	Office of Naval Research Code 40084, Dept. Navy Arlington, VA 22217	
SAE:	Society of Automotive Engineers 400 Commonwealth Drive Warrendale, PA 15096	
SEE:	Society of Environmental Engineers 6 Conduit St. London W1R 9TG, UK	
SESA:	Society for Experimental Stress Analysis 21 Bridge Sq. Westport, CT 06880	
SNAME:	Society of Naval Architects and Marine Engineers 74 Trinity Pl. New York, NY 10006	
SPE:	Society of Petroleum Engineers 6200 N. Central Expressway Dallas, TX 75206	
SVIC:	Shock and Vibration Information Center Naval Research Lab., Code 5804 Washington, D.C. 20375	
URSI-USNC:	International Union of Radio Science U.S. National Committee c/o MIT Lincoln Lab. Lexington, MA 02173	