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SVIC NOTES

A great deal of concern has been expressed, and much has been published in the media, about a shortage of engineers and its effect on our future technical capabilities. A number of issues must be explored to overcome this shortage, and two of these issues are how to attract and retain engineers, and where will the new engineers come from? Mr. William Gregory* very capably discussed the first issue in his editorial in the April 4, 1983 edition of ***Aviation Week and Space Technology.*** I urge you to read it.

The question of the source of new engineers is also very important. If we are to maintain our technical leadership, more engineers must be trained, but we cannot do this in the near future because a shortage of faculty in our engineering schools limits the number of engineers that can be trained. Engineering schools are limited in faculty because of tight budgets, attractive industrial salaries and working conditions and a decline in graduate school enrollments. The decline in the graduate school enrollments means fewer people will be available for teaching the graduate level and the undergraduate level engineering courses. In fact, the present shortage in engineering faculty is directly attributable to the decline in graduate school enrollments that occurred since the late 1960's or ear'y 1970's. Another consequence of the decline in graduate school enrollments is less research will be performed, and this will reduce our future ability to maintain our technical leadership.

If we are serious about maintaining our future technical leadership, we must find ways to overcome the shortage of engineers. The lack of capacity in our engineering schools is only one reason why we have a shortage of engineers; many other reasons for this shortage exist. If we are to overcome this shortage, we must find and correct all of the causes.

R.H.V.

Gregory, W.H., "Incentives and Engineers," Aviation Week and Space Technology, 118 (14), p 9 (Apr 4, 1983)

EDITORS RATTLE SPACE

SOME THOUGHTS ON TESTING

Review of another new textbook on mechanical vibrations revealed the usual lack of balance between mathematical and experimental technologies. Ten pages out of three hundred and fifty were devoted to testing. The material devoted to experimental work was not detailed enough to provide a good understanding of the art and science of mechanical vibration testing. Some of the transducers described were obsolete. This lack of attention and interest in testing also prevails in many academic institutions and some professional societies.

I have tried to analyze why this apparent lack of balance exists. Perhaps the elegance of mathematics motivates those who manipulate equations and crunch numbers to be prolific writers. Perhaps the fact that test engineers who see their work become reality have no need for the further satisfaction of writing about it. Perhaps their careers and pay raises do not depend on publications. Whatever the reason, the lack of writing about test technologies inhibits the technology transfer vitally needed to maintain cost effective product development.

On the positive side, there is a limited amount of technology transfer on testing. Manufacturers of test equipment write about their products and what they can do. Often they are short sighted and the articles become commercial or are perceived to be commercial by the purists in the non-testing world. However, in many cases this is the only place the neophyte can find the technology to do his or her job. Short courses, developed to teach testing techniques, have become very poular. Many times they bridge the gap between the experienced and inexperienced engineer. A few professional societies do publish articles on test techniques and practice.

Much of the lack of attention to testing begins with the rivalry that exists between those who test and those who crunch numbers. I believe this attitude is initiated in the universities through a lack of balance in training and is perpetuated in industry by organization of staff. Fortunate are the few who have the opportunity to see how well their calculations work in reality. I believe that engineers properly trained in both testing and computation would have a better appreciation for the total product development process -- even though they might be specialists in one of the areas. More training in the universities on the fundamentals of testing and test equipment would provide engineers motivated to develop and write about test techniques.

R.L.E.

NONLINEAR VIBRATIONS OF PLATES -- A REVIEW

M. Sathyamoorthy*

Abstract. The survey of literature presented in this paper on nonlinear vibrations of plates is limited to papers published from 1979 to 1982. Geometric, material, and combinations of these nonlinearities are treated; complicating effects of anisotropy, attached masses, cutouts, elastic foundation, nonclassical boundary conditions, stiffeners, thermal stresses, variable thickness, transverse shear deformation, and rotatory inertia are also surveyed.

Nonlinear problems concerning plates of various geometries have received considerable attention in the literature in recent years. An excellent monograph by Leissa [1] deals mostly with linear vibrations of plates but also includes some references on large amplitude vibrations. This monograph provides a wealth of information on linear dynamic problems and introduces the reader to geometric type nonlinearities. In 1973, Sathyamoorthy and Pandalai [2, 3] presented a review of existing literature in the area of large amplitude vibrations of plates and shells. The first part of the paper [2] contains a survey of vibrations of disks, membranes, and rings. Also included is information on simple nonlinear systems to introduce the reader to nonlinear dynamic problems. Nonlinear vibrations of plates and shells are surveyed in the second part [3]. These review papers, however, are mainly confined to cases with geometric-type nonlinearities. A recent survey paper [4] contains discussions of both the importance and various types of nonlinearities encountered in practical situations. Governing equations applicable to beams with both geometric and material-type nonlinearities are presented. Such equations, although complex to derive, can be obtained for plates. In a recent book Chia [5] has presented a complete collection of references in geometrically nonlinear static and dynamic plate problems. Bert [6-10] and Leissa [11-15] have written excellent survey papers concerning several areas pertaining to plates; a number of references [8-10, 12, 14] are of particular interest to researchers in nonlinear areas. Leissa [14] has reviewed large deflection vibrations of plates of various shapes and has discussed the effects of shear deformation and rotatory inertia on nonlinear dynamic behavior. He also pointed out the need to have numerical results for nonlinear dynamic problems in the form of amplitude-frequency curves rather than amplitude-period curves. A recent survey paper by Bert [10] summarizes activities during the period 1979-1981, particularly in experimental research. He included research activities in geometric and material-type nonlinear areas, including the effects of thickness shear flexibility and laminations. Reddy [16, 17] has recently discussed the application of finite element methods to linear and nonlinear plate problems. Nayfeh [18] has considered certain types of geometrically nonlinear beam and plate problems. The most comprehensive work in the nonlinear analysis of plates [5], the book by Chia, is confined to geometrically nonlinear problems; references are reported up to 1978. The present survey paper, therefore, is intended to review most of the papers published from 1979 to 1982. Attention is given to geometric and material nonlinearities as well as combinations of the two. Effects of attached masses, anisotropy, cutouts, elastic foundation, flutter, thickness shear flexibility, nonclassical boundary conditions, stiffeners, thermal stresses, variable rigidity, viscoelasticity, and wave propagation have been treated. Topics on dynamic stability, experimental work, laminated plates, and refined plate theories are also presented. Particular reference is made to the contributions by Reddy [16, 17] in the finite element nonlinear analysis of plates.

THIN PLATES

The most widely used nonlinear equations for thin plates are those originally presented by von Kármán.

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These equations have been modified to include various effects and have been extensively used. Such a set of equations for a thin anisotropic single layered skew plate in an oblique coordinate system is

$$A_{22}F_{,\zeta\zeta\zeta\zeta} - 2A_{26}F_{,\zeta\zeta\zeta\eta} + (2A_{12} + A_{66})F_{,\zeta\zeta\eta\eta} - 2A_{16}F_{,\zeta\eta\eta\eta} + A_{11}F_{,\eta\eta\eta\eta} = w_{,\zeta\eta}^{2} - w_{,\zeta\zeta}w_{,\eta\eta} \quad (1)$$

$$c[\rho h w_{,tt} - q(\zeta,\eta)] + h^3/12\ L(w) = h(F_{,\eta\eta}w_{,\zeta\zeta} + F_{,\zeta\zeta}w_{,\eta\eta} - 2F_{,\zeta\eta}w_{,\zeta\eta}) \quad (2)$$

where

$$L(w) = a_{11}w_{,\zeta\zeta\zeta\zeta} + a_{22}w_{,\eta\eta\eta\eta} + 2(a_{12} + 2a_{66}) w_{,\zeta\zeta\eta\eta} + 4a_{16}w_{,\zeta\zeta\zeta\eta} + 4a_{26}w_{,\zeta\eta\eta\eta}$$

and a_{ij} are the elastic stiffnesses. They can be expressed in terms of the major and minor elastic moduli (E_L, E_T), the Poisson's ratios (ν_{LT}, ν_{TL}), the shear modulus G_{LT}, and the skew angle θ. L and T represent the longitudinal and lateral in-plane directions respectively of the principal elastic axes. In the case of isotropic plates, equations (1) and (2) readily reduce to the well-known von Kármán equations in the x-y coordinate system as given below.

$$D\nabla^4 w - q(x,y) + \rho h w_{,tt} = h(F_{,yy}w_{,xx} + F_{,xx}w_{,yy} - 2F_{,xy}w_{,xy}) \quad (3)$$

$$\nabla^4 F = E(w^2_{,xy} - w_{,xx}w_{,yy}) \quad (4)$$

Equations (1-4) have been widely used for nonlinear studies of plates. The equations are in terms of lateral displacement w and stress function F and therefore correspond to the stress function approach (SFA). Another common approach in solving nonlinear problems is the displacement equations approach (DEA). In this approach, three nonlinear equations are written in terms of median surface displacements of the plate u°, v°, and w. For a single-layered anisotropic skew plate such equations in oblique coordinates become

$$a_{11}(\epsilon^\circ_\zeta)_{,\zeta} + a_{12}(\epsilon^\circ_\eta)_{,\zeta} + a_{16}(\epsilon^\circ_{\zeta\eta})_{,\zeta} + a_{16}(\epsilon^\circ_\zeta)_{,\eta} + a_{26}(\epsilon^\circ_\eta)_{,\eta} + a_{66}(\epsilon^\circ_{\zeta\eta})_{,\eta} = 0 \quad (5)$$

$$a_{12}(\epsilon^\circ_\zeta)_{,\eta} + a_{22}(\epsilon^\circ_\eta)_{,\eta} + a_{26}(\epsilon^\circ_{\zeta\eta})_{,\eta} + a_{16}(\epsilon^\circ_\zeta)_{,\zeta} + a_{26}(\epsilon^\circ_\eta)_{,\zeta} + a_{66}(\epsilon^\circ_{\zeta\eta})_{,\zeta} = 0 \quad (6)$$

$$c[q(\zeta,\eta) - \rho h w_{,tt}] + h[w_{,\zeta\zeta}(a_{11}\epsilon^\circ_\zeta + a_{12}\epsilon^\circ_\eta + a_{16}\epsilon^\circ_{\zeta\eta}) + w_{,\eta\eta}(a_{12}\epsilon^\circ_\zeta + a_{22}\epsilon^\circ_\eta + a_{26}\epsilon^\circ_{\zeta\eta}) + 2w_{,\zeta\eta}(a_{16}\epsilon^\circ_\zeta + a_{26}\epsilon^\circ_\eta + a_{66}\epsilon^\circ_{\zeta\eta})] = h^3/12\ L(w) \quad (7)$$

where ϵ°_ζ, ϵ°_η and $\epsilon^\circ_{\zeta\eta}$ are the median surface strains given by

$$\epsilon^\circ_\zeta = cu^\circ_{,\zeta} + sv^\circ_{,\zeta} + 1/2\ (w_{,\zeta})^2$$

$$\epsilon^\circ_\eta = v^\circ_{,\eta} + 1/2\ (w_{,\eta})^2$$

$$\epsilon^\circ_{\zeta\eta} = cu^\circ_{,\eta} + sv^\circ_{,\eta} + v^\circ_{,\zeta} + w_{,\zeta}w_{,\eta} \quad (8)$$

In deriving equations (1), (2) and (5), (6), (7) the effects of in-plane inertias have been ignored. Equations (5), (6), and (7) can be easily specialized for isotropic plates in the orthogonal x-y coordinate system. In most of the references that follow, either equations (1) and (2) or equations (5), (6), and (7) have been used to investigate various effects on nonlinear static and dynamic behavior of plates.

Several interesting nonlinear problems concerned with thin plates have been considered [19-88]. Large amplitude vibrations of square and circular plates carrying concentrated masses have been studied [19, 20, 32], as have effects of large amplitude on free flexural vibrations of thin, single-layered anisotropic and orthotropic skew plates [21, 22, 60]. Datta [23], Alwar and Reddy [25], Reddy [24, 154, 188], and Huang [80] studied the effects of cutouts on large amplitude vibration behavior. An analog simulation has been used [23] as has the finite element method [24, 154, 188]. Dynamic stability problems [26-29, 95, 107, 161]; plates resting on elastic foundations [30, 31]; flutter of plates [33, 123, 159, 160]; application of the method of conformal transformation to large amplitude vibration problems [34]; application of the modified Berger approximation [35]; plates subjected to in-plane, pulse, and random excitations [36, 37, 41, 47-50]; vibrations of triangular [38, 39] and elliptical plates [42, 56, 57, 61, 63, 75, 76]; dynamic analysis of plates with nonclassical boundary conditions [32, 78, 81, 191]; higher order nonlinear plate theories

[69-71, 131]; stiffened plates [72], thermal effects on nonlinear static and dynamic behavior of plates of various geometries [73-76]; plates of variable flexural rigidity [77-81, 188]; and influences of geometric nonlinearity on wave propagation and stability of plates and spinning disks [82-88] have been discussed.

Although many publications deal with geometric-type nonlinearity, few papers have appeared on material-type nonlinearity [89-93] or combinations of the two types. The scarcity of literature in this area is perhaps due to the very complex nature of the problems, particularly when nonlinearities are combined. Papers dealing with nonlinear systems, structures, and nonlinear differential equations have been published [94-121].

MODERATELY THICK PLATES

The von Kármán nonlinear plate theory can be generalized to include the effects of transverse shear deformation and rotatory inertia for moderately thick plates. Recent investigations by the author have been mainly concerned with this class of problems on plates of various shapes [128-145]. Governing equations applicable for a moderately thick anisotropic single-layered skew plate are given below [143].

$$b_{22}F_{,\zeta\zeta\zeta\zeta} - 2b_{26}F_{,\zeta\zeta\zeta\eta} + (2b_{12} + b_{66})F_{,\zeta\zeta\eta\eta} - 2b_{16}F_{,\zeta\eta\eta\eta} + b_{11}F_{,\eta\eta\eta\eta} = w^2_{,\zeta\eta} - w_{,\zeta\zeta}w_{,\eta\eta} \tag{9}$$

$$L(J_1 + J_2) + M(w) = 0 \tag{10}$$

where,

$$J_1 = q(\zeta,\eta) - h\rho w_{,tt}$$

$$J_2 = h(F_{,\eta\eta}w_{,\zeta\zeta} + F_{,\zeta\zeta}w_{,\eta\eta} - 2F_{,\zeta\eta}w_{,\zeta\eta})$$

L and M are differential operators. These operators and all the required coefficients in equations (9) and (10) can be found [143]. By tracing constants, it is possible to specialize equations (9) and (10) to include or exclude the effects of transverse shear deformation and rotatory inertia. Equations (9) and (10) are in terms of stress function F and normal displacement w and therefore correspond to the stress function approach. Similar equations can be derived in terms of median surface displacements u°, v°, and w. Such equations are used in the displacement equations approach and can be readily found in the literature [130, 132, 133, 140].

As was pointed out earlier, much of the recent analytical research on the effects of thickness shear flexibility and rotatory inertia have been done by Sathyamoorthy [128-145], Reddy [151-153], and others [122-127]. Sathyamoorthy [128-145] and Chia [125, 133, 141-144] investigated these effects on geometrically nonlinear plates of various planforms. Others [151-153] have used the finite element method to solve some of these nonlinear problems. Certain recent investigations of Sathyamoorthy and Prasad [134, 135, 145] were concerned with the influences of modal interaction on the nonlinear static and dynamic behavior of moderately thick plates.

Very little information is available on the effects of higher modes on the fundamental nonlinear frequencies of plates. Chia [5] has investigated this problem for thin plates. In the case of moderately thick plates, these effects are important, particularly for anisotropic plates [134, 135, 145]. The effect of coupling is found to increase the frequency ratios for any given amplitude and is significant at moderately large amplitudes.

OTHER PLATES AND EXPERIMENTS

Nonlinear studies concerned with composite, laminated, and sandwich plates have been reported [40, 46, 64, 65, 123, 131, 147-156, 187]. Amplitude-frequency relationships have been obtained analytically for sandwich plates [147], and composite and laminated plates have been considered [148-155]. Reddy [149-154] has used the finite element method to study the effects of plate aspect ratio, lamination, and thickness shear flexibility in composite and laminated plates. Attention in these cases, however, was limited to studies of fundamental frequency and mode shape. Experimental investigations have been reported [47, 68, 156-162]. Sector plates, I-shaped plates, composite panels, flutter, and dynamic stability aspects were considered in these experimental investigations.

FINITE ELEMENT METHOD

The finite element method has long been used to solve linear plate problems. Thus, the literature in this area has grown enormously. However, only in recent years has this method been applied to various nonlinear static and dynamic problems. Two recent survey papers [16, 17] summarize activities in the linear and nonlinear areas since 1967. One paper [16] contains a review of research in finite element modeling of structural vibrations of beams, plates, and shells. Approximately ten percent of the references were on nonlinear problems. Another review of the literature on linear and nonlinear bending and vibration of layered, anisotropic composite plates, and shells using the finite element method has been published [17]. Various references [24, 27, 45, 51, 55, 74, 81, 89-91, 93, 105, 149-154, 163-194] are on plates of various shapes, loadings, and boundary conditions. The effects of cutouts [24, 154], anisotropy [24, 152-153], laminations [91, 149-155], dynamic stability [27], thermal stresses [74], nonclassical boundary conditions [81, 191], variable thickness [81, 188], and material and combinations of nonlinearities [89-91, 93] were investigated.

REMARKS

The effects of geometric nonlinearity on plates of various geometries indicate a hardening type of nonlinearity; i.e., frequency increases with amplitude. When different types of nonlinearities are considered, solutions to the corresponding problems are approximate in many cases. The bulk of the literature currently available is concerned mainly with the fundamental mode. Recent activities in this area have focused on applications of the finite element method and considerations of complicating effects on nonlinear static and dynamic behavior of plates.

On the basis of references reviewed in this paper, the following comments can be made.

- as has been pointed out by Leissa [14], numerical results for nonlinear dynamic problems would be more useful if they were presented in terms of frequency ratios rather than period ratios.
- Nonlinear materials find wide application. The study of plates made of nonlinear materials deserves attention.
- Very little information can be found in the literature about the effects of higher modes on the nonlinear fundamental frequencies of plates of various geometries and boundary conditions.
- The number of references dealing with experimental investigations is low. This area needs renewed attention.
- There has been a lot of discussion on the Berger approximation to plates with different types of in-plane boundary conditions [54]. Although this has alerted the user about possible grave inaccuracies in some cases, the approximation itself cannot be ignored as not being useful at all. The advantages of this approximation will be obvious when applied with care to such complex problems as thick plates.

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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 mechanical signature analysis; and static and dynamic behavior of mechanical components associated with electrical transmission lines.

Dr. M.S. Hundal of the University of Vermont, Burlington, Vermont has written a review of literature in the field of mechanical signature analysis from 1980 through 1982. Mechanical signature analysis encompasses the analysis of dynamic signals from machines and processes for the purposes of testing, monitoring, diagnostics, and system identification and modification.

Mr. P.G.S. Trainor and Drs. N. Popplewell, A.H. Shah, and R.B. Pinkney of the University of Manitoba, Winnipeg, Canada have written an article describing the behavior of transmission towers, insulator strings, conductors, and foundations as determined from theoretical analyses, model testing, and full-scale tests. Line vibration is also briefly reviewed.

MECHANICAL SIGNATURE ANALYSIS

M.S. Hundal*

Abstract. Mechanial signature analysis encompasses the analysis of dynamic signals from machines and processes for the purposes of testing, monitoring, diagnostics, and system identification and modification. Literature in this field from 1980 through 1982 is reviewed in this paper.

A previous article [1] presented a review of literature on mechanical signature analysis (MSA) up to and including 1979; the fundamentals of machinery vibration and early developments in MSA were included. The present paper discusses literature on the subject that appeared in the years 1980-82.

The surveillance of operating machinery by monitoring and analysis of vibration signals is becoming an accepted practice in industry. Vibrations generated in bearings, shafts, gears, and other machine parts are used to detect wear and degradation and to predict failure. Increasingly sophisticated instruments and signal analysis techniques have been developed over the last several years. Although machinery monitoring and diagnostics are the most important applications of mechanical signature analysis today, it is regarded as a much broader field. Braun [58] has divided MSA into five categories: process monitoring, environmental testing, noise and vibration abatement through identification of sources and effect of material properties, system identification via modal analysis and system modification by structural changes, and diagnostics. The last category includes maintenance as well as quality control by identifying product defects.

For the purpose of review in this paper the literature is classified as follows:

- monitoring and diagnostics: papers of a general nature that describe instrumentation and practical applications
- analytical techniques: development of new methods and extension and adaptations of methods from other fields
- experimental studies: papers that describe work primarily of an experimental nature

MONITORING AND DIAGNOSTICS

Papers that describe general aspects of machinery vibration monitoring include case histories and user experiences. They form a good introduction to the subject, and several are of a tutorial nature. Taylor [21] has presented case histories involving imbalance, looseness, bent shaft, misalignment, cavitation, and rubbing. He stresses the use of both time- and frequency-domain signals in fault detection. A tutorial on the use of real-time analyzers has been given [22]. The establishment of a machine condition monitoring program, including periodic measurement, continuous monitoring, and predictive analysis has been presented [25]. Hasselfeld [29] has described a case history of an induction motor that exhibited axial vibration. Libby and Lundgaard [30] have discussed a program for an aircraft carrier machine condition analysis and evaluation of repair work quality. Application of incipient failure detection techniques to monitor centrifugal pumps has been discussed by Bloch [8]. Monitoring methods for turbomachines as aids in maintenance and redesign have been considered by Sohre [3] and Nelson [9].

The role of polar diagrams in interpreting rotating machine condition has been stressed by Bently [27] and Halloran [28]. The advantages stated are the capability to identify close-spaced resonances and shaft bow mode shapes and to distinguish structural, aerodynamic, and self-balancing resonances. A tutorial on selection and use of a spectrum analyzer to diagnose problems in pump operation has been given [35]. Correlation of machinery faults to sum

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and difference frequencies has been discussed by Eshleman [39]. Faults related to such frequencies include misalignment, rolling bearing and gear defects, oilwhirl, rubbing, and imbalance. The applications of sum and difference frequencies and time signal and spectrum analysis to the identification of gear defects such as number of defective teeth on each gear, number of gears with defective teeth, and location of defective teeth have been described [40].

The necessity of using operating, maintenance, and thermodynamic data in addition to spectrum analysis in preventive maintenance has been discussed [45]. Taylor [46] has presented a tutorial on the use of vibration analysis in a maintenance program that includes monitoring of rotating equipment, spare parts evaluation, and testing of pipes and vessels. The activities of the National Bureau of Standards in the area of monitoring of machines and components via vibration measurement have been discussed [47]. Results of a study to rank the causes of generic problems leading to failure of a rotor/bearing/lubricating system have been reported [48]. A protective system based on frequency signals for such high risk systems as nuclear reactors has been described [18].

Bosmans [49] has given the requirements for proper operation of rotating machinery. He included parameters to be measured, instrumentation required, classification of malfunctions, and corrective actions required. Baur [50] has presented an overview of causes of failure of rotating machinery and monitoring and diagnostic methods to assure reliable operation. Unger [51] has discussed various vibroacoustic machine diagnostic analysis techniques and their applications. Jackson [52] has presented guidelines for achieving a high degree of reliability in rotating machines. McLain [54] has offered guidelines for a monitoring program in paper mills having slow-speed, high-load bearings.

The history of a monitoring program at a fossil-fuel power plant has been given [56]. Sensor selection and location, spectrum analysis methods, computational equipment, and display devices were discussed. King and Goodman [57] have described testing and diagnostic equipment for reciprocating engines and gas turbines. Inoue and King [67] have presented an application of MSA to hydraulic systems. They considered the case vibrations of a vane pump containing a known defect. A program for surveillance in remote locations and small plants with capability to detect rolling bearing failure has been described [68]. Eshleman [69] has presented various techniques for machinery vibration evaluation: time and frequency domain analyses, trend analysis, orbital motion, transient analyses, interference and Lund diagrams, and critical speed and stability maps. Bently [70] has described transducers, analysis, and display instrumentation that are commercially available.

The application of MSA to the detection of structural damage has been demonstrated by West [71]. He used frequency response function data and modal analysis of a space shuttle orbiter body flap that had been subjected to environmental testing. Specific damaged areas were identified that were missed by the conventional methods of visual, X-ray, and ultrasonic inspections. Proceedings of a series of workshop sessions [72] on nondestructive evaluation of turbines and generators included discussions on vibration signature analysis. Schwerdlin and Eshleman [75] described aspects of rotating machine vibration caused by coupling defects. They discussed transducers, analysis equipment, and effects of unbalance and misalignment.

The use of computers with other analytic equipment is becoming more common. The development and use of a spectrum analyzer -- a computer system for signature analysis -- in the chemical industry has been described [23]. Halloran and Mruk [33] described the use of a computer-based system for remote and automatic evaluation of rotating machinery. A microprocessor-based multiple sensor system to monitor engine condition has been described [4]. Piety and Magette [5] have presented a minicomputer-based system that implements an anomaly recognition methodology for rotating systems. Criteria have been presented [10] for the design of a digital analysis system; computational accuracy and the effect of components on system performance were discussed. A general purpose modular digital signal processing system has also been described [15] that operates on signals up to 4 kHz and is capable of scaling, integration, and computation of statistical parameters.

ANALYTICAL TECHNIQUES

By far the greatest advances in MSA in the last three years have been in analytical techniques. Techniques for other fields, notably communications theory, have been applied and extended. Prominent analytical methods mentioned in the literature include random decrement technique, data-dependent systems, dynamic data systems, cepstrum analysis, and adaptive noise cancellation.

The use of data-dependent systems for diagnostic monitoring of tool holder vibration during turning operation has been discussed [12]. The method consists of fitting successively higher-order differential equations to data by the least squares method until a close fit is obtained. A technique called dynamic data systems, which uses statistical quality control theory, has been presented [14] and used to define normal and defective operations of an electric motor. The technique fits a difference equation in the form of an ARMA model to sampled operating data. Radhakrishnan and Wu [38] have used the same technique to monitor the drilling of a composite material. Hole quality was found to be a function of the frequency generated by the laminated fiber. Another application of MSA to the drilling operation [61] involved investigating time, frequency, and amplitude domain techniques and considering drill life, sound, and drift forces produced during drilling.

Although frequency analysis of vibration signals was once the backbone of machine diagnosis, more attention has recently been focused on time-domain methods. The almost-periodic data from mechanisms has been analyzed by an extension of time-domain averaging [17]. The signal is rearranged by using points one period apart that are decomposed into a repetitive and a residual component; the repetitive component is again decomposed into a truly periodic and a random component. An approach for the classification of rotating machinery faults [19] considers data from stationary time series with mean value time functions; the probability of misclassification is computed. The interpretation of processes in rotating systems from vibration signals has been discussed as an inverse dynamics problem [20]. Analogies with other vibrating systems, the equations and solutions of which are known, were utilized. Daly and Smith [36] have showed methods for estimating harmonic input magnitudes and dynamic transmissibility from system output only. This is possible when amplitudes of input components remain constant even if their time scale changes with speed. Examples of gear-induced vibration in gear drives were given.

The adaptive noise cancellation method to improve signal to noise ratio when a synchronizing signal is not available has been described [37, 63]. It is a non-coherent technique in which use is made of an auxiliary or reference input derived from one or more sensors located at points in the noise field where the signal is weak. This input is adaptively filtered and subtracted from a primary input containing both signal and noise.

Cepstrum analysis is finding increasing use in MSA. A cepstrum is a spectrum of a logarithmic amplitude spectrum and can be used to detect periodic phenomena; e.g., harmonics, side bands, and effects of echoes. A discussion of the method and applications to signals containing echoes, speech analysis, and machine diagnostics are available [53]. Randall [41] has shown the advantages of cepstrum analysis in the identification of gear defects; advantages are better diagnostics and repeatability.

Another paper [60] presents applications of synchronous signal averaging and cepstrum analysis to monitoring and diagnosing gearbox faults. The technique is discussed [65] and applied to extracting the properties of an acoustic transmission path and source characteristics. The limitations of the present methods when dispersive effects are present are pointed out.

The random decrement technique of MSA evolved in the aerospace industry and is widely used to calculate modal damping and to detect mechanical failure; the technique has been generalized to a time-domain modal testing technique. One of the chief advantages of this method over frequency-domain methods is that modal parameters can be identified without knowledge of force inputs. The mathematical basis of the random decrement technique has been established [66] and applied to the case of an offshore platform. Ibrahim [24] has shown that nonwhite stationary narrow-band random inputs yield modal parameters as accurately as those obtained by narrow-band white noise input when the random decrement technique is used.

The use of discriminants to describe oscillatory data -- e.g., shape and crest factors -- is not new. Cempel

[32, 44] has extended this concept and presented an analytical formulation of properties of five discriminants to define vibration and noise data. Two of the discriminants are dimensionless and provide information on amplitude and frequency. The other three are dimensional and describe amplitude, spectral spread, and time fluctuations. The last discriminant is shown to detect instability of a rotating machine. Braun [31] has discussed various aspects of monitoring roller bearing vibrations including mechanisms of signal generation, signal modification by structural paths, instrumentation, and signal processing methods. A technique for model characterization and failure detection in vibrating structures has been presented [55]. Recursive on-line algorithms with stochastic models are used for noise sources. Stochastic estimation theory is used for failure detection; a nonlinear identification algorithm is used to estimate modal parameters.

The absence of a significant peak at the fundamental rotational frequency as an indication of bearing race defect has been discussed [59]. Two causes are considered: an average and shift effect that causes a migration of the fundamental impact frequency and an intermodulation effect that translates the defect-related information. Mitchell [62] has presented alternate methods for computing the frequency response function that yield better estimates at resonance and reduce or eliminate biasing contamination. An application of MSA to determining imbalance in flexible rotors has been given [64]. Relationships between imbalance distribution and vibration modes are shown; analytical results are used to calculate the imbalance location from journal vibration.

The determination of deviations in structural parameters from their nominal values by introducing a discrete function model of the system has been presented [6]. Two extensions of the shock spectrum technique for use in pulse signature analysis have been given [7]. One permits the detection of small perturbations on a large pulse shape; the other is the development of a slot transform that is shown to have advantages in the determination of magnitude transfer functions. An analytical method for predicting the vibration spectrum of ball bearings having misaligned and off-size rolling elements has been described [11].

EXPERIMENTAL STUDIES

As might be expected, few works of a purely experimental nature are reported in the current literature; most involve some modeling and analysis. Papers in which the primary emphasis is on experimental methods and results are discussed below.

Gandhi and Sharma [2] studied signatures of a sleeve bearing under boundary lubrication conditions during an investigation of response to friction and wear. Taylor [13] has presented methods of identifying defects in rolling bearings using signals below 2 kHz. Defects included are those in raceways, cage, rolling elements, excessive clearances, looseness, and lack of lubrication. Identification of combinations of defects is also discussed. A method using strain gauges to determine defects in rolling bearings [16] measures local stresses in stationary and rotating portions of bearings. The use of acoustic signatures to inspect railroad wheels and the effects on wheel vibrations of geometrical variations, wear, and stress has been discussed [34].

A novel idea of using an encoder-generated synchronizing signal of high accuracy (0.1°) to analyze rotating machinery vibration signals has been presented [42]. The method utilizes signals taken in short time windows from several locations on a machine. Ray [43] has discussed the problem of identifying rolling bearing defects under adverse conditions of low/high speeds, difficulty of access, and presence of other high-level vibration sources.

Igarashi and Hamada [73] have studied the vibration and sound characteristics of rolling bearings with one introduced defect on the inner and on the outer race. They considered peak vibration pulses and FFT of the signals. A new method of detecting gear surface failure considers frequency fluctuation of gear sound [74]. Results of tests in which pitting and scoring defects were introduced were studied. Burn-in tests were run on electronic equipment to detect mortality-type defects prior to qualification and reliability tests. Burt and Condouris [26] have described the results of a study to evaluate the effectiveness of tests using swept-sine and random vibrations. They claimed superiority of this method over that of conventional burn-in testing at fixed nonresonant frequencies.

CONCLUSION

Mechanical signature analysis is an established technique for machine monitoring and diagnostics. Instrumentation and complete systems are now commercially available for this purpose. Significant advances in analytical techniques have appeared in the literature in the last three years. A book by Mitchell [76] details the practical aspects of machine monitoring including instrumentation, maintenance, and several case histories. An important new work by Bendat and Piersol [77] describes engineering applications of correlation and spectral analysis and should be read by anyone interested in signature analysis.

Avenues for further work in this field are many and potentially fruitful. Areas for future research and development are the following:

- applications in production process monitoring and quality control
- system identification applications in noise and vibration abatement
- use of signature analysis in combination with finite element modeling and experimental modal identification
- improved techniques for detection of weak signals in presence of noise
- development of discriminants to better identify the threshold of failure
- development of systems that employ combination of methods -- e.g., time and frequency domain analyses -- to identify greater variety of problems

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STATIC AND DYNAMIC BEHAVIOR OF MECHANICAL COMPONENTS ASSOCIATED WITH ELECTRICAL TRANSMISSION LINES

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Abstract. *This article describes the behavior of transmission towers, insulator strings, conductors, and foundations as determined from theoretical analyses, model testing, and full-scale tests. Line vibration is also briefly reviewed.*

An overhead transmission line is an interactive system consisting of cables, insulator strings, towers, and foundations. The forces acting on each component, therefore, depend not only upon climatic loads but also upon the configuration and mechanical properties of the system as a whole. Transmission towers, for example, must be designed for static and dynamic conductor loads that can act in different combinations of the vertical, transverse, and longitudinal (i.e., along-the-line) directions. Recommendations for representative load combinations are given in codes and tower design guides [1-8]. Such recommendations are based mainly on the performance of conventional lines that use self-supporting towers. Line loads, however, are increasing rapidly in magnitude due to the need for larger conductors and conductor bundles in high-density power corridors. Consequently, heavier-duty supporting structures are needed that are both economical and aesthetically acceptable. The cross-rope suspension structure [9, 10] is one example of a new design. This tower is similar to a guyed portal structure, but the crossarm is made of flexible wire ropes; this difference complicates the determination of critical design loads. Indeed, the design of any heavy duty support structure, whether it is novel [11-14] or even an enlarged conventional tower, is not completely covered in present codes.

In cases in which codes are not applicable, an appropriate mix of theory with both model and full-scale experimental tests is needed to determine static and dynamic behaviors and the ultimate loads associated with potential failure mechanisms. Analysis is relatively cheap, but a thorough understanding of the physical behavior is required before valid assumptions can be made. Full-scale testing, on the other hand, is difficult, time consuming, and costly. Consequently, model testing is often preferred because tests can be repeated and controlled comparatively easily, and key parameters can be varied more simply.

Dynamic modeling of a transmission line system has been discussed in detail [15] with particular reference to the simulation of a broken wire condition. A convenient length reduction λ_L of the conductor span is about 1/30th, but conductor mass is deficient by a factor of λ_L for the easiest simulation by a uniform metal wire. This problem has been overcome by using either chain links or beaded chains or by attaching additional lumped masses. It should be noted, however, that beaded chains were recently discarded [16] because their likely vibro-impact actions produced artificially high damping. A more general problem with small-scale models is that meaningful destructive tests or tests beyond the elastic limit are seldom possible, even in static cases, because behavior of both materials and joints must be the same.

The important climatic forces acting on a transmission line system are wind and ice. The nature of wind fluctuations has been well researched; local records of maximum wind speeds are often available at airports or weather stations. Ice buildup on conductors, on the other hand, is much more difficult to estimate because appropriate records are rare. Large buildups can occur rapidly due to freezing rain or slowly over days or even weeks due to in-cloud icing at moderate altitudes [17]. In the latter situation, the rate of accretion increases substantially with greater wind speed; there is also the possibility of very high ice

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loads occurring simultaneously with fairly high wind speeds [18].

The behavior of components and the determination of component loadings is examined in six sections in this paper:

- longitudinal loads
- cascade prevention
- line vibration and its effects on other components
- static analysis and testing
- dynamic analysis and testing
- foundation behavior

Static and dynamic longitudinal loads arise from unbalanced tensions in conductors. Determination of the magnitude of such loads is very important because inadequate longitudinal tower strength can lead to sequential failures of successive towers; this phenomenon is known as a cascade. Line vibrations are treated briefly because they can be detrimental to insulators and towers. Although static analyses are becoming increasingly refined, a detailed dynamic study is sometimes required, particularly for the wind loading of novel or very large structures. Furthermore, foundations must be designed for high overturning moments and horizontal forces that are applied cyclically.

LONGITUDINAL LOADS

There is no longitudinal force on a tower under balanced loading because conductor tensions are equal on both sides of a suspension insulator clamp. A tension imbalance, however, results in a swing of the insulator strings and a longitudinal force component on the tower. Examples of conditions that create static longitudinal loads on a tower include unevenly distributed ice on conductors, differential temperature effects, changes in line direction and, in the extreme, a broken wire condition. Furthermore, before a static residual load is established, a broken wire creates a considerable transient or dynamic impact load, as does sudden ice shedding from one conductor span. A separate dynamic analysis is required in these two cases.

The calculation of static longitudinal loads is complicated by the following: interactions over several adjacent spans, nonlinearities caused by insulator swings and changes in conductor sags, and the deflections of such flexible structures as poles or guyed towers. It is possible, however, to calculate the distribution of static imbalance over a section of line by using an iterative approach [19-21]. Example computations of residual static loads from a broken wire have been given for several different types of structure. It has been shown that the restraint offered by the overhead ground wire has the beneficial effect of considerably reducing the groundline bending moment for flexible structures.

Accurate evaluation of longitudinal dynamic loads is difficult. Empirical charts for estimating the peak transient load due to a broken conductor were provided by Govers [22] from model and full-scale tests. He showed that the ratio of peak-to-initial conductor tension increased as a function of the span-to-insulator length and the span-to-conductor sag ratios. More recent full-scale tests [23], however, showed that two peaks occur in the dynamic load following a conductor breakage. The first peak is caused by the transfer of strain energy released by the horizontal recoil of the conductor. The second is due to the transfer of gravitational energy released as the conductor in the intact span falls to its new sag position. It was concluded after a study of the test data [23] that the two effects cannot be entirely uncoupled. Furthermore, it was demonstrated that the peak impact loads on the crossarm of a tower could be determined with less than 30% error by using a semi-theoretical formula based on total available energy.

Similar accuracy was achieved by [16] on a 1/30th scale simulation. One purpose of this study was to investigate the effect of the dynamic response of the tower on the ground-line bending moment. Towers were modeled as arbitrary pole structures the fundamental longitudinal frequencies of which could be adjusted by the removal or addition of mass and stiffness. It was found experimentally that the peak ground-line moment varied from about 70% to 150% of the bending moment calculated by assuming a static transfer of the peak crossarm load. Response spectra were developed to relate the structural amplification to the fundamental natural frequency of the tower. These charts are potentially useful for designing structures against a complete collapse although correlation of model and full-scale tests is still required.

Results [16, 22, 23] show that crossarm impact loads can be from 2.5 to approximately 5 times higher than static residual loads. Thus, because the probability of impact loads is generally low, it is possibly cheaper to repair collapsed or damaged towers than to design every structure to withstand dynamic impacts. Precautions must be taken, however, to assure that an initial failure does not expand into a major cascade of tower collapses.

CASCADE PREVENTION

A cascade is a progressive failure that propagates from one span to the next. Several very long cascades have occurred, most notably in Denmark (50 km of a 150-kV line) [24] and in Wisconsin (125 km of a 345-kV line) [25]. Towers have usually failed as a result of inadequate longitudinal strength, although vertical and transverse cascades have also occurred. In general, failure of any along-line component leads to a release of the gravitational and strain energy of the conductor; the result is an impact load at the attachment points of the conductor, followed by a residual static load if the tower survives.

As discussed previously, the severest impact is caused by a broken wire or phase. Although this impact can initiate a failure of several adjacent towers, three factors can alleviate impact loads as the failure propagates. They are:

- energy dissipation at a previous tower
- a graduated release of energy in the conductor span; the structural deflection and insulator swing at the previous tower will transfer some of the energy of the conductor along the line before the collapse of the previous tower releases the remaining energy
- frictional drag of conductors along the ground

The relative importance of these factors is unclear; research is necessary to establish the efficiency of a flexible guyed tower as opposed to a fairly rigid self-supporting design.

Three methods of containing failures have been identified by White [26]:

- placement of strong towers intermittently along the line
- use of structural fuses to limit longitudinal forces on towers
- extra longitudinal and torsional strength at every suspension tower

The third method is the most common design procedure according to White. However, specification of the longitudinal strength required to prevent a cascade is somewhat arbitrary. Most utilities specify the residual static tension that arises from a broken wire under normal tension conditions (i.e., no climatic loading). The success of this practice, which assumes that any dynamic effect dies after the failure of only a few towers, is undoubtedly helped by the overstrength of some towers due to statistical variation and by the slippage of conductors through suspension clamps. Sliding clamps are a good example of a structural fuse -- the second method above -- but regular clamps are unreliable and regular steel-reinforced aluminum (acsr) conductors are easily chafed. Special clamps with a controlled-limit sliding load have been used extensively in France, however, along with strong aluminum alloy conductors [27, 28].

An assessment of the most economical anti-cascade method is not possible without determining the likely repair costs in the life time of the line. Peyrot and Naik [29] have set out a cost-benefit framework that can be used qualitatively to weigh the alternatives; it is based on the relative probabilities of failure. It was suggested that such analyses highlight the benefits of using anti-cascade towers; they are unpopular at present because of a higher initial cost.

The decision to use anti-cascade towers at 5-km intervals on 735-kV lines in Quebec followed cascades triggered by heavy icing [30]. The suspension towers, already loaded within a few percent of capacity, were incapable of withstanding the extra longitudinal load from a failure of highly tensioned conductors. Any condition that generally reduces the reserve longitudinal strength of suspension towers or increases conductor tension renders a line more susceptible to a cascade, and anti-cascade towers are recommended when such conditions can occur.

Employment of intermittent anti-cascade towers gives greater flexibility in designing sections of line between strong towers. The relative strengths of line components (suspension towers, angle towers, insulators, conductors, and foundations) can be adjusted so that failure at the climatic limit load produces the least dynamic effect [31]. Such an approach, which has been used by Hydro Quebec, allows a better estimation of repair costs, a more meaningful cost-benefit analysis, and a generally more economical design.

LINE VIBRATION AND ITS EFFECT ON OTHER COMPONENTS

The subject of line vibration has received much attention worldwide and is itself suitable for a review article. Only a brief introduction and a listing of previous review articles is given below. Stress is placed on the ways in which line vibrations can affect the design of components other than the conductors themselves.

Several articles that review line vibration have appeared [32-36]. The general field -- including galloping, aeolian vibration, and sub-span oscillation -- has been summarized [32]. Beards [33] concentrated on the control of aeolian vibration; others [34, 35] focused on conductor galloping. Johns [36] reviewed wind loading of general structures and included references on the vibration of conductors and the wind excitation of transmission towers. Several other review articles relate to aeolian vibration. Fleishmann and Sallet [37, 38] covered the unsteady flow phenomena related to vortex shedding. A comprehensive paper by Tsui [39] summarizes modern advances in nonlinear mechanics and fluid dynamics as they are applied to aeolian vibrations. A practical method for calculating the peak response of a conductor was included.

Galloping motions are low-frequency, vertical, or horizontal oscillations. They correspond to mode shapes having from 1 to 4 loops per conductor span and natural frequencies from 0.1 to 0.8 Hz. The term conductor galloping generally refers to the self-excitation of these modes to very large amplitudes; self-excitation is usually initiated by an icing storm. Aeolian vibrations, conversely, are high-frequency vertical oscillations with mode shapes of 50 to 250 loops per span. They are caused by vortex shedding and have a frequency range of about 10 to 50 Hz. The upper frequency limit depends upon air turbulence and conductor tension and can be greater for long spans over water or very flat terrain. The third major type of vibration, sub-span oscillation, is a wake-induced phenomenon affecting the opposite pairs of a multi-conductor bundle. Single or double vibration loops occur in the spacer sub-spans at frequencies of about 1 to 3 Hz.

Both aeolian vibrations and galloping have an indirect influence on tower dimensions. Phase-to-phase clearances are determined by galloping amplitudes [40]. In addition, conductor tensions are usually set at a limit of 20% of ultimate tensile strength (UTS) to control the aeolian response. This limit determines the magnitude of sag, which, in turn, dictates tower height [41]. Thus, successful efforts to construct more economical and more compact transmission lines depend somewhat on improving the control of line vibrations [42, 43].

Most galloping does not cause tower damage. Measurements during galloping on a line with self-supporting lattice towers [44] have shown that the insulator tension fluctuates from about 60% to about 160% of the tension under no-wind conditions. Such loads can be considered as being transferred statically to the towers because the fundamental frequency of a lattice tower ranges from about 1.5 Hz to 4 Hz; i.e., substantially above the range of conductor galloping frequencies.

Qualitative investigations by White [45], however, have shown that certain structural arrangements can nevertheless convert galloping motions into destructive forces that cause tower collapse. A running-angle suspension insulator assembly connected to any type of tower and a dead-end insulator assembly connected to a very flexible tower are examples of hazardous arrangements. The potential for any new type of insulator assembly to be affected adversely by galloping requires investigation by model or full-scale tests [9].

Aeolian vibrations can also occasionally lead to structural damage. For example, they have caused the crossarms of towers on several lines in Saskatchewan to suffer severe fatigue damage. According to Mitchell [46], individual crossarm members were observed to vibrate violently although the conductors were fitted with Stockbridge dampers and the bending amplitude of the conductors appeared to be within acceptable limits. In this case the problem was resolved only by the addition of bracing, which raised the resonant frequencies of individual crossarm members above the frequency range for aeolian vibration.

STATIC ANALYSIS AND TESTING

Computers are now readily available as an aid to the design of transmission lines [47]. Linear finite element programs are commonly used to compute member stresses in self-supporting lattice towers. Such programs can be modified to accommodate guyed towers by taking advantage of the observation that only the guy wires behave nonlinearly [48, 49]. Although beam elements provide the best representation of a lattice tower, space truss elements are more commonly employed because less computer storage is required. However, no rotational stiffness occurs at any of the nodes if all the members are idealized as truss elements; instabilities occur particularly at the interior nodes of planar truss panels. Although these nodes can be stabilized by adding a small lateral spring or stiffness coefficient, the procedure can lead to inaccuracies, especially in dynamic analyses. The process is also tedious, so that many specialized transmission tower programs automatically stabilize the stiffness matrix [50, 51]. Furthermore, the most sophisticated programs consider the post-buckling behavior of individual members and sometimes feature automatic member sizing by means of an iterative analysis.

Several authors have advocated computer-oriented methods for optimizing the weight of latticed transmission towers. The substructuring technique permits an economical reanalysis after corrective design changes [52]. Trial changes in shape allow a semi-manual optimization of weight. Crossbracing can be optimized by means of dynamic programming [53]. These latter methods can be extended, in principle, to alter the shape of a tower automatically to give minimum overall weight [54]. Limit or collapse load analysis also has the potential for optimizing overall weight [55, 56]. A small weight saving can be made overall for a fixed tower shape, as compared to an elastic design optimization, although the members most important in resisting collapse, such as the main legs, might be increased in size.

Most lattice-tower members are presently sized on the basis of allowable stress. Drawbacks, however, are that high factors of safety are applied unrealistically to the dead-load forces; such factors are applied essentially against first yield and not collapse. An ultimate strength design [31, 57] is more reliable because the underlying strategy is to weigh the statistical variations in component strengths against the statistical variations in the ultimate loads. Consequently, the probability of failure is acceptably small during the life of a line. In general, the relative reliability of components can and should be different; the failure of a cheap component such as an insulator should not be allowed to damage an expensive component like a tower. Furthermore, only conductors have to be designed for a serviceability condition. This is because a tension of greater than about 75% of UTS will lead to large and permanent sag increases.

At present a rigorous ultimate design method is difficult to implement on a transmission line. Problems arise because the shapes of the probability density functions for different ultimate loads and ultimate component strengths are rarely known accurately. An alternate method of determining reliability is the safety index approach, which has been explained in a recent article [58]. Ultimate design methods in general [59], and the safety index method in particular, are especially useful for checking the ability of towers and foundations to withstand the extra loads from reconductoring.

Any new tower design is usually checked by full-scale static load tests. A comparison between predicted and actual performance of towers tested at the national testing station in England highlighted numerous examples of underdesign [60]. In particular, it was found that not enough attention had been given to the eccentricity and end restraint of angle members in compression. It appears that the major difficulty in improving tower design is not a lack of analytical tools but rather a lack of understanding of the nonlinearities caused by joints and compression members.

DYNAMIC ANALYSIS AND TESTING

Dynamic loads on transmission lines can be transient, harmonic, or randomly fluctuating. The principal transient and harmonic loads have been discussed above in the sections on longitudinal loading and line vibration, respectively. The peak dynamic response of a transmission line to fluctuating transverse wind loads, on the other hand, can be obtained from a probabilistic analysis. Several authors have presented methods for calculating the peak support reactions of a conductor [61-63]. These methods have been extended [64, 65] to include the direct effect of wind on towers, so that the peak groundline bending moment could be evaluated. Furthermore, it can be inferred [65] that the fluctuating wind pressures on both conductors and towers are transferred essentially statically to the ground lines of self-supporting towers carrying typical lines. Consequently, the largest errors in corresponding response calculations likely arise from an inaccurate evaluation of wind pressures. This difficulty occurs because drag coefficients vary significantly with velocity at Reynolds numbers typical of design wind speeds.

Although resonance terms of the conductor and tower can be included in the calculation of gust factors, they are usually so small that an accurate knowledge of the structural dynamic properties is not required. Conversely, such special structures as extremely tall, self-supporting towers can exhibit a significant resonant response to the fluctuating load of wind [66]. This phenomenon occurs because such towers have especially low fundamental natural frequencies; they are much closer to the central band of the fluctuating spectrum of the wind -- typically 0.08 to 0.24 Hz [67]. In general, therefore, a dynamic study of such structures should include model tests [68] or a finite element analysis [69] so that the response of higher modes is properly included. Even so, the results are liable to be inaccurate for the following reasons.

- the mean square resonant displacement will be approximately proportional to the inverse of the structural damping ratio, which cannot be estimated reliably without full-scale tests.
- the variation in the spectrum of the wind at different elevations of a tall tower and the cross correlation between wind pressures cannot be accurately known without measurements at a particular locale.

A rare comparison of the responses of a tower as measured during a storm and as computed from corresponding wind records has been given [70]. The three lowest frequency modes of a space truss model were excited in the computations by the input of wind records measured at 14 different elevations. Displacements differed significantly even though experimentally measured values of structural damping were available. It was conjectured that this difference was due to inaccuracies in the assumed drag coefficients. Further correlations between measurement and calculation are obviously required.

Very little corroborating data are available in the open literature concerning the structural damping of towers. A bolted tower has the potential in theory to dissipate energy through joint slippage, but, in practice, slippage need not occur before structural damage. Data from free vibration tests on latticed towers [23, 70-73] suggest that measured damping ratios vary from about 0.3% to 7% of critical. It appears that the damping ratios for the fundamental transverse and longitudinal bending modes of an isolated latticed tower can be as low as 0.3% regardless of whether the tower has bolted or riveted connections. However, the restraint of conductors, particularly overhead wires, can double or triple the measured damping ratio for the fundamental longitudinal mode although the transverse mode may be affected much less.

Full-scale dynamic tests on modified 500-kV towers strung with 1200-kV eight-conductor bundles have been reported [71-73]. A pretest, finite element frame analysis predicted three tower modes between 2 and 3 Hz. The first and third modes largely involved coupled longitudinal bending/torsional motions; the second mode was the fundamental transverse bending mode. All three modes were confirmed by twang tests -- that is, sudden release from an initial displacement -- but the measured natural frequencies were approximately 10% lower than predicted. This difference was attributed to the analytically neglected mass of the insulator strings and conductors. The eight-conductor bundle itself was excited similarly in subsequent tests. A significant interaction occurred unexpectedly between the conductor bundle and the crossarm of the tower. It had been anticipated that the insulator string would isolate these two components, but the transmissibility was particularly high around the resonant frequencies of the tower. This and the detection of a resonance in the V-string insulator at 1.5 Hz show that a better understanding of insulator strings is needed.

Composite long-rod insulators are expected to become increasingly popular because they are lightweight and have a core with high tensile and compressive strengths and resistant to cyclic loads [74]. Initial problems with manufacturing defects and electrochemical attack [75-77] are being overcome, so that such insulators are likely to be used in structural arrangements [13]. However, recent tests have shown that, even when such insulators are used in conventional tensile arrangements, high transient bending stresses can occur in the long-rod core from conductor impacts. Such stresses should be considered in design [78].

FOUNDATION BEHAVIOR

The foundations of a transmission tower must be designed for the normal foundation requirements of limited settlement and adequate bearing capacity. Additional and crucial requirements are to provide resistance to significant overturning moments and horizontal shear forces. An analysis of foundation strength is complex because typical tower foundations act within the top 10 meters of soil where there is usually a high variation in the shear strength of soil. The groundwater table also fluctuates within this zone, so that the static uplift capacity of a foundation can show a seasonal variation of 5 to 1 [79]. Such variations can be predicted, however, by assuming different water pressures and by using the soil mechanics principle of effective stress.

A state-of-the-art review of methods for predicting the lateral resistance of single piles has recently been presented [80]. Various predictions were compared with results from full-scale tests on large diameter piles (piers) of the type used to support pole-like towers. The authors suggested that a semi-empirical computer analysis could provide good forecasts of both the nonlinear load-deflection curve and the ultimate strength. The method cannot be accurate, however, without in situ measurement of the lateral compression modulus of the soil.

The ultimate capacity of anchor plates, used typically for guyed towers, has been examined by a study committee of CIGRE [81]. Strength formulas were developed from full-scale tests; three kinematic patterns of failure could occur depending upon soil depth, soil type, and size of the anchor plate. The type of failure can be predicted only by determining which formula gives the lowest capacity although results agree with experiments to within 15%.

Static analysis and testing of foundations can be insufficient by themselves because a tower can overturn after a cyclic degradation of the foundation. Non-belled pile foundations seem to be particularly susceptible to this phenomenon. For example, several four-pile foundations are reported to have failed as a result of clean ejection of piles on the uplift side [82]. Based on meteorological information, the failure load was only about 35% of the static uplift resistance. Full-scale dynamic tests [67] showed that a foundation can withstand a high transient load without damage. Long-term fluctuating loads, however, could cause a gradual uplift of foundations even though the peak load was significantly below the ultimate static resistance. Tests [83] on model foundations showed that tension-compression cycles are much more damaging than tension-tension cycles.

A parametric study of soil-structure interactions for tower structures on elastic foundations has been reported [84]. It was shown theoretically that the relative stiffnesses of the tower body and the foundation can affect the mode shapes and natural frequencies of the tower. In practice, a foundation is generally much stiffer than a transmission tower, so that foundations on soils as different as rock and a non-cohesive sand have given similar dynamic responses [66]. Therefore, it appears that, unless the foundation undergoes some kind of degradation such as liquefaction during an earthquake, the common assumption of a rigid tower base is probably justified.

CONCLUSIONS

Static longitudinal loads can be calculated iteratively by taking into account the interactions among towers, insulators, and conductors. Peak dynamic loads can be estimated to within 30% for conventional lines. There is a controversy, however, over the longitudinal strength needed for suspension towers and the optimum strategy for preventing cascades. Line vibrations can damage insulator strings or tower crossarms and can even cause collapse of a tower. Static tower designs are being refined through computer analyses and ultimate design methods, but the behavior of joints and compression members has not yet been researched adequately. A dynamic analysis will be required for tall or heavy-duty towers although some uncertainty exists regarding structural damping. Furthermore, recent testing suggests that the insulator string does not isolate the conductor and tower; thus, their interactions cannot be ignored. The resistance of foundations to overturning moments can be determined by static analysis and full-scale tests. Fluctuating wind loads, however, can cause a progressive foundation failure.

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BOOK REVIEWS

MODERN AUTOMOTIVE STRUCTURAL ANALYSIS

M. Kamal and J.A. Wolf, Jr., eds.
Van Nostrand Reinhold Co., New York, NY
1982, 450 pp, $34.50

The book consists of 12 chapters written by several individuals employed by the General Motors Corporation. Chapter titles are: ***The Automobile and Its Structure - A Historical Review; Establishing Automobile Structural Design Criteria; Introduction to Matrix Structural Analysis; Finite Element Modeling of Automotive Structures; Automobile Structural System Models for Vibration; Solution Methods for Vehicle Structural Models; Design Analysis for Stiffness and Deflection; Design Analysis for Stress and Fatigue; Collision Simulation; Plastic Deformation Analysis; Structural Acoustic Analysis Using Finite Element Methods; Optimization in Structural Design.***

According to the authors, the purposes of the book are to describe analytical methods and to discuss their basis in structural mechanics. Methods developed since 1970 are used to analyze trial designs and predict their performance.

The book contains a great deal of descriptive material, many photographs and illustrations, an extensive bibliography, and comparisons of theory and experiment. It succeeds in describing the variety of problems that must be addressed in analyses and in suggesting methods of attack. The variety and sophistication of these methods are sufficiently great that previous exposure at approximately the master's degree level is necessary because space does not allow a thorough discussion of all methods.

On the whole the book is interesting, readable, and a good contemporary survey.

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STRESS, VIBRATION AND NOISE ANALYSIS IN VEHICLES

H.G. Gibbs and T.H. Richards, eds.
Applied Science Publishers Ltd., London
1975

This edition is a collection of 23 papers from the annual conference of the Stress Analysis Group of The Institute of Physics in the United Kingdom. The authors represent a blend of industrial and academic organizations. About half of the authors (eleven) are from universities; the others represent industrial and governmental organizations.

All of the papers emphasize specific applications of analysis and experimental methods rather than the development of theory. The book contains a collection of case studies that emphasize the state of the art of vehicle design technology up to 1975. A wide range of practical problems encountered in transportation vehicles is presented. The book should therefore be of interest to the generalist desiring a broad look at technical approaches to realistic problems as well as to the specialist focusing on a few papers relating directly to his technical expertise.

Many of the papers illustrate computer methods. Eight papers are direct applications of finite element modeling techniques. Eight papers report primarily experimental studies. Four papers deal directly with spectral analysis techniques, and one author applies photoelasticity to the study of stresses and deflections in diesel engines.

Ground-based transportation vehicles were studied with the exception of an airframe structure. Automotive, rapid-transit, trucks, earthmoving vehicles, buses, light vans, and very heavy transport vehicles (trucks) are represented.

The papers generally are well written, technically sound and detailed, and well edited and arranged. Print is typeset, and photographs and illustrations are good. The overall print quality is equal to that in a good textbook.

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SOUND PROPAGATION IN THE SEA

R.J. Urick
Peninsula Publishers, Los Altos, CA
1982, 225 pp

One way to convey the scope and nature of a new textbook in a well established field is to compare the newcomer with familiar books. I compared Professor Urick's recent addition to the literature on sound propagation in the ocean with such standard textbooks as C.B. Officer's Introduction to the Theory of Sound Transmission with Application to the Ocean and I. Tolstoy and C.S. Clay's Ocean Acoustics. Urick's book is oriented toward the practical needs of sonar engineering, oceanography, and related fields. A chapter on recent mathematical models developed by the sonar community to describe propagation loss, ambient noise, and active sonar reverberation is a unique convenience not usually available in textbooks. Up-to-date experimental data are presented in accessible form in numerous tables and graphs. This rather bookish reviewer particularly enjoyed the occasional description of tests used to acquire data. Also useful are the two chapters on spatial and temporal coherence.

On the negative side, this reviewer was repeatedly frustrated by the author's practice of stating important analytical results without deriving them from basic principles. For example, the eikonal equation, which can be concisely derived, is merely stated -- and misleadingly so in terms of the Laplace operator instead of the squares of the first spatial derivatives.

In summary, this book is highly recommended to workers in the area of underwater sound, but students or workers new to this field who wish to acquire solid theoretical foundations will want to supplement the book with an older text on underwater acoustics.

M.C. Junger
Cambridge Acoustical Associates, Inc.
54 Rindge Ave.
Cambridge, MA 02140

PHYSICS VADE MECUM

H.L. Anderson, ed.
American Institute of Physics, New York, NY
1981, 330 pp, $25.00

The American Institute of Physics (AIP) issued this handbook to celebrate 50 years of journal publishing by AIP. The intent was to assemble a compendium that would be useful to the wide range of subjects that a physicist might encounter. Each chapter is approximately 10 pages in length and contains useful information, formulas, numerical data, definitions, and references. A detailed index is also included.

The first section is general in nature and contains constants, SI units and prefixes, conversion factors, and basic mathematical and physics formulas. Section 2, entitled Acoustics, describes wave propagation in fluids, macrosonics, atmospheric acoustics, underwater sound, and acoustic transmission in solids. There are also sections on room acoustics, physiological and psychological acoustics, speech, music, and acoustic measurements and instruments. Several useful tables are presented on velocity and attenuation of sound in various media.

The book also contains information on other areas of physics such as atomic spectroscopy, cryogenics, fluid dynamics, nuclear physics, optics, and solid state physics. The information presented about each area is brief but provides an excellent starting point for the user and readily available information for the physicist. For the acoustician, the book will provide important basic information. For information beyond the basics the reader will be required to use such established texts as Beranek's Noise and Vibration

Control, Morse and Ingard's Theoretical Acoustics, or Harris' Handbook of Noise Control.

V.R. Miller
5331 Pathview Drive
Huber Heights, OH 45424

SHORT COURSES

JULY

IMPACT DYNAMICS
Dates: July 11-15, 1983
Place: Los Angeles, California
Objective: It is the principal aim of this course to provide those new to the area of impact dynamics with an introduction to the behavior of structures and materials subjected to impact or short-duration impulsive loading. The course aims to bring together the varied aspects of material behavior under intense impulsive loading from the linear elastic through the hydrodynamic deformation regimes. In general, the course addresses problems where loading and response times are in the submillisecond regime and a wave description of the resulting phenomena is appropriate. The emphasis throughout is on a thorough coverage of fundamentals and their application to practical problems.

Contact: Short Course Program Office, UCLA Extension, P.O. Box 24901, Los Angeles, CA 90024 - (213) 825-1295 or 825-3344.

PRINCIPLES OF MICROCOMPUTERS AND MICROPROCESSORS
Dates: July 18-22, 1983
Place: Ann Arbor, Michigan
Objective: Today these small computers are commonly used in many research, engineering, manufacturing, communications, and business applications. This course acquaints scientists, engineers, and managers with the relevant characteristics and application techniques of these computers.

Contact: Engineering Summer Conferences, 200 Chrysler Center, North Campus, The University of Michigan, Ann Arbor, MI 48109 - (313) 764-8490.

DYNAMIC BALANCING
Dates: July 20-21, 1983
August 17-18, 1983
September 21-22, 1983
October 19-20, 1983
November 16-17, 1983
Place: Columbus, Ohio
Objective: Balancing experts will contribute a series of lectures on field balancing and balancing machines. Subjects include: field balancing methods; single, two and multi-plane balancing techniques; balancing tolerances and correction methods. The latest in-place balancing techniques will be demonstrated and used in the workshops. Balancing machines equipped with microprocessor instrumentation will also be demonstrated in the workshop sessions. Each student will be involved in hands-on problem-solving using the various balancing techniques.

Contact: R.E. Ellis, IRD Mechanalysis, Inc., 6150 Huntley Road, Columbus, OH 43229 - (614) 885-5376.

FINITE ELEMENTS IN MECHANICAL DESIGN: DYNAMIC AND NONLINEAR ANALYSIS
Dates: July 25-29, 1983
Place: Ann Arbor, Michigan
Objective: Covers vibration, material nonlinearities and geometric nonlinearities. Includes normal modes, transient response, and Euler buckling of column and plate structures. Attendees use personal computers to develop models of several problems using MSC/NASTRAN in laboratory sessions.

Contact: Engineering Summer Conferences, 200 Chrysler Center, North Campus, The University of Michigan, Ann Arbor, MI 48109 - (313) 764-8490.

AUGUST

DESIGN AND ANALYSIS OF ENGINEERING EXPERIMENTS
Dates: August 1-12, 1983
Place: Ann Arbor, Michigan
Objective: Recent developments in the field of testing, methods for designing experiments, interpre-

tation of test data, and procedures for better utilization of existing data. Design of experiments with small numbers of test pieces and runs with high dispersion are emphasized. Obtaining maximum information from limited data is stressed.

Contact: Engineering Summer Conferences, 200 Chrysler Center, North Campus, The University of Michigan, Ann Arbor, MI 48109 - (313) 764-8490.

SIMULATION USING GPSS

Dates: August 8-12, 1983
Place: Ann Arbor, Michigan
Objective: This course is designed for persons working in management science, operations research or analysis, facilities planning, or manufacturing system design. Simulation concepts are illustrated with GPSS applications, using case studies. Computer workshops provide participants with hands-on experience in building and using GPSS models.

Contact: Engineering Summer Conferences, 200 Chrysler Center, North Campus, The University of Michigan, Ann Arbor, MI 48109 - (313) 764-8490.

MACHINERY VIBRATION ANALYSIS

Dates: August 16-19, 1983
Place: New Orleans, Louisiana
Dates: November 15-18, 1983
Place: Chicago, Illinois
Objective: In this four-day course on practical machinery vibration analysis, savings in production losses and equipment costs through vibration analysis and correction will be stressed. Techniques will be reviewed along with examples and case histories to illustrate their use. Demonstrations of measurement and analysis equipment will be conducted during the course. The course will include lectures on test equipment selection and use, vibration measurement and analysis including the latest information on spectral analysis, balancing, alignment, isolation, and damping. Plant predictive maintenance programs, monitoring equipment and programs, and equipment evaluation are topics included. Specific components and equipment covered in the lectures include gears, bearings (fluid film and antifriction), shafts, couplings, motors, turbines, engines, pumps, compressors, fluid drives, gearboxes, and slow-speed paper rolls.

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

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

Dates: August 22-26, 1983
Place: Santa Barbara, California
Dates: October 17-21, 1983
Place: England
Dates: October 24-28, 1983
Place: Boulder, Colorado
Dates: November 21-25, 1983
Place: Ottawa, Ontario
Dates: November 28 - December 3, 1983
Place: Cincinnati, Ohio
Dates: December 5-9, 1983
Place: Santa Barbara, California
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 Street, Santa Barbara, CA 93105 - (805) 682-7171.

DYNAMICS AND CONTROL OF LARGE FLEXIBLE STRUCTURES

Dates: August 22-26, 1983
Place: Los Angeles, California
Objective: The theme of the course is the need to integrate the understanding of physical system dynamics with the methods of modern control theory to accomplish the practical control of the class of large, flexible structures of current interest. Attention focuses initially on the idealization of spacecraft structures and the formulation of their equations of motion. Dynamics and control theory are then developed in integrated teams, with emphasis gradually shifting to the applications of modern control theory. The limitations of conventional optimal

estimation and control theory for such applications are illustrated, and various techniques for reducing the sensitivity of conventional methods to modeling errors are presented.

Contact: Short Course Program Office, UCLA Extension, P.O. Box 24901, Los Angeles, CA 90024 - (213) 825-1295 or 825-3344.

SEPTEMBER

STRUCTURAL DYNAMICS: COMPUTER-ORIENTED APPROACH WITH APPLICATIONS

Dates: September 26-30, 1983

Place: Los Angeles, California

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

Contact: Short Course Program Office, UCLA Extension, P.O. Bos 24901, Los Angeles, CA 90024 - (213) 825-1295 or 825-3344.

OCTOBER

UNDERWATER ACOUSTICS AND SIGNAL PROCESSING

Dates: October 3-7, 1983

Place: State College, Pennsylvania

Objective: This course is designed to provide a broad, comprehensive introduction to important topics in underwater acoustics and signal processing. The primary goal is to give participants a practical understanding of fundamental concepts, along with an appreciation of current research and development activities. Included among the topics offered in this course are: an introduction to acoustics and sonar concepts, transducers and arrays, and turbulent and cavitation noise; an extensive overview of sound propagation modeling and measurement techniques; a physical description of the environment factors affecting deep and shallow water acoustics; a practical guide to sonar electronics; and a tutorial review of analog and digital signal processing techniques and active echo location developments.

Contact: Alan D. Stuart, Course Chairman, Applied Research Laboratory, The Pennsylvania State University, P.O. Box 30, State College, PA 16801 - (814) 865-7505.

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

SAE AEROSPACE CONGRESS AND EXPOSITION
Week of 3 October, 1983
Long, Beach California

Papers on "Dynamic Analysis and Testing" will be presented at two sessions during the 1983 SAE Aerospace Congress and Exposition, week of 3 October, 1983, at the Long Beach Convention Center, Long Beach, California. These two sessions are being organized by the SAE Technical Committee G-5 on Aerospace Shock and Vibration. The G-5 Committee has organized shock and vibration sessions at each SAE national aeronautic or aerospace meeting since 1957. The G-5 Committee was formed on December 8, 1955 with Dr. C.T. Molloy as Chairman, and the Committee selected and published as its first task a document on the design of vibration isolation systems for aircraft, missiles, and spacecraft. This document presented state of the art methodology utilizing mechanical impedance analyses.

The G-5 membership was selected from experienced practitioners in the field of shock and vibration control all over the United States. Committee meetings were held monthly in the Los Angeles area for many years. Presently, the meetings are held monthly at the Aerospace Corporation in El Segundo, California. Committee business is discussed at these meetings followed by a technical presentation on current dynamic advances by a Committee member or an invited speaker. The 265th meeting is scheduled for April 26, 1983. Guests are always welcome at these meetings. New members are welcome to join the G-5 committee and may do so by contacting the present Chairman of the G-5 Committee, Dr. Sheldon Rubin, at the Aerospace Corporation - (213) 648-6408.

Preliminary information on the G-5 technical sessions may be obtained from Roy W. Mustain, Rockwell Space Transportation Systems Group, Mail Sta. AB97, 12214 Lakewood Blvd., Downey, CA 90241. The final program for the 1982 SAE Aerospace Congress and Exposition may be obtained by writing to: SAE, 400 Commonwealth Dr., Warrendale, PA 15096.

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 publications abstracted are not available from SVIC or the Vibration Institute, except those generated by either organization. Government Reports (AD-, PB-, or N-numbers) can be obtained from NTIS, Springfield, Virginia 22151; Dissertations (DA-) from University Microfilms, 313 N. Fir St., Ann Arbor, Michigan 48106; U.S. Patents from the Commissioner of Patents, Washington, DC 20231; Chinese publications (CSTA-) in Chinese or English translation from International Information Service Ltd., P.O. Box 24683, ABD Post Office, Hong Kong. In all cases the appropriate code number should be cited. All other inquiries should be directed to libraries. The address of only the first author is listed in the citation. The list of periodicals scanned is published in issues 1, 6, and 12.

ABSTRACT CONTENTS

MECHANICAL SYSTEMS

ROTATING MACHINES

(Also see Nos. 1255, 1275)

83-1090

Noise Reduction in Centrifugal Fans by the Use of Lambda/4 Resonators

W. Neise and G.H. Koopmann
European Space Agency, Paris, France, Rept. No. ESA-TT-723, DFVLR-FB-81-09, 64 pp (Mar 1982) (Engl. trans. of "Geraeuschminderung bei Radialventilatoren durch lambda/4-Resonatoren," Rept. Dfvlr-FB-81-09 Dfvlr, Goettingen, West Germany, Mar 1981, 52 pp)
N82-33173

Key Words: Fans, Noise reduction, Blade passing frequency

Aerodynamic blade passage noise reduction, using a resonator at the cutoff of a centrifugal fan, is described. While preserving the original cutoff geometry, the perforated mouth of the resonator forms the new cutoff. The resonator can be tuned to various frequencies, e.g., the blade passing frequency, via a movable end plug, enabling tone intensity to be reduced by up to 29 dB.

83-1091

Utilizing Numerical Techniques in Turbofan Inlet Acoustic Suppressor Design

K.J. Baumeister
NASA Lewis Res. Ctr., Cleveland, OH, Rept. No. E-1427, NASA-TM-82994, 23 pp (1982)
N83-10885

Key Words: Fans, Turbofans, Noise reduction

Numerical theories in conjunction with previously published analytical results are used to augment current analytical theories in the acoustic design of a turbofan inlet nacelle. In particular, a finite element-integral theory is used to study the effect of the inlet lip radius on the far field radiation pattern and to determine the optimum impedance in an actual engine environment.

83-1092

Effects of Flue Gas Contamination on the Acoustical Performance of Tuned Discharge Silencers for Induced Draft Fans

T.D. Thunder and J.E. Shahan
Transco, Inc., Hinsdale, IL, ASME Paper No. 82-WA/NCA-6

Key Words: Fan noise, Noise reduction

Recently sophisticated tuned-dissipative silencers have been designed for reducing induced draft fan noise emitted from the tops of power plant stacks. These designs incorporate tuned cavities located out of the flow of flue gas and are intended to preclude, to the maximum extent feasible, the adverse effects of contaminants. This paper takes an analytical look at the probable effect of fly ash contamination of the absorptive materials located in the cavities of such tuned silencers. Measurements of the changes in the normal acoustical impedance of clean and contaminated absorptive materials provide the basis of this investigation.

83-1093

Finite Element-Integral Simulation of Static and Flight Fan Noise Radiation from the JT15D Turbofan Engine

K.J. Baumeister and S.J. Horowitz
NASA, Cleveland, OH, ASME Paper No. 82-WA/NCA-7

Key Words: Turbofan engines, Fan noise, Noise prediction, Finite element technique

An iterative finite element-integral technique is used to predict the sound field radiated from the JT15D turbofan inlet. For some single mode JT15D data, the theory and experiment are in good agreement for the far field radiation pattern as well as suppressor attenuation. Also, the computer program is used to simulate flight effects that cannot be performed on a ground static test stand.

83-1094

Unbalance Response Analysis of a Complete Turbomachine

N. Klompas
Gas Turbine Div., General Electric Co., Schenectady,

NY 12345, J. Engrg. Power, Trans. ASME, 105 (1), pp 184-191 (Jan 1983) 6 figs, 2 tables, 6 refs

Key Words: Turbomachinery, Unbalanced mass response

A new method is derived to calculate unbalance response of a complete turbomachine, including mount asymmetry, disk flexibility, and fluid-film bearing anisotropy by utilizing conventionally obtained stiffness coefficients for the rotor and stator.

83-1095

Strut or Guide Vane Secondary Flows and Their Effect on Turbomachinery Noise

B. Lakshminarayana, D.E. Thompson, and R. Trunzo
Pennsylvania State Univ., University Park, PA, J. Aircraft, 20 (2), pp 178-186 (Feb 1983) 12 figs, 1 table, 18 refs

Key Words: Rotors, Turbomachinery, Noise measurement, Aerodynamic loads

Results of an investigation in which the turbomachinery rotor sound spectra were correlated with aerodynamic measurements of upstream strut secondary flow are reported. The aerodynamic measurements, carried out in an aeroacoustic turbomachinery facility, include mean-velocity and turbulence-intensity profiles across the wake and the secondary flow regions at the strut exit or rotor inlet.

83-1096

Vortex Shedding: The Source of Noise and Vibration in Idling Circular Saws

M.C. Leu and C.D. Mote, Jr.
Cornell Univ., Ithaca, NY, ASME Paper No. 82-WA/NCA-2

Key Words: Saws, Circular saws, Noise generation, Vibration generation, Vortex shedding

Vortices separating from the edges of cutting teeth are shown to be the dominant source of pressure fluctuation and hence noise in circular saws. Measurement of pressure on the surfaces of the blade and teeth show: strong periodicity of the pressure on the tooth lateral surfaces, a 180 degree phase difference between the pressure variation on both tooth lateral surfaces, and pressure variations dominantly occurring on the tooth rather than the blade surface. The presence of an afterbody downstream of the blade and tooth edges of flow separation was necessary for aerodynamic excitation of the blade and generation of noise.

POWER TRANSMISSION SYSTEMS

83-1097

Computer Controlled Four Square Dynamometer for Transient and Cycle Testing of Continuously Variable Transmissions

H. Vahabzadeh
Ph.D. Thesis, Univ. of Wisconsin-Madison, 231 pp (1982)
DA8224071

Key Words: Power transmission systems, Transmission systems, Dynamic tests

Continuously variable transmissions (CVT) have been considered for optimum engine operation using a hybrid powerplant that incorporates an energy storage device or an advanced powertrain system. These have been recently demonstrated to offer a potential for significantly improved fuel economy and performance under most driving conditions. One of the principal difficulties in the development of such transmissions is the absence of efficient and appropriate test facilities for this purpose. This dissertation is aimed at a solution of this problem.

METAL WORKING AND FORMING

(Also see Nos. 1245, 1252, 1253)

83-1098

Dynamic Problems of Heavy Duty Machine Tools are Soluble (Grosswerkzeugmaschinen Dynamikprobleme sind lösbar)

K. Teipel
Industrie Anzeiger, 104 (104), pp 74, 76-77 (1982) 7 figs, 3 refs
(In German)

Key Words: Machine tools, Design techniques

Measures for achieving high dynamic performance of heavy duty boring machines are described. They are the minimization of mass-stiffness ratio, maximization of joint damping, decoupling of vibration direction, and dividing the resonances.

MATERIALS HANDLING EQUIPMENT

(Also see No. 1174)

83-1099

Crane Cabin Vibration Damping (Schwingungsdämpfung für Krankabinen)

Industrie Anzeiger, 104 (99), p 22 (1982)
(In German)

Key Words: Crane cabins, Vibration damping

A crane cabin suspension system is described which consists of three vertically suspended hydraulic cylinders, attached on both sides of connecting heads which, together with a membrane pressure reservoir, comprise a hydropneumatic spring element. To reduce the oscillation of the cabin during startup and braking these supporting cylinders are mounted far outside of the cabin. The natural frequency of the system in the vertical direction is about 0.9 Hz. The damping properties of the supporting cylinders are obtained by means of the adjustable throttle inside the connecting line to the pressure reservoir and can be individually optimized on location. The measurement results show that this type of cabin suspension provides high damping especially at high vibration excitation.

STRUCTURAL SYSTEMS

83-1100

Vertical Seismic Behaviour of Suspension Bridges

A.M. Abdel-Ghaffar and L.I. Rubin
Civil Engrg. Dept., Princeton Univ., Princeton, NJ 08544, Intl. J. Earthquake Engrg. Struc. Dynam., 11 (1), pp 1-19 (Jan/Feb 1983) 14 figs, 4 tables, 13 refs

Key Words: Bridges, Suspension bridges, Seismic response, Frequency domain

The vertical response of suspension bridges to multi-support seismic excitations is investigated. A frequency-domain random-vibration approach is utilized to take into account not only the differences in ground motion inputs, but also the correlation among the various input motions.

83-1101

Wind-Induced Response of Golden Gate Bridge

H. Tanaka and A.G. Davenport
Univ. of Ottawa, Ottawa, Ontario, Canada, ASCE J. Engrg. Mech., 109 (1), pp 296-312 (Feb 1983) 18 figs, 2 tables, 11 refs

Key Words: Bridges, Suspension bridges, Spectrum analysis, Wind-induced excitation

Full-scale observation data of wind-induced behavior of the Golden Gate Bridge from a 1962 study was extensively re-examined by spectral analysis. The experimental investigation on the same bridge was also conducted using proposed taut strip bridge model with the simulation of natural wind turbulence at laboratory scale.

83-1102

Nonlinear Free Vibrations of Suspension Bridges: Theory

A.M. Abdel-Ghaffar and L.I. Rubin
Princeton Univ., Princeton, NJ 08544, ASCE J. Engrg. Mech., 109 (1), pp 313-329 (Feb 1983) 5 figs, 6 refs

Key Words: Bridges, Suspension bridges, Torsional vibration, Vertical vibration

A general theory and analysis of the nonlinear free coupled vertical-torsional vibrations of suspension bridges with horizontal decks are presented. Approximate solutions are developed by using the method of multiple scales via a perturbation technique. The amplitude-frequency relationships for any single set of coupled vertical-torsional modes are presented for three cases.

83-1103

Nonlinear Free Vibrations of Suspension Bridges: Application

A.M. Abdel-Ghaffar and L.I. Rubin
Princeton Univ., Princeton, NJ 08544, ASCE J. Engrg. Mech., 109 (1), pp 330-345 (Feb 1983) 15 figs, 6 tables, 2 refs

Key Words: Bridges, Suspension bridges, Torsional vibration, Vertical vibration

The basic characteristics of the nonlinear free flexural-torsional vibrations of two suspension bridges are examined. The amplitude-frequency relationships of the first six modes (symmetric and antisymmetric) of both vertical and torsional vibrations for each bridge are presented. The case when one of the linear natural frequencies of vertical vibration is equal to, or approximately equal to, another linear natural frequency of torsional vibration, is considered.

83-1104

Lateral Earthquake Response of Suspension Bridges

A.M.Abdel-Ghaffar and L.I. Rubin

Dept. of Civil Engrg., Princeton Univ., Princeton, NJ, ASCE J. Struc. Engrg., 109 (3), pp 664-675 (Mar 1983) 9 figs, 2 tables, 9 refs

Key Words: Bridges, Suspension bridges, Seismic response, Frequency domain method

The lateral response of suspension bridges to multiple-support seismic excitations is investigated. A frequency-domain random-vibration approach is utilized to take into account not only the differences in ground motion inputs, but also the correlation among the various input motions.

BUILDINGS

(Also see Nos. 1156, 1157, 1158, 1206, 1271)

83-1105

The Acoustic Performance of Building Facades in Hot Climates: Part 1 – Courtyards

R.N.S. Hammad and B.M. Gibbs

Dept. of Bldg. Engrg., The Univ. of Liverpool, P.O. Box 147, Liverpool L69 3BX, UK, Appl. Acoust., 16 (2), pp 121-137 (Mar 1983) 17 figs, 1 table, 15 refs

Key Words: Buildings, Acoustic properties

The acoustic performance of perforated screens of unusual geometry was investigated by means of model work and computer simulation resulting from diffraction theory in which the barrier produces an amplitude gradient (thnadner) or a phase gradient (splitter). The results indicate that the protection obtained is similar to that of a solid thin barrier of equal height for a wide range of frequencies when the receiver is near the barrier.

83-1106

The Base Balance Measurement Technique and Applications to Dynamic Wind Loading to Structures

T. Tschanz

Ph.D. Thesis, The Univ. of Western Ontario, Canada (1982)

Key Words: Buildings, Wind-induced excitation, Measurement techniques

Wind tunnel testing is the only confident method of predicting the response of buildings to natural wind currently available. Modeling techniques are well developed, but rely in most instances on representation of the turbulent boundary layer in a wind tunnel, and complete modeling of all the structural parameters such as shape, mass, damping and stiffness. The resulting dynamic responses of the aeroelastic models can directly be scaled to full scale values. Aeroelastic models, however, are expensive, require much time before availability of results, and are specific to the structural parameters modeled. The subject of this study is to directly measure the total dynamic modal forces, using a high frequency, balance-model system with a flat frequency response. The foam models are mounted on a sensitive, but rigid five-component balance which is described in detail. This balance is believed to represent the state of the art for the intended load ranges.

83-1107

Inelastic Earthquake Response of Steel Structures

A.M. Kabe and D. Rea

The Aerospace Corp., El Segundo, CA, ASCE J. Struc. Engrg., 109 (3), pp 705-719 (Mar 1983) 17 figs, 14 refs

Key Words: Buildings, Framed structures, Steel, Shakers, Computer programs

Results from experiments in which small three story steel frame structures were subjected to simulated earthquake motions by means of a shaking table are described. The results of the experiments were used to evaluate the accuracy of a computer program by comparing computed time histories and hysteresis loops with those obtained experimentally.

83-1108

Active Control of Tall Buildings

M. Abdel-Rohman and H.H. Leipholz

Faculty of Engrg. and Petroleum, Kuwait Univ., P.O. Box 5969, Kuwait, ASCE J. Struc. Engrg., 109 (3), pp 628-645 (Mar 1983) 19 figs, 1 table, 23 refs

Key Words: Buildings, Wind-induced excitation, Active control, Tendons

The active control of a tall building, using tendons, is offered as an alternative control mechanism to that using an active tuned mass damper. The paper shows systematically, with a numerical example, how to design the optimal control forces for both active tendons and active tuned mass dampers in order to introduce active damping to a tall building, even under nonlinear structural behavior, and the paper provides a comparison between two schemes of control.

83-1109

Seismic Design for Buildings and Building Codes. 1970 - November, 1982 (Citations from the NTIS Data Base)

NTIS, Springfield, VA, 201 pp (Nov 1982)
PB83-853655

Key Words: Buildings, Seismic design, Standards and codes, Bibliographies

This bibliography contains 154 citations concerning seismic design criteria and building codes for various types of non-nuclear structures, principally buildings, and their foundations. The design criteria for seismic protection are discussed both in general and with respect to specific types of structures. Cases of actual damage assessment for earthquake resistant and non-resistant structures are included. Applications to new building construction, particularly in the eastern metropolitan area, are discussed.

83-1110

Simple Nonlinear Modelling of Earthquake Response in Torsionally Coupled R/C Structures - A Preliminary Study

M. Saiidi
College of Engrg., Univ. of Nevada at Reno, Rept. No. COLLEGE OF ENGINEERING-60, NSF/CEE-82035, 82 pp (July 1982)
PB83-112821

Key Words: Buildings, Reinforced concrete, Seismic response

Results are presented of a study to determine the seismic response of a torsionally coupled building based on multi-degree-of-freedom (MDOF) and single-degree-of-freedom (SDOF) nonlinear models and to develop a simple SDOF nonlinear model to calculate displacement history of structures with eccentric centers of mass and stiffness.

83-1111

An Automated Design Study of the Economics of Earthquake Resistant Structures

F. Naeim
Ph.D. Thesis, Univ. of Southern California (1982)

Key Words: Earthquake resistant structures, Seismic design, Computer-aided techniques, Buildings, Steel, Reinforced concrete

This dissertation presents an automated design approach to the study of the economics of earthquake resistant design. Two automated strength design programs which are developed as part of this research, and a data base of uniform risk relative pseudo velocity response spectra for regions of shallow seismicities, prepared in the Univeristy of Southern California (1980), have been utilized in this study. The automated design programs are capable of efficiently producing final designs for steel and reinforced concrete buildings, starting with any arbitrary preliminary design. The programs may be used to design two or three dimensional ductile moment frames, braced frames, shear wall systems, shear wall-frames, and framed tubes. The design of steel structures conforms to the AISC (1978) specification for plastic design, and reinforced concrete design meets the requirements of ACI 318-77 Code.

83-1112

System Identification Methods for Damage Evaluation of Existing Structures

S. Toussi
Ph.D. Thesis, Purdue Univ., 171 pp (1982)
DA8300968

Key Words: Buildings, Multistory buildings, Natural frequencies, Hysteretic damping, System identification techniques, Earthquake damage

The objective of this study is to develop a practical approach for damage assessment of existing structures using structural response data as measured. Although the main emphasis is on the safety evaluation of structures following the occurrence of an earthquake, there is no restriction regarding the use of the approach for structures which have experienced other kinds of loads. In this dissertation, several methods are developed for the identification of inter-story hysteresis behavior of high-rise buildings and the detection of changes in their main natural frequency. Then apparent and meaningful features of the identified hysteresis behaviors are found. Finally, a suitable and practical damage indicator is obtained from and correlated to the extracted features. Because there exist uncertainties in results from using system identification techniques, the third part of this study is devoted to the search for techniques with which such uncertainties can be dealt.

TOWERS

83-1113

Time Series Analysis of Cooling Tower Wind Loading

D.A. Reed and R.H. Scanlan

National Bureau of Standards, Washington, DC 20234, ASCE J. Struc. Engrg., 109 (2), pp 538-554 (Feb 1983) 6 figs, 5 tables, 31 refs

Key Words: Towers, Cooling towers, Wind-induced excitation, Time domain method

This paper considers full-scale wind velocity and wind pressure time series data collected on two cooling towers. ARIMA time series models are shown to describe these data adequately. Transfer function models in the time domain relating input wind velocity to output wind pressure-difference at three circumferential tower locations are presented and discussed.

FOUNDATIONS

83-1114

Effect of Random Loading on Modulus and Damping of Sands

H.A.A. Al-Sanad

Ph.D. Thesis, Univ. of Maryland, 271 pp (1982) DA8301376

Key Words: Sand, Random excitation, Shear modulus, Damping

The two primary dynamic soil properties, namely shear modulus and damping, of three types of dry sand were evaluated in a resonant column device using random vibrations in addition to the conventional sinusoidal vibrations. The difficulty of analyzing random response is overcome by the use of a new method called random decrement technique. A comprehensive testing program covering a wide range of variables was carried out. The damping and modulus were calculated for both the sinusoidal and random vibrations over a wide range of strains.

83-1115

Rocking of Slender Rigid Bodies Allowed to Uplift

I.N. Psycharis and P.C. Jennings

Div. of Engrg. and Appl. Science, California Inst. of Tech., Pasadena, CA, Intl. J. Earthquake Engrg. Struc. Dynam., 11 (1), pp 57-76 (Jan/Feb 1983) 12 figs, 25 refs

Key Words: Foundations, Seismic excitation, Rocking, Earthquake response, Winkler foundations, Two degree of freedom systems

Strong shaking of structures during large earthquakes may result in some cases in partial separation of the base of the structure from the foundation. A simplified problem of this type, the dynamic response of a rocking rigid block allowed to uplift, is examined here. Two foundation models are considered: the Winkler foundation and the much simpler two-spring foundation. It is shown that an equivalence between these two models can be established, so that one can work with the much simpler two-spring foundation. Simple solutions of the equations of motion are developed and simplified methods of analysis are proposed.

83-1116

Dynamic Compaction of Saturated Granular Media

D. Kolymbas

Institut f. Bodenmechanik und Felsmechanik, Univ. of Karlsruhe, W. Germany, Mech. Res. Comm., 9 (6), pp 351-358 (Nov/Dec 1982) 2 figs, 6 refs

Key Words: Granular materials, Dynamic response, Cyclic loading, Compacting

The effort to compact a saturated granular body having a water-permeable part of its boundary is counteracted by two actions: the volumetric stiffness of the grain skeleton and the viscosity of the porewater. Experiments with dry sand show that the resistance to compaction exerted by the volumetric stiffness can be largely overcome by the application of cyclic loading.

83-1117

A Probabilistic Approach to Seismic Soil-Structure Interaction Analysis

Jen-Hwa Chen

Ph.D. Thesis, Univ. of California, Berkeley, 161 pp (1982) DA8300453

Key Words: Interaction: soil-structure, Seismic analysis, Random vibration, Probability theory

Earthquake motions are so uncertain that their spectral contents are best treated as random events for design purposes. The objective of the investigation reported herein was to develop a probabilistic method of seismic soil-structure interaction analysis which properly accounts for the uncertainty in the spectral contents. Two existing methods of soil-structure interaction analysis were examined. Their ability to consider the uncertainty in spectral contents were found to be qualitative at best.

83-1118
Non-Linear Seismic Response Analysis of Soil-Structure Interaction Systems
K. Toki and F. Miura
Disaster Prevention Research Institute, Kyoto Univ., Uji, Kyoto 611, Japan, Intl. J. Earthquake Engrg. Struc. Dynam., 11 (1), pp 77-89 (Jan/Feb 1983) 12 figs, 4 tables, 24 refs

Key Words: Interaction: soil-structure, Seismic response, Nuclear reactors, Nuclear power plants, Nonlinear response

This paper presents an effective analysis procedure for the dynamic soil-structure interaction problem considering not only the sliding and separation phenomena but also the nonlinear behavior of soil by the finite element method. The load transfer method is adopted to carry out dynamic nonlinear response analysis. The method is applied to the response analysis of a nuclear reactor building resting on the ground surface. The effects of nonlinear behavior of soil on the safety against sliding of the structure are examined.

HARBORS AND DAMS

83-1119
Finite Element Analysis of Reservoir Vibration
J. Humar and M. Roufaiel
Dept. of Civil Engrg., Carleton Univ., Ottawa, Ontario, Canada, ASCE J. Engrg. Mech., 109 (1), pp 215-230 (Feb 1983) 10 figs, 9 refs

Key Words: Dams, Seismic design, Finite element technique, Harmonic excitation

The finite element method of analysis is applied to the calculation of hydrodynamic pressures in a reservoir impounded by a gravity dam and subjected to a harmonic ground motion. A radiation condition which adequately models the energy loss over a wide range of excitation frequency is developed. Finite element solutions are obtained for several reservoir vibration problems.

83-1120
Dynamic Analysis of Arch Dams Including Hydrodynamic Effects
J.F. Hall and A.K. Chopra
California Inst. of Tech., Pasadena, CA, ASCE J. Engrg. Mech., 109 (1), pp 149-167 (Feb 1983) 8 figs, 2 tables, 9 refs

Key Words: Dams, Earthquake response, Hydrodynamic response

A procedure is developed to analyze, under the assumption of linear behavior, the earthquake response of arch dams including hydrodynamic effects. The dam and fluid domain are treated as substructures and modeled with finite elements.

83-1121
Seismic Stability of the Revelstoke Earthfill Dam
K.S. Khilnani, P.M. Byrne, and K.K. Yeung
British Columbia Hydro and Power Authority, Revelstoke Project, Revelstoke, B.C., Canada, Canadian Geotech. J., 19 (1), pp 63-75 (Feb 1982) 18 figs, 2 tables, 11 refs

Key Words: Dams, Seismic response

The foundation soil beneath the earthfill section of the proposed Revelstoke dam comprises, in part, a deep silt-clay layer that contains pockets of loose to compact saturated sands. Removal of this material beneath the core of the dam was required for seepage and erosion control. Analyses were performed to determine if considerations of earthquake stability would also require removal of this material beneath the shells.

ROADS AND TRACKS

83-1122
Investigation of the Vibrations of Rails (Schwingungsuntersuchungen an Eisenbahnschienen)
W. Scholl

Institut f. Technische Akustik, TU Berlin, Acustica, 52 (1), pp 10-15 (Dec 1982) 8 figs, 4 refs
(In German)

Key Words: Railroad tracks, Wave propagation, Sound waves, Vibration analysis

A two-dimensional theoretical model was used to describe the wave propagation along rails. It consists of three infinitely long layers representing head, web, and foot of the rail. Using the equations of elastic continua, the propagating modes of such a model were calculated.

POWER PLANTS

(Also see No. 1118)

83-1123
In-Plane Free-Field Response of Actual Sites
J.P. Wolf and P. Obernhuber
Electrowatt Engrg. Services Ltd., 8022 Zurich, Switzerland, Intl. J. Earthquake Engrg. Struc. Dynam., 11 (1), pp 121-134 (Jan/Feb 1983) 20 figs, 2 tables, 9 refs

Key Words: Nuclear power plants, Seismic response, Harmonic response, Transient response

To study the characteristic features of the in-plane free-field response, two actual sites of nuclear power plants, a soft and a rock site, are analyzed, by varying the location of the control point and the nature of the wave pattern. Harmonic and transient seismic excitations are examined.

OFF-SHORE STRUCTURES

83-1124
Analytical Correlation of a Dynamic Brace Buckling Experiment
Y. Ghanaat and R.W. Clough
ISEC, Inc., San Francisco, CA 94111, Intl. J. Earthquake Engrg. Struc. Dynam., 11 (1), pp 111-120 (Jan/Feb 1983) 13 figs, 7 refs

Key Words: Off-shore structures, Drilling platforms, Braces, Dynamic buckling

A dynamic response analysis procedure for an x-braced tubular steel offshore platform frame is described, including details of the mathematical model adopted to represent the dynamic buckling behavior of the brace member. Results obtained with this mathematical technique are compared with experimental data.

83-1125
Model Study of Effects of Damage on the Vibration Properties of Steel Offshore Platforms
F. Shahrivar
Ph.D. Thesis, Univ. of California, Berkeley, 208 pp (1982)
DA8300648

Key Words: Off-shore structures, Drilling platforms, Failure detection, Natural frequencies, Mode shapes

Changes in the vibration frequencies and mode shapes of fixed offshore platforms can be used to detect damage. The vibratory properties of a 1/50th scale, three dimensional model possessing the key features of a typical, eight legged, k-braced steel offshore platform were studied considering both damaged and undamaged conditions. In this study, for the first time, quantitative information on mode shapes were utilized leading to improved damage detection capabilities. The scaling considerations, the model and the experimental method are described. The experimental results are complemented with analytical results showing excellent correlation.

VEHICLE SYSTEMS

SHIPS

83-1126
Analytical Prediction of Pressures and Forces on a Ship Hull Due to Cavitating Propellers
P. Kaplan, J. Bentson, and M. Benatar
Hydromechanics, Inc., Plainview, NY, Rept. No. 82-47, 81 pp (Sept 1982) (Presented at the Symposium on Naval Hydrodynamics (14th), Aug 23-27, 1982, Ann Arbor, MI)
AD A 121 238

Key Words: Ship hulls, Ship vibration, Cavitation

An existing technique for determining free space pressures generated by a cavitating propeller operating in a ship wake is used as the basic input for determining the pressure distribution on various ship sections. The procedure involves establishing a boundary value problem on the ship section and the free surface, with appropriate conformal mapping operations that allow conversion of the problem to a more simplified boundary.

83-1127

Beam Models for Ship Hull Vibration Analysis

J.J. Jensen

Dept. of Ocean Engrg., The Technical Univ. of Denmark, DK - 2800 Lyngby, Denmark, Shock Vib. Dig., 15 (2), pp 23-27 (Feb 1983) 27 refs

Key Words: Ship hulls, Ship vibration, Beams, Timoshenko theory, Reviews

Beam models used for hull vibration analysis are reviewed. The main conclusion drawn is that the Timoshenko beam theory, with a proper definition of the shear coefficient, can accurately predict the lowest vertical hull vibration modes and corresponding natural frequencies. For coupled horizontal-torsional vibrations a realistic modeling of major discontinuities in the hull beam is necessary in order to achieve reliable results.

83-1128

Procedures for Conducting Shock Tests on Navy Class HI (High Impact) Shock Machines for Lightweight and Mediumweight Equipments

E.W. Clements

Naval Res. Lab., Washington, DC, Rept. No. NRL-8631, 19 pp (Sept 30, 1982)
AD-A121 051

Key Words: Shipboard equipment response, Shock tests

Combat worthiness of Navy shipboard systems and equipment is in large part due to tests conducted on the Navy Class HI (High Impact) Shock Machines for Lightweight and Mediumweight Equipments. These machines are often referred to by the abbreviated names of Lightweight Shock Machine (LWSM) and Mediumweight Shock Machine (MWSM). The validity of tests performed on these machines depends on their being operated properly. This report provides a comprehensive assembly of the rules to be followed and the guides to be observed to achieve consistent, valid tests of Navy equipment by use of the LWSM and MWSM.

AIRCRAFT

(Also see Nos. 1152, 1153, 1154, 1155, 1164, 1177, 1190)

83-1129

Noise Control for Aircraft. 1975 - November, 1982 (Citations from the International Information Service for the Physics and Engineering Communities Data Base)

NTIS, Springfield, VA, 258 pp (Nov 1982)
PB83-854414

Key Words: Aircraft noise, Noise reduction, Bibliographies

This bibliography contains 255 citations concerning the techniques for studying and predicting aircraft noise. Noise control techniques, including landing trajectories, noise impact and other sources of noise pollution are discussed. Community response to aircraft noise is considered.

83-1130

Aerodynamic Estimation Techniques for Aerostats and Airships

S.P. Jones and J.D. DeLaurier

TCOM Corp., Columbia, MD, J. Aircraft, 20 (2), pp 120-126 (Feb 1983) 5 figs, 2 tables, 22 refs

Key Words: Aircraft, Aerodynamic loads

A semiempirical steady-state model of a finned axisymmetric body is developed and used to compute hull-fin mutual interference factors and cross-flow drag coefficients from wind tunnel data on five aerostats and airships. The results are in general agreement with expectations from theory and provide a basis for predicting aerodynamic coefficients.

83-1131

Aircraft Gas Turbine Engines: Noise Reduction and Vibration Control. 1973 - December, 1982 (Citations from Information Services in Mechanical Engineering Data Base)

NTIS, Springfield, VA, 185 pp (Dec 1982)
PB83-85421

Key Words: Aircraft engines, Gas turbine engines, Noise reduction, Vibration control, Bibliographies

This bibliography contains 235 citations concerning the design of aircraft gas turbine engines with respect to noise reduction and vibration control. The aerodynamics of inlet design is considered for several types of engine applications including turbofan, turboprop, and vertical takeoff and land aircraft.

83-1132

A New Measurement Method for Separating Airborne and Structureborne Aircraft Interior Noise

M.C. McGary and W.H. Mayes

NASA Langley Res. Ctr., Noise Effects Branch, Hampton, VA 23665, Noise Control Engrg., 20 (1), pp 21-30 (Jan/Feb 1983) 21 figs, 23 refs

Key Words: Aircraft noise, Noise measurement, Measurement techniques, Interior noise

A new measurement method is presented for separating airborne and structureborne noise in propeller driven aircraft. The theory of the measurement method and the results of two experiments designed to validate the theory are presented. The method is based on the two-microphone cross spectral acoustic intensity measurement method and the theory of sound radiation of plate and thin shell structures.

83-1133

Theoretical and Experimental Evaluation of Transmission Loss of Cylinders

Y.S. Wang, M.J. Crocker, and P.K. Raju

Purdue Univ., West Lafayette, IN, AIAA J., 21 (2), pp 186-192 (Feb 1983) 15 figs, 15 refs

Key Words: Aircraft noise, Interior noise, Shells, Cylindrical shells, Statistical energy analysis, Two microphone technique, Fast Fourier transform

A light aircraft fuselage was idealized by a cylindrical shell. Its sound transmission loss was evaluated theoretically by using statistical energy analysis (SEA). The parameters used in SEA were obtained theoretically from the wavenumber diagrams using a computer.

83-1134

High Bypass Ratio Engine Noise Component Separation by Coherence Technique

B.N. Shivashankara

The Boeing Commercial Airplane Co., Seattle, WA, J. Aircraft, 20 (3), pp 236-242 (Mar 1983) 12 figs, 9 refs

Key Words: Aircraft engines, Engine noise, Noise component separation, Signal processing techniques

Aft fan, core, and jet noise components of a large high bypass ratio engine were separated by the use of a signal enhancement technique. This technique uses simultaneous signals from three or more microphones that are assumed to have a common correlated part and uncorrelated extraneous noise at each location. This paper includes a description of the technique, its validation by controlled model-scale experiments and examples of results from the full-scale engine test.

83-1135

Minimum Angular Vibration Design of Airborne Electro-Optical Packages

P.W. Whaley

Univ. of Nebraska, Lincoln, NB, AIAA J., 21 (2), pp 277-282 (Feb 1983) 3 figs, 3 tables, 9 refs

Key Words: Torsional vibration, Airborne equipment response, Vibration control, Pontryagin's principle

Low-level angular vibration disturbances to airborne electro-optical packages can sometimes severely degrade the accuracy of such systems. This paper is an investigation into the possibility of minimizing the angular vibration response of selected points on an optical bench by redistributing the mass. The governing equations are presented in a form suitable for application of the Pontryagin maximum principle with the beam cross-sectional area playing the role of the control function. Angular vibration reduction at the ends of a pinned beam of an order of magnitude are demonstrated.

83-1136

Development and Flight Test of an Active Flutter Suppression System for the F-4F with Stores. Part 1. Design of the Active Flutter Suppression System

H. Honlinger, D. Mussman, R. Manser, and L.J. Huttsell

Air Force Wright Aeronautical Labs., Wright-Patterson AFB, OH, Rept. No. AFWAL-TR-82-3040-PT-1, 91 pp (Sept 1982)

AD-A121 485

Key Words: Flutter, Active flutter control, Wing stores, Aircraft wings

Extensive research programs have been conducted to investigate the application of active controls for the suppression of wing/store flutter. A flutter suppression system was developed and flight tested on an F-4F aircraft. The control law was designed using optimal control theory to minimize the control surface motion and to provide the required stability margins.

83-1137

Flight Test Results of an Active Flutter Suppression System

J.E. Edwards

NASA Langley Res. Ctr., Hampton, VA, J. Aircraft, 20 (3), pp 267-274 (Mar 1983) 15 figs, 1 table, 10 refs

Key Words: Active flutter control, Damping

Flight flutter test results of the first aeroelastic research wing of NASA's Drones for Aerodynamic and Structural Testing Program are presented. The implementation of the flutter suppression system and the flight test operation are described. The conduct of the flutter testing and the near-real-time damping estimation algorithm are also described in detail.

83-1138

Active Flutter Suppression Using Optical Output Feedback Digital Controllers

Information and Control Systems, Inc., Hampton, VA, Rept. No. NASA-CR-165939, 79 pp (May 1982) N82-32375

Key Words: Flutter, Active flutter control, Digital techniques, Aircraft wings

A method for synthesizing digital active flutter suppression controllers using the concept of optimal output feedback is presented. A convergent algorithm is employed to determine constrained control law parameters that minimize an infinite time discrete quadratic performance index. Low order compensator dynamics are included in the control law and the compensator parameters are computed along with the output feedback gain as part of the optimization process.

83-1139

Crashworthy Airframe Design Concepts: Fabrication and Testing

J.D. Cronkhite and V.L. Berry

Textron Bell Helicopter, Fort Worth, TX, Rept. No. NASA-CR-3603, 206 pp (Sept 1982) N82-33735

Key Words: Aircraft, Crashworthiness, Floors, Energy absorption, Computer programs

Crashworthy floor concepts applicable to general aviation aircraft metal airframe structures were investigated. Initially several energy absorbing lower fuselage structure concepts were evaluated. Full scale floor sections representative of a twin engine, general aviation airplane lower fuselage structure were designed and fabricated.

83-1140

Dynamic Stability of a Buoyant Quad-Rotor Aircraft

B.L. Nagabhushan

Goodyear Aerospace Corp., Akron, OH, J. Aircraft, 20 (3), pp 243-249 (Mar 1983) 13 figs, 4 tables, 21 refs

Key Words: Aircraft, Vertical takeoff aircraft, Helicopters, Dynamic stability

Stability characteristics of a buoyant quad-rotor aircraft in hover and forward flight are examined by considering linear, state-variable, and nonlinear flight simulation models of such a vehicle configuration. Inherent stability characteristics of the vehicle are analyzed and compared with those of a conventional helicopter and an airship in free flight.

83-1141

Holographic Interferometry Technique for Rotary Wing Aerodynamics and Noise

J.K. Kittleson and Yung H. Yu

NASA Ames Res. Ctr., Moffett Field, CA, 15 pp (Nov 3, 1982) AD-A121 347

Key Words: Helicopters, Propeller noise, Aerodynamic noise, Holographic techniques, Interferometers

The concepts of holography and holographic interferometry, as applied to the visualization and measurement of the three-dimensional flow field near a rotor tip, are previewed, and initial experimental results of investigations of local shock structures and tip vortices behind the blade are presented. An additional method to visualize the flow in a three-dimensional manner is demonstrated, and finally, a method to quantitatively measure the three-dimensional flow, which will provide the necessary information to help improve helicopter performance and reduce noise, is introduced.

83-1142

The Influence of Helicopter Operating Conditions on Rotor Noise Characteristics and Measurement Repeatability

M.R.P. Law and J. Williams

Royal Aircraft Establishment, Farnborough, UK, Rept. No. RAE-TR-82030, DRIC-BR-84664, 63 pp (Apr 1982)

AD-A121 426

Key Words: Helicopter noise, Noise generation, Noise measurement

Extensive measurements of noise characteristics and associated flight-path data have been made on several helicopters in various operational modes, with repeated flight trajectories over longitudinal and lateral arrays of ground-based microphones under quiet airfield conditions. This analysis presents some experimental results from Lynx aircraft with standard rotor configurations, being concerned primarily with the influence of different operating procedures on both main-rotor and tail-rotor noise characteristics and on measurement repeatability during level-flight, oblique landing-approach, and oblique takeoff.

83-1143

Development of a Rotorcraft. Propulsion Dynamics Interface Analysis, Volume 1

R. Hull

Systems Control, Inc. (VT), Palo Alto, CA, Rept. No. NASA-CR-166380, 147 pp (Aug 1982)

N82-32368

Key Words: Helicopters, Rotors, Propulsion systems, Coupled response

The details of the modeling process and its implementation approach are presented. A generic methodology and model structure for performing coupled propulsion/rotor response analysis that is applicable to a variety of rotocraft types was developed. A method for parameterizing the model structure to represent a particular rotorcraft is defined. The generic modeling methodology, the development of the propulsion system and the rotor/fuselage models, and the formulation of the resulting coupled rotor/propulsion system model are described.

83-1144

Development of a Rotorcraft. Propulsion Dynamics Interface Analysis, Volume 2

R. Hull

Systems Control Inc. (VT), Palo Alto, CA, Rept. No. NASA-CR-166381, 56 pp (Aug 1982)

N82-32369

Key Words: Helicopters, Rotors, Propulsion systems, Coupled response

A study was conducted to establish a coupled rotor/propulsion analysis that would be applicable to a wide range of rotorcraft systems. Documentation of the computer models developed is presented.

83-1145

Rotorcraft Blade Mode Damping Identification from Random Responses Using a Recursive Maximum Likelihood Algorithm

J.A. Molusis

Ashford, CT, Rept. No. NASA-CR-3600, 49 pp (Sept 1982)

N82-33373

Key Words: Helicopters, Propeller blades, Damping coefficients, Modal analysis, System identification techniques

An on line technique is presented for the identification of rotor blade modal damping and frequency from rotorcraft random response test data. The identification technique is based upon a recursive maximum likelihood (RML) algorithm, which is demonstrated to have excellent convergence characteristics in the presence of random measurement noise and random excitation. The RML technique requires virtually no user interaction, provides accurate confidence bands on the parameter estimates, and can be used for continuous monitoring of modal damping during wind tunnel or flight testing. Results are presented from simulation random response data which quantify the identified parameter convergence behavior for various levels of random excitation.

83-1146

Further Advances in Helicopter Vibration Control

G.T.S. Done

The City University, Northampton Square, London EC1V OHB, UK, Shock Vib. Dig., 15 (2), pp 17-22 (Feb 1983) 2 figs, 52 refs

Key Words: Helicopter vibration, Vibration control, Reviews

This article describes advances that have been made since 1979 in the control of helicopter vibration and reviews the associated literature. Vibration isolation, absorbers, direct rotor control, structural design and modification, and vibration studies are considered.

83-1147

Design of Helicopter Rotor Blades for Optimum Dynamic Characteristics

D.A. Peters, T.Ko, A.E. Korn, and M.P. Rossow

Dept. of Mech. Engrg., Washington Univ., St. Louis, MO, Rept. No. SASR-1, NASA-CR-169352, 33 pp (Sept 15, 1982)

N82-33374

Key Words: Helicopters, Propeller blades, Mass coefficients, Stiffness coefficients, Design techniques

The possibilities and the limitations of tailoring blade mass and stiffness distributions to give an optimum blade design in terms of weight, inertia, and dynamic characteristics are investigated. Changes in mass or stiffness distribution used to place rotor frequencies at desired locations are determined. Theoretical limits to the amount of frequency shift are established. Realistic constraints on blade properties based on weight, mass moment of inertia size, strength, and stability are formulated.

MISSILES AND SPACECRAFT

(Also see Nos. 1161, 1270)

83-1148

Dynamic Wind Tunnel Tests of the Simulated Shuttle External Cable Trays

K.J. Orlik-Rückemann and J.G. LaBerge

National Aeronautical Establishment, National Res. Council of Canada, Ontario, Canada, J. Spacecraft Rockets, 20 (1), pp 5-10 (Jan/Feb 1983) 20 figs, 8 refs

Key Words: Space shuttles, Cable trays, Wind tunnel testing

Oscillatory pitching and plunging experiments were performed on models of the cable trays employed on the external tank of the Space Shuttle. The models were mounted transversally to the flow to simulate the significant local cross flows that can be expected as a result of the effects of the bow shock around the nose of the solid rocket booster and the associated flow separation. Several cross sections of the trays were investigated and the surface of the external tank was simulated by a ground plane. The oscillatory experiments were supplemented by some flow visualization studies.

83-1149

Vibrational Analysis in Aerodynamics. 1970 - November, 1982 (Citations from the NTIS Data Base)

NTIS, Springfield, VA, 238 pp (Nov 1982)

PB83-854984

Key Words: Spacecraft, Helicopters, Aircraft, Flutter, Bibliographies

This bibliography contains 185 citations concerning excitation and analysis techniques for flight flutter tests. Although fixed-wing aircraft, space flight vehicles, VTOL and V/STOL vehicles are included, helicopter generated vibration analysis is emphasized in this bibliography. Among the variations of flutter included are unsteady airloads, fluidelastic vibration, rotor blade in forward flight, turbomachine blades, composite wings, response of re-entry vehicles, tail vibration, hingeless helicopter rotors and hinge-type, propeller whirl and SST related vibration.

83-1150

Vibrational Analysis in Aerodynamics. 1972 - November, 1982 (Citations from the International Aerospace Abstracts Data Base)

NTIS, Springfield, VA, 158 pp (Nov 1982)

PB83-854976

Key Words: Spacecraft, Helicopters, Aircraft, Flutter, Bibliographies

This bibliography contains 144 citations concerned with design and performance relative to aerodynamic vibration. Among the topics discussed are torsion blade flutter; vibration generated by rudders, rotor blades, panels, air foils; vortex sheddings; load control; and helicopter gust response flutter. Aircraft vibrational analyses by means of analog computer simulation, auto-flight control systems, and structural dynamics of aircraft are included with consideration for flight vehicle vibration control and reduction.

83-1151

Design of a Hydrodynamic Support System for the Saturn V Launch Vehicle: A Case Problem

R.A. Hirsch

AAI Corp., Cockeysville, MD, ASME Paper No. 82-WA/DE-29

Key Words: Launchers, Spacecraft, Dynamic tests

A hydrodynamic support system to be used in ground dynamic testing of the Saturn V launch vehicle was designed in 1965. A design review team uncovered a serious flaw in the support system concept. This paper presents the details of the analysis and describes how the system was subsequently modified.

BIOLOGICAL SYSTEMS

HUMAN

83-1152

USAF Bioenvironmental Noise Data Handbook. Volume 157. KC-10A In-Flight Crew Noise

H.K. Hille

Air Force Aerospace Medical Res. Lab., Wright-Patterson AFB, OH, Rept. No. AMRL-TR-75-50-VOL-157, 18 pp (Sept 1982)

AD-A120 507

Key Words: Aircraft noise, Interior noise, Human response

The KC-10A is a standard USAF tanker-transport aircraft with high-speed, high altitude refueling and long range transport capability. This report provides measured data defining the bioacoustic environments at flight crew/passenger locations inside this helicopter during normal flight operations.

83-1153

USAF Bioenvironmental Noise Data Handbook. Volume 150. C-140 In-Flight Crew Noise

H.K. Hille

Air Force Aerospace Medical Res. Lab., Wright-Patterson AFB, OH, Rept. No. AMRL-TR-75-50-VOL-150, 18 pp (Sept 1982)

AD-A120 508

Key Words: Aircraft noise, Interior noise, Human response

The C-140 is a USAF transport aircraft used for operational support. This report provides measured data defining the bioacoustic environments at flight crew/passenger locations inside this aircraft during normal flight operations. Data are reported for seven locations in a wide variety of physical and psychoacoustic measures.

83-1154

USAF Bioenvironmental Noise Data Handbook. Volume 152. C-12A In-Flight Crew Noise

H.K. Hille

Air Force Aerospace Medical Res. Lab., Wright-Patterson AFB, OH, Rept. No. AMRL-TR-75-50-VOL-152, 18 pp (Sept 1982)

AD-A120 509

Key Words: Aircraft noise, Noise reduction, Human response

The C-12A is a military version of the Beechcraft Super King Air 200. This report provides measured data defining the bioacoustic environments at flight crew/passenger locations inside this aircraft during normal flight operations.

83-1155

USAF Bioenvironmental Noise Data Handbook. Volume 155. CH-3 In-Flight Crew Noise

H.K. Hille

Air Force Aerospace Medical Res. Lab., Wright-Patterson AFB, OH, Rept. No. AMRL-TR-75-50-VOL-155, 18 pp (Sept 1982)

AD-A120 791

Key Words: Helicopter noise, Interior noise, Human response

The CH-3 is a USAF tactical combat transport helicopter. This report provides measured data defining the bioacoustic environments at flight crew/passenger locations inside this helicopter during normal flight operations.

MECHANICAL COMPONENTS

ABSORBERS AND ISOLATORS

(Also see Nos. 1156, 1235)

83-1156

Probabilistic Optimum Base Isolation of Structures

M.C. Constantinou and I.G. Tadjbakhsh

Rensselaer Polytechnic Inst., Troy, NY, ASCE J. Struc. Engrg., 109 (3), pp 676-688 (Mar 1983) 5 figs, 4 tables, 14 refs

Key Words: Buildings, Base isolation, Earthquake resistant structures

The problem of the optimal base isolation system of multistory shear type buildings has been considered in a probabilistic sense. For white noise ground accelerations the response of the structure relative to the base was minimized subject to constraints on the maximum displacements of the base.

83-1157

A Study of Energy Absorbing Aseismic Base Isolation Systems

S.B. Hodder

Ph.D. Thesis, Univ. of California, Berkeley, 154 pp (1982)

DA8300532

Key Words: Seismic isolation, Base isolation, Seismic design

The use of base isolation as an aseismic design strategy can be a very effective means of providing structural protection during strong earthquakes. In this approach, significant energy absorbing capacity must be provided at the base of the structure in order to limit the relative displacement demands on the isolation system. The recently proposed combination lead/rubber bearing system, which incorporates this energy absorbing capacity directly into the isolation bearings, is the subject of this research.

83-1158

A Friction Damped Base Isolation System with Fail-Safe Characteristics

J.M. Kelly and K.E. Beucke

Univ. of California, Berkeley, CA, Intl. J. Earthquake Engrg. Struc. Dynam., 11 (1), pp 33-56 (Jan/Feb 1983) 16 figs, 2 tables, 13 refs

Key Words: Base isolation, Elastomeric bearings, Hysteretic damping, Buildings, Seismic response, Experimental test data

An experimental study of a Coulomb friction damped aseismic base isolation system with fail-safe characteristics is described. The base isolation system utilized commercially made natural rubber bearings and a skid system which comes into operation at preset-levels of relative horizontal displacement between the structure and the foundation. The fail-safe skid provides hysteretic damping and prevents failure of the isolation system in the event of displacements larger than those assumed in the original design.

83-1159

Use of Absorbers in Reducing Footbridge Vibrations

R.T. Jones and A.J. Pretlove

Structures Dept., RAE Farnborough, UK, Proc., Dynam. Vib. Isolation and Absorption Conf., Sept 8, 1982, Univ. of Southampton, UK, pp 7-20, 13 figs, 2 tables, 9 refs

Key Words: Dynamic absorbers, Suspension bridges

Extensive work is reported in developing tuned vibration absorbers for modern footbridges. The problem of low frequency footbridges was not solved by altering the mass and stiffness properties of the bridge. The problem is, in fact, a classic one in vibration control for which the provision of additional damping is the solution. Several different methods of adding to the damping of bridge vibrations were considered, and on the grounds of effectiveness, low cost and ease of maintenance the dynamic vibration absorber was chosen for further research, design and development.

83-1160

Reduction of Cantilever Vibration by a Cantilever Absorber

N.G. Stephen, J.B. Hunt, and D.P. Gao

Dept. of Mech. Engrg., Univ. of Southampton, UK, Proc., Dynam. Vib. Isolation and Absorption Conf., Sept 8, 1982, Univ. of Southampton, UK, pp 71-79, 9 figs, 1 ref

Key Words: Absrobers (equipment), Beams

The purpose of this paper is to describe work in progress on a novel design of vibration absorber, specifically intended for the suppression of lateral vibration of beams. The design considered here is intended to overcome the single frequency limitation of the conventional absorber and consists of an auxiliary beam attached to the free end of a cantilever beam which is assumed to be part hollow.

83-1161

Study of the Evolution of Structural Acoustic Design Guides, Volume 2

B.L. Clarkson, R.J Pope, and M.F. Ranky

Southampton Univ., UK, Rept. No. ISVR-TR-3-2-V-L-2, ESA-CR(P)-1609-V-2, 83 pp (June 1981) N82-32784

Key Words: Mountings, Equipment mounts, Spacecraft equipment response

The vibration levels at equipment mounting points on satellite platforms, including the case of several simulated boxes on a platform connected to a central unstiffened cylinder were studied.

83-1162

Shock Transmission Properties of Selected Packaging Materials (Untersuchung zum Stossubertragungsverhalten ausgewählter Verpackungen)

W. Fiedler and H.-J. Hage

VEB Kombinat Robotron-Messelektronik „Otto Schön" Dresden, German Dem. Rep., Feingerätetechnik, 31 (11), pp 483-484 (Nov 1982) 4 figs, 1 table, 2 refs

(In German)

Key Words: Shock response spectra, Packaging materials

Shock transmission properties of elastic cushions are determined by means of shock spectrum analysis. The dependence of these shock transmission properties on cushion material, cushion configuration and excitation acceleration is given.

BLADES

83-1163

The Dynamic Flexural Response of Propeller Blades

S.Z. Djordjevic

Dept. of Aerospace Engrg., Pennsylvania State Univ., University Park, PA, Rept. No. NASA-CR-169318, 226 pp (Nov 1982)
N82-32313

Key Words: Blades, Propeller blades, Flexural response

The determination of the torsional constants of three blade models having NACA four-digit symmetrical airfoil cross sections is presented. Values were obtained for these models analytically and experimentally. Results were also obtained for three other models having rectangular, elliptical, and parabolic cross sections. Complete modal analyses were performed for five blade models.

83-1164

Aeroelastic Stability of Rotor Blades Using Finite Element Analysis

I. Chopra and N. Sivaneri

Joint Inst. of Aeronautics and Acoustics, Stanford Univ., Stanford, CA, Rept. No. NASA-CR-166389, 119 pp (Aug 1982)
N82-32342

Key Words: Helicopters, Blades, Propeller blades, Flutter, Finite element technique

The flutter stability of flap bending, lead-lag bending, and torsion of helicopter rotor blades in hover is investigated using a finite element formulation based on Hamilton's principle.

83-1165

Three-Dimensional Aerodynamic Characteristics of Oscillating Supersonic and Transonic Annular Cascades

M. Namba and A. Ishikawa

Dept. of Aeronautical Engrg., Kyushu Univ., Fukuoka, Japan, J. Engrg. Power, Trans. ASME, 105 (1), pp 138-146 (Jan 1983) 11 figs, 6 refs

Key Words: Blades, Cascades, Aerodynamic loads, Flutter

A lifting surface theory is developed for unsteady three-dimensional flow in rotating subsonic, transonic and supersonic annular cascades with fluctuating blade loadings. Application of a finite radial eigenfunction series approximation not only affords a clear insight into the three-dimensional structures of acoustic fields but also provides mathematical expressions advantageous to numerical work. The theory is applied to oscillating blades. Numerical examples are presented to demonstrate three-dimensional effects on aerodynamic characteristics.

83-1166

Response Sensitivity of Typical Aircraft Jet Engine Fan Blade-Like Structures to Bird Impacts

D.P. Bauer and R.S. Bertke

Aircraft Engine Business Group, General Electric Co., Cincinnati, OH, Rept. No. AFWAL-TR-82-2045, 49 pp (May 1982)
AD-A119 974

Key Words: Blades, Fan blades, Aircraft, Bird strikes

The response sensitivity of jet engine fan blade-like structures to the details of impact loading were studied. In particular, impacts of birds and ice on jet engines are difficult to model analytically. This report provides guidance in determining the spatial and temporal loading parameters that must be most accurately modeled in a coupled load-response analysis.

BEARINGS

83-1167

Effect of Bearing Bushing Elasticity on the Stability of Plain Bearings (Stabilitätseigenschaften von Gleitlagern bei Berücksichtigung der Lagerschalenelastizität)

M. Qiande, D.-C. Han, and J. Glienicke

Beijing Institute of Technology at the Inst. of Machine Construction Science of the Univ. of Karlsruhe, Karlsruhe, Fed. Rep. Germany, Konstruktion, 35 (2), pp 45-52 (Feb 1983) 12 figs, 9 refs
(In German)

Key Words: Bearings, Plain bearings, Bushings, Elastic properties

The authors investigate the effect of bearing bushing elasticity on the static and dynamic characteristics, as well as stability of plain bearings, at high journal velocities and high static loads.

83-1168

Dynamic Characteristics of Tilting Pad Gas Journal Bearing Supported by Rotary Spring

H. Izumi

Mech. Engrg. Res. Lab., Hitachi Ltd., 502, Kandatsu-Machi, Tsuchiura-shi, Ibaraki 300, Japan, Bull. JSME, 26 (211), pp 125-131 (Jan 1983) 12 figs, 3 refs

Key Words: Bearings, Tilting pad bearings, Gas bearings, Elastic foundations

Experimental and theoretical research has been conducted to explain the dynamic characteristics of a tilting pad gas journal bearing supported by a rotary spring. Experimental results on the effects of the moment of inertia of the pad and the bearing clearance are compared with theoretical calculations by the frequency response method to confirm that the theory is effective to predict the dynamic characteristics of this kind of bearing.

83-1169

Influence of Gas Inertia Forces Generated Within the Stabilizing Restrictor on Dynamic Characteristics of Externally Pressurized Thrust Gas Bearings (2nd Report, Case of Turbulent Flow at the Capillary Restriction)

Y. Haruyama, T. Kazamaki, H. Mori, and K. Nakagawa

Toyama Univ., 1-1, Nakagawa-Sonomachi, Takaoka, Japan, Bull. JSME, 26 (211), pp 117-124 (Jan 1983) 9 figs, 4 refs

Key Words: Bearings, Gas bearings, Stiffness coefficients, Damping coefficients, Inertial forces

The influence of the gas inertia forces generated within the stabilizing restrictor in capillary form in the case of a laminar flow was previously reported. In this paper the inertia effect generated within the capillary restricted part in the case of a turbulent flow is investigated.

GEARS

(Also see No. 1248)

83-1170

The Design of Quiet and Nonvibrating Involute Special Gears (Auslegung evolventischer Sonderverzahnungen fur schwingungs- und gerauscharmen Lauf)

M. Weck

Laboratorium f. Werkzeugmaschinen und Betriebslehre RWTH, Aachen, Fed. Rep. Germany, Industrie Anzeiger, 105 (13), pp 32-37 (1983), 12 figs, 5 refs (In German)

Key Words: Gears, Design techniques

A procedure for the design of quiet, nonvibrating gears is described. It is shown that for any load conditions gear geometry has a considerable effect on the intensity of vibration and noise. Also, limiting quantities of the profile overlap are described, showing that they are independent of the size of the gear.

83-1171

The Electro-Magnetic Graduation Harmonic Analysis Measuring Technique

Tsao Lin Hsiang, et al

Chinese J. of Sci. Instrument, 3 (2), pp 177-184 (1982)

CSTA No. 681-82.29

Key Words: Gears, Harmonic analysis, Measurement techniques

The harmonic analysis measuring technique based on technology of the electro-magnetic graduation is given. Utilizing this technique, the dynamic errors of cylindrical external gears, worm and wheel pairs or gear trains can be measured. The dynamic errors of cylindrical internal gears or bevel gears can also be measured by attachment of a reference gear bracket.

83-1172

Study on Bending Fatigue Strength of Helical Gears (3rd Report, Mechanism of Bending Fatigue Breakage)

S. Oda and T. Koide

Tottori Univ., 4-101 Minami, Koyama-cho, Tottori, Japan, Bull. JSME, 26 (211), pp 146-153 (Jan 1983) 21 figs, 7 refs

Key Words: Gears, Gear teeth, Helical gears, Fatigue life, Crack propagation

The relationship between stress distribution on root fillet and crack initiation and propagation in helical gears, thin rim gear teeth and cantilever plates were examined and the mechanism of bending fatigue breakage of helical gears was investigated. It was found that a crack of helical gear teeth occurs at the position of maximum root stress on the tensile fillet and the directions of crack propagation differ in each normal section. Existing testing methods of bending strength, for helical gear teeth were compared on the basis of the experimental results.

83-1173

Study on Bending Fatigue Strength of Bevel Gears (2nd Report, Bending Fatigue Strength of Straight Bevel Gears of Gleason Type)

S. Oda, T. Koide, and K. Higuchi

Tottori Univ., 4-101 Minami, Koyama-cho, Tottori, Japan, Bull. JSME, 26 (211), pp 140-145 (Jan 1983) 15 figs, 9 refs

Key Words: Gears, Bevel gears, Fatigue life, Fatigue tests

Bending fatigue strength and bending fatigue breakage of straight bevel gears of the Gleason type were investigated in bending fatigue tests (Wöhler method) using a bevel gear pulsator of the hydraulic type. The bending fatigue limit loads were also determined. Existing equations of the bending strength for straight bevel gears were compared on the basis of the experimental results.

FASTENERS

83-1174

Conveyor System Bolt Failure Analysis

S.H. McCutcheon and R.E. Waaser

E.I. DuPont de Nemours & Co., Aiken, SC, ASME Paper No. 82-WA/DE-30

Key Words: Bolts, Failure analysis, Fatigue life, Conveyors, Nuclear reactors

An analysis of a broken bolt, discovered during a routine preoperational inspection on a conveyor system which was to have been used for transporting irradiated nuclear fuel assemblies to a storage basin, revealed that the bolt, as well as other components of the system, was susceptible to fatigue failure. The steps necessary for a complete evaluation of equipment used beyond the design life are illustrated in the analysis of this failure.

83-1175
The Crack-Free Life Prediction for Structural Joints under Constant Amplitude Loads
Xue Jing Chuan and Yang Yu Gong
J. of Chem. Indus. and Engrg., 2, p 65 (1982)
CSTA No. 624-82.69

Key Words: Joints (junctions), Rivets, Fatigue life

This paper briefly describes a method of detailed designing and predicting the fatigue life for structural joints under constant amplitude loads by means of the stress severity factor concept.

83-1176
Vibratory Stress Relief of Mild Steel Weldments
S. Shankar
Ph.D. Thesis, Oregon Graduate Center, 130 pp (1982)
DA8300030

Key Words: Welded joints, Resonant frequencies

The influence of resonant and sub-resonant frequency vibration on the longitudinal residual stresses in A-36 mild steel weldments has been studied. Residual stress analysis was carried out using sectioning, x-ray and blind-hole-drilling techniques. The hole-drilling method was modified to take into account the effect of local plastic yielding due to stress concentration and the machining stresses, with a resultant accuracy comparable to that obtained by the sectioning method.

83-1177
Fatigue Sensitivity of Composite Structure for Fighter Aircraft
L.L. Jeans, G.C. Grimes, and H.P. Kan
Northrop Corp., Hawthorne, CA, J. Aircraft, 20 (2), pp 102-110 (Feb 1983) 12 figs, 2 tables, 9 refs

Key Words: Joints (junctions), Aircraft wings, Aircraft, Composite structures, Fatigue life

A spectrum sensitivity study was conducted on chordwise splices in a fighter aircraft composite wing. Composite-to-metal bolted and bonded joints were used to experimentally determine their fatigue sensitivity to spectrum loading and environmental content.

STRUCTURAL COMPONENTS

CABLES

83-1178
Free Vibration of Parabolic Cables
A.S. Veletsos and G.R. Darbre
Rice Univ., Houston, TX 77251, ASCE J. Struc. Engrg., 109 (2), pp 503-519 (Feb 1983) 8 figs, 7 refs

Key Words: Cables, Natural frequencies, Mode shapes

Salient features of the free vibration of simply supported, inclined parabolic cables are examined, and simple approximate expressions are presented with the aid of which the complete spectrum of natural frequencies can be determined readily. Closed-form expressions for several infinite series involving integrals of the natural modes of the cable are given which are of value in analyses of dynamic response.

BARS AND RODS

83-1179
Wave Propagation in a Straight Elastic Rod Subjected to Initial Finite Extension and Twist
G. Eason
Dept. of Mathematics, University of Strathclyde, Glasgow, UK, Arch. Mech., 33 (4), pp 541-563 (1981) 3 figs, 7 refs

Key Words: Rods, Wave propagation

The propagation of waves in a straight elastic rod subjected to an initial finite extension and twist is considered. The basic equations due to Green and Laws are assumed. It is found that effects arising from the initial twist may be important; in particular, they give a linking between certain of the modes. Some numerical results are presented in graphical form.

BEAMS

(Also see No. 1127)

83-1180

The Design of Beams on Winkler-Pasternak Foundations for Minimum Dynamic Response and Maximum Eigenfrequency

S. Adali
National Res. Inst. for Mathematical Sciences, CSIR, P.O. Box 395, Pretoria, Rep. of South Africa, Theoretique et Appliquee, 1 (6), pp 975-993 (1982) 9 figs, 3 tables, 33 refs

Key Words: Beams, Winkler foundations, Pasternak foundations, Natural frequencies, Optimum design

The profile of a beam of rectangular cross section supported by a Winkler-Pasternak foundation is determined which will minimize the dynamic response of the beam or maximize its fundamental eigenfrequency. The dynamic response is defined either as the maximum dynamic deflection or the maximum dynamic normal stress when the beam is subject to a periodic dynamic load. To obtain the optimal designs, the methods of mathematical programming are employed, the area function being approximated by constant or linear splines on specified partitions.

83-1181

Vibrations of Double-Span Uniform Beams Subject to an Axial Force

P.A.A. Laura, G.S. Sarmiento, and A.N. Bergmann
Inst. of Appl. Mechanics, 8111 Puerto Belgrano Naval Base, Argentina, Appl. Acoust., 16 (2), pp 95-104 (Mar 1983) 7 figs, 2 refs

Key Words: Beams, Flexural vibration, Natural frequencies, Axial force

This study deals with the determination of natural frequencies of transverse vibrations of simply supported, clamped, and clamped-simply supported beams with an intermediate support subject to an axial force. Results are presented in graphical fashion as a function of the governing geometric and mechanical parameter.

83-1182

Attitude and Vibration Control of a Large Flexible Space-Based Antenna

S.M. Joshi and G.L. Goglia
Dept. of Mech. Engrg. and Mechanics, Old Dominion Univ., Norfolk, VA, Rept. No. NASA-CR-169419, 33 pp (Sept 1982)
N82-33422

Key Words: Spacecraft antennas, Vibration control

The problem of control systems synthesis is considered for controlling the rigid body attitude and elastic motion of a large deployable space based antenna. Two methods for control systems synthesis are considered. The first method utilizes the stability and robustness properties of the controller consisting of torque actuators and collocated attitude and rate sensors. The second method is based on the linear quadratic Gaussian control theory.

83-1183

Attitude and Vibration Control of a Large Flexible Space-Based Antenna

S.M. Joshi
Old Dominion Univ., Norfolk, VA, Rept. No. NASA-CR-165979, 32 pp (Aug 1982)
N83-10110

Key Words: Antennas, Spacecraft antennas, Vibration control

Control systems synthesis is considered for controlling the rigid body attitude and elastic motion of a large deployable space-based antenna. Two methods for control systems synthesis are considered. The first method utilizes the stability and robustness properties of the controller consisting of torque actuators and collocated attitude and rate sensors. The second method is based on the linear-quadratic-Gaussian control theory.

83-1184

Geometrically Nonlinear Mode Approximations for Impulsively Loaded Homogeneous Viscous Beams and Frames

P.D. Griffin and J.B. Martin

Dept. of Civil Engrg., Univ. of Cape Town, South Africa, Intl. J. Mech. Sci., 25 (1), pp 15-26 (1983) 6 figs, 23 refs

Key Words: Beams, Frames, Viscous medium, Impulse response, Mode shapes

Homogeneous viscous relations are used to model rigid-visco plastic materials under impulsive loading conditions, and offer computational advantages because of their homogeneity and the absence of a rigid phase. This paper extends earlier work on the analysis of geometrically linear problems to the practically more realistic case of structures undergoing large displacements. The well established instantaneous mode approximation technique is used, together with the implementation of a new algorithm for the determination of the instantaneous mode shape.

83-1185
Static, Dynamic and Stability Analysis of Structures Composed of Tapered Beams
D.L. Karabalis and D.E. Beskos
Dept. of Civil and Mineral Engrg., Univ. of Minnesota, Minneapolis, MN 55455, Computers Struc., 16 (6), pp 731-748 (1983) 21 figs, 49 refs

Key Words: Beams, Variable cross section, Finite element technique

A new numerical method is proposed for the static, dynamic and stability analysis of linear elastic plane structures consisting of beams with constant width and variable depth. It is a finite element method based on an exact flexural and axial stiffness matrix and approximate consistent mass and geometric stiffness matrices for a linearly tapered beam element with constant width. Use of this method provides the exact solution of the static problem with just one element per member of a structure with linearly tapered beams and excellent approximate solutions of the dynamic and stability problems with very few elements per member of the structure in a computationally very efficient way.

COLUMNS

83-1186
Transient Flexural Vibrations of an Elastic Column Supported by an Elastic Half-Space
H. Wada
Dept. of Mech. Engrg., Tohoku Univ., Sendai 980, Japan, Intl. J. Earthquake Engrg. Struc. Dynam., 11 (1), pp 21-31 (Jan/Feb 1983) 8 figs, 10 refs

Key Words: Flexural vibration, Transient response, Columns, Elastic half-space, Seismic response

An analysis is presented of the transient flexural vibrations of an elastic column supported by an elastic half-space under the condition that an arbitrarily shaped free-field lateral acceleration and displacement are given as inputs. Applying Laplace transformations with respect to time and numerical inverse Laplace transformations, the time histories of the column acceleration at the interface and free end, and the column and half-space displacement distributions are obtained.

FRAMES AND ARCHES

(Also see Nos. 1184, 1274)

83-1187
Dynamics of Frames with Axial Constraints
W. Weaver, Jr. and M. Eisenberger
Dept. of Civil Engrg., Stanford Univ., Stanford, CA 94305, ASCE J. Struc. Engrg., 109 (3), pp 773-784 (Mar 1983) 8 figs, 1 table, 13 refs

Key Words: Framed structures, Joints (junctions), Dynamic analysis

The number of degrees of freedom for the dynamic analysis of plane and space frames may be considerably reduced by introducing axial constraints. Determination of the rank and basis of the constraint matrix by Gauss-Jordan elimination with pivoting leads to automatic selection of the best set of dependent and independent joint translations. A transformation of the equations of motion to generalized coordinates produces a reduced set of equations that may be solved for the dynamic response of the independent joint translations.

PANELS

83-1188
Flutter of Orthotropic Panels in Supersonic Flow Using Affine Transformations
G.A. Oyibo

Rensselaer Polytechnic Inst., Troy, NY, AIAA J., 21 (2), pp 283-289 (Feb 1983) 8 figs, 24 refs

Key Words: Panels, Rectangular panels, Flutter

Affine transformations are used in analyzing the flutter problem of rectangular simply supported orthotropic panels subjected to supersonic flow over one surface. With the help of certain defined characteristic and bounded quantities a comprehensive solution, which has the isotropic panels solution as a subset, is found to this problem. The physics of this aeroelastic problem is thus clearly exposed by showing how the aerodynamic and the elastic forces interact to produce the panel flutter phenomenon.

83-1189

Vibrations of Axially Loaded Stiffened Cylindrical Panels with Elastic Restraints

J. Singer, O. Rand, and A. Rosen

Technion - Israel Inst. of Tech., Haifa, Rept. No. TAE-439, 54 pp (July 1981)
N82-33730

Key Words: Panels, Elastic properties, Computer programs

The vibrations and buckling of preloaded stiffened cylindrical panels with different boundary conditions, including elastic restraints are analyzed. The analysis uses linear, smeared stiffener, Flugge type theory. A computer program VIPAL was developed and its details are presented.

83-1190

Sonic Fatigue of Advanced Composite Panels in Thermal Environments

M.J. Jacobson

Northrop Corp., Hawthorne, CA, J. Aircraft, 20 (3), pp 282-288 (Mar 1983) 9 figs, 4 tables, 12 refs

Key Words: Panels, Composite structures, Aircraft, Acoustic fatigue

Combined analytic and experimental activities were performed to evaluate an advanced structural design concept for advanced composite fuselage panels suitable for V/STOL aircraft. An existing sonic fatigue analysis procedure was evaluated and both flat and slightly curved multibay cross-stiffened panels with graphite-epoxy skins were designed, analyzed, fabricated, and tested.

PLATES

83-1191

Hamilton's Law Applied to the Non-Stationary Elastodynamics of Plates

C.D. Bailey

Dept. of Aeronautical and Astronautical Engrg., The Ohio State Univ., Columbus, OH 43210, Mech. Res. Comm., 9 (6), pp 381-389 (Nov/Dec 1982) 4 figs, 21 refs

Key Words: Plates, Elastodynamic response

Hamilton's law of varying action is applied to obtain direct analytical solutions to the non-stationary, non-conservative and conservative motion of plates with prescribed initial conditions. By direct analytical solution is meant analytical solutions generated directly from the law of varying action without any use or reference to the theory of differential or integral equations. Calculated results are compared to experimental results for two separate sets of initial conditions.

83-1192

A Finite Element Procedure for Studying the Acoustic Radiation of a Vibrating Plate

S.H. Sung

GM Labs., Warren, MI, ASME Paper No. 82-WA/NCA-3

Key Words: Plates, Vibrating structures, Elastic waves, Sound propagation, Finite element technique

A finite element procedure has been developed for studying the acoustic radiation associated with a vibrating plate. With this procedure, the detailed distribution of acoustic pressure and intensity at a vibrating surface can be calculated. The finite element procedure of this paper is verified by computing the acoustic radiation efficiency for a baffled plate vibrating at its resonances.

SHELLS

(Also see No. 1133)

83-1193

Transient Response of an Inhomogeneous Elastic Hollow Cylinder to an Impulsive Line SH-Source

K. Watanabe

Dept. of Mech. Engrg., Technical College, Yamagata Univ., Yonezawa, Yamagata 992, Japan, Bull. JSME, 26 (211), pp 30-34 (Jan 1983) 5 figs, 13 refs

Key Words: Shells, Cylindrical shells, Transient response

This paper considers the two-dimensional wave propagation in an inhomogeneous elastic hollow cylinder. An impulsive line SH-source is placed in the hollow cylinder. An exact solution is obtained in closed form with an application of the ray expansion technique.

83-1194

Free Vibrations of Layered Spheres

M.J. Frye, A.H. Shah, and H.D. McNiven

Plan Examination Dept., City of Winnipeg, Manitoba, Canada, Acustica, 52 (1), pp 1-9 (Dec 1982) 3 figs, 6 tables, 9 refs

Key Words: Shells, Spherical shells, Layered materials, Finite element technique, Natural frequencies

A finite element method is employed to study the natural frequencies of vibration of elastic layered transversely isotropic spheres. A six-mode shell theory which includes the effects of transverse shear, transverse normal stress and strain, and rotatory inertia is included. The numerical results of two example problems are presented and discussed.

83-1195

A Nonlinear Analysis of Liquid Sloshing in Rigid Containers

T.C. Su, Y.K. Lou, J.E. Flipse, and T.J. Bridges

Dept. of Civil Engrg., Texas A&M Univ., College Station, TX, Rept. No. COE-240, DOT-RSPA-DMA-50-82/1, 646 pp (Oct 1981)

PB83-133199

Key Words: Tanks (containers), Fluid-filled containers, Sloshing

Liquid sloshing in a moving container constitutes a broad class of problems of great practical importance with regard to the safety of transportation systems, such as tank trucks on highways, liquid tank cars on railroads, and liquid cargo in oceangoing vessels. Two nonlinear theories are developed in which the effects of large tank motions on liquid sloshing are properly accounted for. One theory is applicable for the near resonance oscillations while the other is valid when the tank is oscillating at a frequency away from resonance.

PIPES AND TUBES

83-1196

Stochastic Analysis of Response of Structures and Multiply Supported Secondary Systems to Multidirectional Ground Motion

W. Smeby

Ph.D. Thesis, Univ. of California, Berkeley, 115 pp (1982)

DA8300659

Key Words: Multidegree of freedom systems, Piping systems, Seismic response spectra, Stochastic processes

A mode superposition procedure is developed for the response of linear multi-degree-of-freedom structures subjected to multidirectional ground motions. The ground motion is modeled as a transient, stationary Gaussian vector process, having components that are assumed to be uncorrelated along a set of orthogonal principal axes. The analysis takes into account the correlation between modal responses of the structure, which is shown to be significant for closely spaced model frequencies, and the correlation between the ground motion along the structure axes.

83-1197

Stochastic Analysis of Structures and Piping Systems Subjected to Stationary Multiple Support Excitations

Meng-Chi Lee and J. Penzien

URS/John A. Blume & Associates, Engineers, San Francisco, CA, Intl. J. Earthquake Engrg. Struc. Dynam., 11 (1), pp 91-110 (Jan/Feb 1983) 3 figs, 10 tables, 29 refs

Key Words: Structural response, Piping systems, Stochastic processes, Seismic response

A stochastic method has been developed for seismic analysis of structures and piping systems subjected to multiple support excitations. In either the time or the frequency domain, mean and extreme values of structural and piping system response can be found, including the effects of cross-correlations of modal response and cross-correlations of multiple support excitations. Stationary white noise and stationary filtered white noise ground excitations are used. A computer program has been developed to carry out the stochastic seismic analysis.

83-1198

Analysis of Cracked Piping Systems Subjected to Thermal Stress, Residual Stress and Dynamic Loading

S.R. Sharma
Ph.D. Thesis, Univ. of California, Berkeley, 138 pp (1982)
DA8300400

Key Words: Piping systems, Dynamic response, Cracked media, Failure analysis, Nuclear power plants

This study is divided into two major parts: analysis of the cracked pipe behavior under normal service loads such as the pressure, thermal and weld residual stress loadings; and evaluation of structural integrity of the cracked piping system subjected to a dynamic loading.

83-1199

Ground Strain Estimation for Seismic Risk Analysis

M. Shinozuka, H. Kameda, and T. Koike
610 Mudd Bldg., Columbia Univ., New York, NY 10027, ASCE J. Engrg. Mech., 109 (1), pp 175-191 (Feb 1983) 8 figs, 2 tables, 20 refs

Key Words: Pipelines, Seismic response, Underground structures

Under the assumption that strong motion earthquakes result primarily from surface waves in a layered medium resting on a semi-infinite rock formation, a method is developed to derive the expression for the Rayleigh wave that produces acceleration at the ground surface with a specified power spectral density. The Rayleigh wave characteristics are then used to obtain a corresponding free-field normal ground strain at any depth in the medium.

DUCTS

83-1200

Acoustics in Variable Area Duct: Finite Element and Finite Difference Comparisons to Experiment

K.J. Baumeister, W. Eversman, R.J. Astley, and J.W. White
NASA Lewis Res. Ctr., Cleveland, OH, AIAA J., 21 (2), pp 193-199 (Feb 1983) 9 figs, 3 tables, 19 refs

Key Words: Ducts, Variable cross section, Sound propagation, Finite element technique, Finite difference technique

Plane wave sound propagation without flow in a rectangular duct with a converging-diverging area variation is studied experimentally and theoretically. The area variation was of sufficient magnitude to produce large reflections and induce modal scattering. The rms pressure and phase angle on both the flat and curved surface were measured and tabulated.

83-1201

Eigensolutions for Liners in Uniform Mean Flow Ducts

W. Koch and W. Mohring
DFVLR/AVA Inst. for Theoretical Fluid Mechanics, Gottingen, W. Germany, AIAA J., 21 (2), pp 200-213 (Feb 1983) 11 figs, 33 refs

Key Words: Ducts, Acoustic linings, Sound attenuation

The problem of sound attenuation in a rectangular acoustically lined duct containing uniform mean flow is investigated analytically by means of the generalized Wiener-Hopf technique. For lined sections of finite axial extent uniqueness of the solution is enforced by imposing edge conditions at the liner interfaces. Several possible edge conditions are considered, including the Kutta condition. The corresponding solutions differ by eigensolutions and it is demonstrated that solution methods, like the mode matching and singularity method, imply differing edge conditions.

83-1202

The Tight-Coupled Monopole Active Attenuator in a Duct

Kh. Eghtesadi, W.K.W. Hong, and H.G. Leventhall
Dept. of Electrical Engrg., Abadan Inst. of Tech., Abadan, Iran, Noise Control Engrg., 20 (1), pp 16-20 (Jan/Feb 1983) 11 figs, 22 refs

Key Words: Ducts, Noise reduction, Active control, Sound attenuation

Methods of active attenuation of noise, that is, the cancelling of noise from a source by the addition of further noise, include both absorptive and non-absorptive systems. The theory of one-dimensional active attenuation for ductborne noise is reviewed and an overview of a monopole system used to realize attenuation is given.

83-1203

Engineering Applications of Plane Wave Duct Acoustics

L. Pande

Ph.D. Thesis, Purdue Univ., 169 pp (1982)

DA8300948

Key Words: Ducts, Sound waves, Wave propagation, Fan noise

The work in this thesis elucidates the physical and mathematical concepts involved in understanding the propagation and measurement of acoustic waves in a duct in the plane wave mode and its engineering applications. A discussion of the two-microphone technique using random stationary sound to measure in-duct properties is given. Source characteristics are studied and a method of source identification is given.

83-1204

Acoustical Properties of Porous Material and Dissipative Silencers with Several Gas Media

S. Shimode

Mech. Engrg. Res. Lab., Hitachi, Ltd., Tsuchiura, Ibaraki, Japan, Acustica, 52 (2), pp 98-105 (Jan 1983) 12 figs, 4 tables, 13 refs

Key Words: Ducts, Acoustic linings, Porous materials, Sound attenuation

In this paper measurements are made of the normal incident absorption coefficients of typical acoustical materials and of the sound attenuation of lined-ducts in several media. With use of the relation between the specific flow resistance and viscosity of gas media and Beranek's method, good agreement is found at room temperature between calculated and measured absorption coefficients of glasswool boards in freon and helium gases as well as in air.

BUILDING COMPONENTS

83-1205

The Effect of Sound Bridge Eccentricity on the Sound Propagation in Double Walls

G. Rosenhouse and F.P. Mechel

Fraunhofer-Institut f. Bauphysik, D-7000 Stuttgart, Bundesrepublik Deutschland, Acustica, 52 (1), pp 16-23 (Dec 1982) 10 figs, 4 tables, 5 refs

Key Words: Walls, Sound waves, Wave propagation

Analysis of plane acoustic wave propagation in one dimensional elements of a two dimensional system is used in order to outline the flanking through sound bridges. The effect of eccentricity which is characterized by additional moments was examined. Numerical results give the particle velocity distribution within the double wall skins.

83-1206

Seismic Design Charts for Coupled Shear Walls

A.K. Basu

Brown & Root (UK) Ltd., Southwell House, 1B Amity Grove, Raynes Park, London, UK, ASCE J. Struc. Engrg., 109 (2), pp 335-352 (Feb 1983) 19 figs, 1 table, 3 refs

Key Words: Walls, Buildings, Multistory buildings, Seismic design

Charts are presented for the seismic design of uniform fixed-base coupled shear wall buildings by the response spectrum method using the first two modes. The building is treated as a continuum and its actual mode shapes are utilized for evaluating the various modal responses; namely, the top deflection, the shear force and moments in the walls, and the shear force in the connecting medium. The distributions of the moments and shears along the height are also presented.

ELECTRIC COMPONENTS

MOTORS

83-1207

Synthesis of Time-Optimal Control of a Linear Motor

S. Kiausinis

Kaunas Politechnical Inst., Kaunas, Lithuanian SSR,

Vibrotechnika, 3 (33), pp 131-138 (1981) 6 figs, 3 refs
(In Russian)

Key Words: Linear induction motors

A problem of this synthesis of time-optimal control with fixed current feedback of a linear motor is solved by means of maximum principle. Equations to control switching surface in three-dimensional phase space and a system of nonlinear equations for determination of switching points are presented.

83-1208
Investigation of Dynamic Regimes of Discrete Electromagnetic Converter of Energy on the Electronic Digital Computer
V. Šležas and A. Šukelis
Kaunas Politechnical Institute, Kajnas, Lithuanian SSR, Vibrotechnika, 1 (39), pp 139-145 (1981) 7 figs, 2 tables, 1 ref

Key Words: Energy conversion, Electromagnetic properties, Digital techniques

The work of a discrete electromagnetic converter in start-stop and oscillation conditions is analyzed. Differential equations of the armature movement are solved by the method of Runge-Kutta by means of an electronic digital computer.

DYNAMIC ENVIRONMENT

ACOUSTIC EXCITATION

83-1209
Acoustic Environment in Large Enclosures with a Small Opening Exposed to Flow
L. Shaw, H. Bartel, and J. McAvoy
Flight Dynamics Lab., Wright-Patterson Air Force Base, OH, J. Aircraft, 20 (3), pp 250-256 (Mar 1983) 13 figs, 13 refs

Key Words: Enclosures, Fluid-induced excitation, Sound generation

The acoustic environment in large enclosures with a small opening exposed to aerodynamic flow are quantified. Theoretical/empirical techniques are developed for predicting the oscillatory frequencies, acoustic pressure level, spatial distribution of the acoustic pressures in the cavity, and the degree of alleviation achievable with suppressors. Experimental tests in a semifree jet facility are performed on scale models of large enclosures.

83-1210
Sound Source Radiation in Two-Dimensional Shear Flow
S.M. Candel
Office National d'Etudes et de Recherches Aerospatiales, Chatillon, France, AIAA J., 21 (2), pp 221-227 (Feb 1983) 7 figs, 20 refs

Key Words: Sound waves, Wave propagation

A fundamental problem encountered in the analysis of aerodynamic noise is that of acoustic source radiation in nonhomogeneous flow. Exact numerical solutions have been obtained recently for source radiation near a plane interface and a shear discontinuity by directly synthesizing the wavefield from its spatial Fourier transform. This method is applied here to stratified flow configurations and the structure of the radiated field is obtained for several shear layer velocity profiles of practical interest.

83-1211
The Data Processing and Spectral Analysis of Propeller Noise
Zhu Wu Hua and Zhu Shi Ti
J. of Shanghai Chiao Tung Univ., 2, pp 17-32 (1982)
CSTA No. 623.8-82.44

Key Words: Propeller noise, Spectrum analysis, Data processing

Noise measurements were made for a model propeller in a cavitation tunnel as well as for a full scale propeller in the sea. The data so obtained were processed with a signal processor type 7T08 in the forms of power spectrum and correlations in order to analyze the high frequency continuous spectrum and the low frequency discrete spectral lines for the cavitating and noncavitating propeller.

83-1212
Effect of Excitation on Coaxial Jet Noise
H.Y. Lu
Boeing Commercial Airplane Co., Seattle, WA, AIAA J., 21 (2), pp 214-220 (Feb 1983) 14 figs, 8 refs

Key Words: Jet noise, Noise generation

Coaxial model jets, including those of high bypass ratio engine exhaust hot gas conditions, were excited internally by tone and broadband noise. Acoustic excitation in the secondary (outer) duct was found to be most effective in jet noise amplification due to the sensitivity of the outer shear layer. Jet noise amplification at the subharmonic of the excitation frequency occurred in a number of cases. An acoustic elliptic mirror was used to observe the noise sources along the jet. It revealed local noise source characteristics in different shear layer regions and noise source location changes from unexcited to excited jets.

83-1213
Noise Reduction of a Small Fast Two-Stroke Engine by the Modification of Engine Exit Slot (Auslass-Schlitzmodifikation an Einem Kleinen Schnellaufenden Zweitaktmotor mit dem Ziel der Geräuschminderung)
N. Kania
Institut f. Kolbenmaschinen, Universitat Hannover, Hannover, Fed. Rep. Germany, Appl. Acoust., 16 (2), pp 79-93 (Mar 1983) 7 figs, 5 refs
(In German)

Key Words: Engine noise, Noise reduction, Silencers

With small port-controlled two-stroke engines the dominating source of noise is the exhaust noise. As a result of the sudden opening of large advance-outlet cross-sections, the expanding gases produce an outlet pulse in the exhaust silencer. This outlet pulse is characterized by high amplitudes of the pressure fluctuations and very steep gradients. The influence of advancing the opening point (extension of the expansion period) and increasing the advance-outlet port width is shown by means of the pressure fluctuations measured in the exhaust silencer and their frequency analyses.

83-1214
Coherence Coefficient Measuring System and Its Application to Some Acoustic Measurements
T. Yanagisawa and H. Takayama
Faculty of Engrg., Shinshu Univ., 500 Wakasato, Nagano, Japan, Appl. Acoust., 16 (2), pp 105-119 (Mar 1983) 11 figs, 7 refs

Key Words: Acoustic measurement, Coherence function technique

A measuring system based on the definition of coherence coefficient and some examples applying the system to acoustic measurement are discussed in this paper. It is shown that the measured values agree well with the theoretical ones.

83-1215
A Comparison of Parabolic Wave Theories for Linearly Elastic Solids
S.C. Wales and J.J. McCoy
The Catholic Univ. of America, Washington, DC 20064, Wave Motion, 5 (2), pp 99-113 (Apr 1983) 2 figs, 16 refs

Key Words: Wave propagation, Elastic waves, Sound waves

The Schrodinger equation describes a theory for propagating scalar waves which is frequently termed a parabolic theory. This theory has been demonstrated to provide a paraxial, or narrow-angled, approximation to the theory of acoustic wave propagation, described by the Helmholtz equation, by a variety of seemingly different procedures. In this paper three parabolic theories of elastodynamics are considered and applied in turn to a computational experiment that can be solved in the perturbation limit using the exact equations of elastodynamics.

83-1216
Application of the BIE Method to Sound Radiation Problems Using an Isoparametric Element
A.F. Seybert, B. Soenarko, F.J. Rizzo, and D.J. Shippy
Univ. of Kentucky, Lexington, KY, ASME Paper No. 82-WA/NCA-1

Key Words: Sound waves, Wave propagation, Spheres

This paper discusses the application of the Boundary Integral Equation method (BIE) for the numerical solution of radiation problems governed by Helmholtz's equation. Introduced is an isoparametric element formulation in which both the surface geometry and the acoustic variables on the surface of the radiating body are represented by quadratic shape

functions within the local coordinate system. The BIE method is used to obtain numerical solutions to two well-known radiation problems for which analytical solutions are well known: the pulsating and the oscillating spheres. For both problems the exact and numerical solutions are compared on the surface of the sphere and in the far field.

83-1217

The Performance of Jet Noise Suppression Devices for Industrial Applications

M.D. Dahl and O.H. McDaniel
Pennsylvania State Univ., University Park, PA, ASME Paper No. 82-WA/NCA-5

Key Words: Noise reduction

Commercially available jet noise suppression devices were tested to determine their noise reducing characteristics compared to an open pipe. Both exhaust silencers and ejector nozzles were measured for sound power level and mass flow rate. In addition, the pressure pattern developed on a flat plate by the ejector nozzles was measured. In light of jet noise theory, it is shown that these devices reduce turbulent noise levels by restricting the flow and creating interactions between smaller jets.

83-1218

Noise Level Prediction Using a Small Computer

C.J. Hurst and P.J. Nemergut
Virginia Polytechnic Inst. and State Univ., Blacksburg, VA, ASME Paper No. 82-WA/NCA-8

Key Words: Noise prediction, Computer-aided techniques

A common problem in noise control work is the prediction of sound pressure levels in large areas where many noise sources are present. Computational approaches in this problem involve the input of large amounts of data and extensive calculations. Described in this paper is a basic program which makes use of a desktop-sized computer and its associated digitizing tablet to allow the rapid modeling of such spaces.

83-1219

Radiation Characteristics of a Slender Box-Type Structure

M. Mezache and G.H. Koopmann
Univ. of Houston, Houston, TX, ASME Paper No. 82-WA/NCA-9

Key Words: Sound waves, Box type structures, Elastic waves, Finite element technique, SAP (computer program), Computer programs

The acoustic radiation characteristics of a slender boxlike structure is investigated. Use is made of a finite element package, SAP-IV, to determine the natural frequencies and mode shapes of the box. The radiated acoustic power for each mode is calculated using a computer program, PSI-I. These modes are then evaluated according to their radiation efficiency.

83-1220

Computer-Aided Analysis of Exhaust Mufflers

P.T. Thawani and R.A. Noreen
Nelson Industries, Inc., Stoughton, WI, ASME Paper No. 82-WA/NCA-10

Key Words: Noise reduction, Mufflers, Computer-aided techniques

In this work, an approach has been developed for the computer-aided analysis of various configurations of realistic mufflers. The two-by-two transfer matrices can be derived for several fully and partially perforated muffler components. A comprehensive computer program based on the transfer matrix formulation was written to predict the transmission loss characteristics of muffler systems.

83-1221

Analysis of a Noise-Generating Random Repeated Impact Process

L.A. Wood
Ph.D. Thesis, Univ. of New South Wales, Australia, (1982)

Key Words: Impact noise, Random excitation, Machinery noise

A random repeated impact process which is an idealized representation of random impact phenomena in machinery has been analyzed with the aim of estimating the noise levels generated by the process. The process was physically modeled by a ball bouncing on a randomly vibrating surface. The relevance of the random repeated impact process to the estimation of noise levels generated by rolling contact situations, especially the railway wheel/rail system, is discussed.

83-1222
Distributions Characterizing the Acoustic Impulse Response of Spherical Targets (Distributions caractérisant la réponse acoustique impulsionnelle des cibles sphériques rigides)
M. Auphan
Laboratoires d'Electronique et de Physique Appliquée, F-94450 Limeil-Brévannes, Acustica, 52 (2), pp 68-85 (Jan 1983) 7 tables, 7 refs
(In French)

Key Words: Acoustic response, Acoustic scattering, Spheres

Emphasis is placed on the advantage of the scattering impulse response of a spherical target compared to the transfer function expressed in the frequency domain. The mathematical difficulty of finding an expression in the time domain lies in the summation of a series of which the Fourier transform does not converge. Thus the series is replaced by another one by use of the poisson's summation formula.

83-1223
Barrier Insertion Loss Versus Fresnel Number and Secondary Parameters
Zhangwei Hu and Raymond L.M. Wong
Univ. of Toronto, Inst. for Aerospace Studies, 4925 Dufferin St., Downsview, Ontario, Canada M3H 5T6, Noise Control Engrg., 20 (1), pp 31-36 (Jan/Feb 1983) 9 figs, 11 refs

Key Words: Noise barriers, Noise reduction

The purpose of this article is to provide a quick, but accurate, estimation of sound reduction by a semi-infinite barrier for a wide range of source/observer geometries. In addition to Fresnel number N (in a range down to 0.05), it brings out the influence of three secondary parameters; although often neglected, these can be significant. The insertion loss for a pure tone point source is computed via the exact solution.

83-1224
Supersonic Jet Noise Generated by Large Scale Instabilities
J.M. Seiner, D.K. McLaughlin, and C.H. Liu
NASA Langley Res. Ctr., Hampton, VA, Rept. No. L-15307, NASA-TP-2072, 45 pp (Sept 1982)
N82-34189

Key Words: Jet noise

The role of large scale wavelike structures as the major mechanism for supersonic jet noise emission is examined. With the use of aerodynamic and acoustic data for low Reynolds number, supersonic jets at and below 70 thousand comparisons are made with flow fluctuation and acoustic measurements in high Reynolds number, supersonic jets. These comparisons show that a similar physical mechanism governs the generation of sound emitted in the principal noise direction.

SHOCK EXCITATION

83-1225
Periodic Response of a Sliding Oscillator System to Harmonic Excitation
B. Westermo and F. Udwadia
Dept. of Civil Engrg., San Diego State Univ., San Diego, CA, Intl. J. Earthquake Engrg. Struc. Dynam., 11 (1), pp 135-146 (Jan/Feb 1983) 8 figs, 6 refs

Key Words: Oscillators, Harmonic excitation, Periodic response, Seismic response

This paper deals with the periodic response of an oscillating system which is supported on a frictional interface. The base excitation is assumed harmonic and the frictional force is assumed to be of the Coulomb type. Though each segment of the motion of such a system is described by linear equations, its complete response is highly nonlinear and varied. The most fundamental periodic solutions are derived analytically and numerically.

83-1226
Computation of Inelastic Response Spectra
J.M. Nau
North Carolina State Univ., P.O. Box 5993, Raleigh, NC 27650, ASCE J. Engrg. Mech., 109 (1), pp 279-288 (Feb 1983) 2 figs, 2 tables, 9 refs

Key Words: Response spectra, Seismic response, Hysteretic damping

A method for the computation of response spectra for elastoplastic and bilinear hysteretic systems subjected to strong-motion earthquake records is described and compared to Newmark's method. The technique provides the exact solution to the governing equations of motion assuming that the ground acceleration varies linearly between successive points. A fractional time stepping scheme is incorporated to detect yielding and unloading accurately.

83-1227

Shock Spectrum Calculation from Acceleration Time Histories

H.A. Gaberson

Civil Engrg. Lab., Naval Construction Battalion Ctr., Port Hueneme, CA 93043, Rept. No. TN-1590, 66 pp (Sept 1980)

ADA097162

Key Words: Shock response spectra, Seismic response, Equipment response, Computer-aided techniques

The report mainly discusses, compares, and derives one new and improved and two popular shock spectrum computation methods. The new one is a single recursive equation method that approximates the acceleration as a straight line between the digitized values. The new method is easily derived without recourse to Z transform theory and, thus, should contribute to improved understanding of the computations. A new source of low frequency error common to all of the calculation methods was found, and empirical testing of the coefficients was used to establish digitizing rules to avoid the error.

83-1228

Stability of Forced Shock Oscillations of a System with Two Degrees of Freedom

K. Bauer

Vibrotechnika, 3 (33), pp 103-107 (1981) 1 fig, 3 refs

(In Russian)

Key Words: Impact pairs, Two degree of freedom systems, Shock response

The paper considers a shock system with two degrees of freedom. The system consists of a spring-supported body (the working one) harmonically excited by another body. The exciting body moves either together with the working body or separately, acted upon by gravity. The impact of bodies is considered as completely non-elastical. The conditions of stability of oscillations with one impact in each period are obtained.

VIBRATION EXCITATION

83-1229

Response of Equipment in Structures Subjected to Transient Excitation

A.G. Hernried

Ph.D. Thesis, Univ. of California, Berkeley, 107 pp (1982)

DA8300529

Key Words: Equipment-structure interaction, Equipment response, Transient excitation, Modal analysis, Perturbation theory

The response of light equipment in structures subjected to transient excitation is explored. Various discrete equipment-structure models are considered. Among these are the two-degree-of-freedom secondary system, the multi-degree-of-freedom secondary system, the three-degree-of-freedom tertiary system, and the multi-degree-of-freedom tertiary system. Analytical results for equipment response are developed when the structure is subjected to either short duration ground shock, impact, or earthquake excitation.

83-1230

Dynamic Analysis of Light Equipment in Structures: Modal Properties of the Combined System

J.L. Sackman, A. Der Kiureghian, and B. Nour-Omid

Dept. of Civil Engrg., Univ. of California, Berkeley, CA 94720, ASCE J. Engrg. Mech., 109 (1), pp 73-89 (Feb 1983) 4 figs, 4 tables, 7 refs

Key Words: Equipment-structure interaction, Equipment response, Natural frequencies, Mode shapes, Modal damping, Perturbation theory

Perturbation methods are employed to determine the dynamic properties of a combined system composed of a multi-degree-of-freedom structure to which is attached a light, less single-degree-of-freedom equipment item. Closed-form expressions are derived for the natural frequencies, mode shapes, modal dampings, and other modal properties of the combined system in terms of the dynamic properties of the structure alone, and the equipment alone. The effect of tuning and equipment-structure interaction are included in this analysis.

83-1231

Dynamic Analysis of Light Equipment in Structures: Response to Stochastic Input

A. Der Kiureghian, J.L. Sackman, and B. Nour-Omid

Dept. of Civil Engrg., Univ. of California, Berkeley, CA 94720, ASCE J. Engrg. Mech., 109 (1), pp 90-110 (Feb 1983) 6 figs, 13 refs

Key Words: Equipment-structure interaction, Stochastic processes, Modal analysis, Mode superposition method

A mode-superposition method for the evaluation of the dynamic response of light equipment in structures subjected to stochastic excitations is developed. Previously obtained results for modal properties of the combined equipment-structure system in terms of the modal properties of the two subsystems are used. Both power spectral density and response spectrum descriptions of the input are considered. Results include the effects of tuning, equipment-structure interaction, and correlation between modal responses.

83-1232

Self-Excited Wave Oscillations in a Water Table

W. Calarese and W.L. Hankey

Air Force Wright Aeronautical Labs., Wright-Patterson Air Force Base, OH, AIAA J., 21 (3), pp 372-378 (Mar 1983) 11 figs, 10 refs

Key Words: Self-excited vibrations, Water table testing

An experimental investigation has been performed on self-excited wave oscillations on cavity, spike-tipped, and inlet models in a water table. Buzzing was generated by positioning the models at a small angle of attack with respect to the freestream flow. The hydraulic analogy was used to compare the results obtained in water to results obtained in a gas. High-speed and real-time photography were used in the experiment. The frequencies of oscillations in water and air were consistent with the hydraulic analogy. Numerical solutions of the phenomenon were also obtained.

83-1233

Vibrational Analysis in Fluids. 1970 - November, 1982 (Citations from the Engineering Index Data Base)

NTIS, Springfield, VA, 150 pp (Nov 1982)
PB83-853747

Key Words: Vibration analysis, Fluids, Bibliographies

This bibliography contains 152 citations concerning vibrational fatigue, stress, and mechanical responses of fluids through a range of applications. The report discusses general areas of shapes and mechanisms working within and/or in conjunction with fluids. The general information is experimental in nature and could transfer to numerous fields. Specific data and procedures include applications in mechanical engineering, hydrodynamics, hydraulics, and nuclear reactor technology.

83-1234

Random Vibration of One-Dimensional Structures

S. Crandall and A. Kulvets

Massachusetts Inst. of Tech., Cambridge, MA, Vibrotechnika, 3 (33), pp 51-63 (1981) 10 figs, 8 refs (In Russian)

Key Words: Single degree of freedom systems, Random excitation

The vibration of one-dimensional uniform structures under wide-band random point forces is considered. The mean-square displacement, velocity, acceleration, and bending moment response depend on the number and location of exciting forces and on the joint statistical properties of the random force or kinematic excitation processes. When all forces have identical spectra the mean-square response depends on the cross-correlations between processes.

83-1235

Construction Investigation and Application of Electromagnetic Vibrators

J. Gudonis, V. Paškevičius, B. Stulpinas, and A. Šukelis

Kaunas Politechnical Institute, Kaunas, Lithuanian SSR, Vibrotechnika, 1 (39), pp 119-131 (1981) 7 figs, 28 refs

Key Words: Vibrators (machinery), Electromagnetic shakers, Active vibration control, Active damping, Vibration tests

A survey of various designs of small-size electromagnetic vibrators with radial laminated magnetic circuits and electromagnetic vibrators with different degrees of freedom are presented. Active vibration damping systems, stabilization of stress in metal and vibrotesting systems were built on the basis of these vibrators.

83-1236
Vibrational Analysis in Aerodynamics. 1970 - December, 1982 (Citations from the Engineering Index Data Base)
NTIS, Springfield, VA, 145 pp (Dec 1982)
PB83-855478

Key Words: Vibration analysis, Bibliographies

This bibliography contains 140 citations concerning aerodynamic aircraft and spacecraft generated vibration. Structural design flutter in air cushion vehicles; helicopter blade flutter; steady lift wing flutter; bending-torsion flutter at supersonic, subsonic and transonic speeds; wake induced wing flutter; stalled and unstalled flutter, and panel flutter are among the conditions discussed relative to such analysis techniques as finite element analysis. Ground vibration test results, space vehicle automated design, and calculation of critical flutter speeds for fixed wing aircraft are included with respect to vibrational suppression performance.

MECHANICAL PROPERTIES

DAMPING

83-1237
Recent Research on Dynamic Mechanical Properties of Fiber Reinforced Composite Materials and Structures
R.F. Gibson
Univ. of Idaho, Moscow, ID 83843, Shock Vib. Dig., 15 (2), pp 3-15 (Feb 1983) 124 refs

Key Words: Internal damping, Dynamic stiffness, Composite materials, Fiber composites, Reviews

This article reviews recent analytical and experimental efforts to characterize the internal damping and dynamic stiffness of fiber-reinforced composite materials and structures under vibratory loading. The implications of these findings and directions of continued research are discussed.

83-1238
Vitreous Enamel Damping Material Development
B. Kumar
Univ. of Dayton Res. Institute, 300 College Park, Dayton, OH 45469, Rept. No. AFWAL-TR-82-4162, 100 pp (Nov 1982) 49 figs, 20 tables, 13 refs

Key Words: Material damping

This report describes the results of several experimental investigations pertaining to the effects of composition, viscosity, microstructure, and constraining layer on the damping properties of vitreous enamels. New vitreous enamels such as mixed alkali silicate, lead silicate, and two phase fluoride composition are characterized.

FATIGUE
(Also see Nos. 1172, 1173, 1190)

83-1239
Fatigue Life Calculation Using Mean Slope of Sequential Wöhler Curves (Lebensdauerberechnung bei Schwingbelastung auf der Grundlage des mittleren Steigungsverlaufs der Folgewöhlerkurven)
G. Schott
Technische Universitat Dresden, German Dem. Rep., Maschinenbautechnik, 32 (1), pp 29-34 (Jan 1983) 12 figs, 2 tables, 5 refs
(In German)

Key Words: Fatigue life

Sequential Wöhler curves are obtained from two-stage tests. Fatigue life of specific material and a test sample is demonstrated. The calculation method presented is based on mean slope of sequential Wohler curves. This assures that the real fatigue behavior of the test sample is included in the fatigue life calculation.

EXPERIMENTATION

MEASUREMENT AND ANALYSIS

83-1240
Experimental Modal Analysis, Structural Modifications and FEM Analysis on a Desktop Computer
K.A. Ramsey

Structural Measurement Systems, San Jose, CA, S/V, Sound Vib., 17 (2), pp 19-27 (Feb 1983) 13 figs, 2 tables, 5 refs

Key Words: Modal tests, Modal analysis, Structural modification techniques, Finite element techniques, Computer-aided techniques

This article discusses two popular parts of modern day structural dynamics technology: the experimental portion which is referred to as experimental modal analysis or modal testing, and the analytical portion, which is referred to as finite element analysis or finite element modeling. It discusses how experimental and analytical methods are used to solve noise and vibration problems and the importance of using modal parameters to link testing and analysis. Finally, it shows how structural modification techniques are used as a complement to both methods and how all of the tools may be combined on an inexpensive desktop computer.

83-1241

Feynman Diagram Analysis of Transducer Impulse Response

A.H. Banah, A. Korpel, and R.F. Vogel

Dept. of Electrical and Computer Engrg., The Univ. of Iowa, Iowa City, IA 52242, J. Acoust. Soc. Amer., 73 (2), pp 677-687 (Feb 1983) 14 figs, 4 tables, 24 refs

Key Words: Transducers, Piezoelectric transducers

Transducer impulse response is analyzed by introducing two novel elements. The usual equivalent circuit of the transducer is replaced by a simple reentrant transmission line configuration and a Feynman diagram method is applied which involves tracing the exciting signal through all possible pathways to the time and place of observation. The theory is applied under various conditions of electrical and acoustical loading, and results are compared with computer simulations and physical experiments.

83-1242

Measuring Shock and Vibration

Mech. Engrg., pp 30-36 (Feb 1983) 6 figs, 2 tables, 1 ref

Key Words: Accelerometers, Piezoelectric transducers, Piezoresistive gages, Vibration measurement, Measurement techniques, Shock Response, Measuring instruments

Mode of operation, range, sensitivity and calibration of piezoelectric accelerometers and piezoresistive strain gage accelerometers is reviewed. In most cases involving shock and vibration testing the piezoelectric accelerometer has been used. Recently, for some applications where long duration shock motions must be measured, piezoresistive strain gage accelerometers have been developed. They have not only higher gage factors than the earlier wire-resistive gages, but also higher sensitivity and higher operating frequency range.

DYNAMIC TESTS

83-1243

Minimization of Torsional Vibrations of Dynamic Transmission Test Stands (Minimierung der Drehschwingungen von dynamischen Getriebeprüfständen)

I. Schmid, G. Fietz, and H.-J. von Thun

Automobiltech. Z., 85 (1), pp 25-30 (Jan 1983) 12 figs, 1 table, 4 refs

(In German)

Key Words: Test facilities, Torsional vibration, Vibration control

The necessity of simulating in the laboratory the operating conditions of real vehicle operation taxes the dynamics of test stands. Damping of the complex test plant control must be kept to a minimum to ensure high dynamics. A further reduction of damping may be caused by coupling the control circuits of multi-variable control systems, thus provoking the risk of torsional vibration in the test stands. Investigations carried out with an analog computer as well as vibration analysis on test stands revealed causalities and gave concrete hints on how to counteract vibrations while maintaining dynamic control characteristics.

83-1244

Test Tailoring in the 80's

C.E. Wright and P. Bouclin

Naval Weapons Ctr., China Lake, CA, J. Environ. Sci., 26 (1), pp 13-18 (Jan/Feb 1983) 10 figs, 4 refs

Key Words: Dynamic tests, Testing techniques, Standards and codes

Determining test levels for climatic and dynamic simulation is a complex business. In the absence of other data, one must turn to military standards. However, it must be understood that military standards are only guidelines. To use them without tailoring will generally result in an improper test. If data is available, or becomes available, it should be merged with the guidelines of the military standards to develop the most realistic test possible.

DIAGNOSTICS

(Also see No. 1171)

83-1245

Continuous Determination of Machine Tool Breakage and Wear Limits (Processbegleitendes Erkennen von Werkzeugbruch und Verschleisswertgrenzen)

W. König and W. Kluft

Industrie Anzeiger, 104 (96), pp 33-35 (1982) 5 figs, 4 refs

(In German)

Key Words: Diagnostic techniques, Machine tools

Systems for the determination of wear limits and breakage of machine tools are presented. The messages "tool breakage" and "end of service lives" may be utilized by means of the CNC program for an automatic replacement of machine tools. Due to the extremely quick detection of breakage, as well as quick stopping, the damage to the blank, the tool, and the machine is avoided. Piezoelectric dynamometer rings, mounted at suitable locations between the tool turner (Revolver M2T) and machine slide (Maschinenschlitten M2T) are used as force sensors.

83-1246

Machinery Vibration Measurement and Monitoring (Schwingungs-Messung und -Überwachung an Maschinen)

G. Peters

Industrie Anzeiger, 105 (1/2), pp 32-33 (1983) 2 figs, 1 table, 5 refs

(In German)

Key Words: Diagnostic techniques, Machinery vibration

The basics of machinery vibration monitoring and diagnosis is described. The authors discuss the quantities and parameters for evaluating measured vibration data, measurement locations, what types of measurements are suitable for particular machinery and vibration isolation.

83-1247

Electrically Excitable Purely Mechanical Resonances in Piezoelectric and Ferroelectric Materials - Geometrical Considerations

P.J. Chen

Sandia National Labs., Albuquerque, NM 87185, Wave Motion, 5 (2), pp 177-183 (Apr 1983) 5 tables, 7 refs

Key Words: Resonant response, Piezoelectricity

Mechanical displacements of electrically excited specimens of piezoelectric and ferroelectric materials are determined using a displacement laser interferometer system. It is found that purely mechanical resonances can exist in these specimens independent of any detectable electrical disturbance, including virgin and depoled specimens of ferroelectric ceramics. For specimens of the ceramic PZT8 it is shown that the number of purely mechanical resonances increases with decreasing specimen thicknesses, but there seems to be no other correlation between the resonances and the geometries of the specimens.

83-1248

Case History of a Compressor Drive Train Dynamically Induced Gear Failure

J.M. Steele and N.F. Rieger

Stress Technology, Inc., Rochester, NY, ASME Paper No. 82-WA/DE-27

Key Words: Gears, Gear teeth, Failure analysis

A helical gear set, part of a methanol compressor drive train, has experienced tooth failures. The gear teeth had shown visible signs of wear after only 72 hours of service and had to be replaced after 6 months. The acoustic noise from the gearbox was excessive. An analytical model of the torsional drive system was developed.

83-1249

Investigation of a Steam Turbine Rotor-Bearing System Displaying Uncommon Response Characteristics

N.S. Nathoo

Shell Development Co., Houston, TX, ASME Paper No. 82-WA/DE-16

Key Words: Diagnostic techniques, Rotors, Steam turbines

This paper presents a theoretical-experimental approach that was used to investigate and rectify abnormal vibration response characteristics of a steam turbine-fan system. Extensive experiments were conducted to establish the nature of the vibration excursions and to determine their probable causes.

83-1250

Bibliographic Study on the Possibility of Controls by Acoustic Emission During Welding (Etude Bibliographique sur les Possibilites de Controle en Cours de Soudage Par Emission Acoustique)

M. Nogues

Centre Technique des Industries Mecaniques, Senlis, France, Rept. No. CETIM-15-Y-121-X, 40 pp (Dec 1981)

N82-32766

(In French)

Key Words: Diagnostic techniques, Acoustic emission, Failure detection, Welded joints, Reviews

A literature review shows that most welding faults are detectable by acoustic tests, in which both the rate and the amplitude of the signal are altered by cracks and other defects.

BALANCING

83-1251

Determination of Resilient Inertial Characteristics and Unbalance of Flexible Rotors by Using Electric Tensiometer

L. Vaingortin and V. Roizman

Vibrotechnika, 3 (33), pp 65-71 (1981) 3 refs

(In Russian)

Key Words: Rotors, Flexible rotors, Balancing techniques, Parameter identification technique

The article deals with parameter identification of a flexible rotor system, based on tensio-resister indication arranged in some sections of shaft-length. By converting these indications in relative strain, curvature, tensions, section angle etc., some known and some new methods of balancing are obtained and flexible inertial rotor characteristics are determined.

MONITORING

83-1252

Tool Monitoring Systems in the Field (Werkzeugsüberwachungssysteme in der Praxis)

G. Lechler

Industrie Anzeiger, 104 (96), pp 39-41 (1982) 3 figs

(In German)

Key Words: Machine tools, Monitoring techniques, Wear, Failure detection

A system for monitoring the breakage and wear of machine tools is described. It is based on the fact that upon the breakage of the tool the feeding energy increases sharply within fractions of a second. Special additional calculations enable to determine the wear of the tool. Both systems, for breakage and for wear, use the same sensor, the force measurement bearing, which is also briefly described in the article.

83-1253

Tool Monitoring During Drilling and Milling (Werkzeuguberwachung beim Bohren und Fraasen)

W. König and K. Christoffel

Industrie Anzeiger, 104 (96), pp 36-38 (1982) 6 figs

(In German)

Key Words: Monitoring techniques, Machine tools, Drills, Milling (machinery)

Two systems for tool monitoring – one for drilling, the other for milling operations -- are described. The unit for monitoring drilling operations detects tool breakage and wear by evaluating the static and dynamic feeding force components. The unit for monitoring milling operations, on the other hand, uses the passive force as the process characteristic and from its duration detects the onset of breakage of the tool. Within miliseconds, both systems issue a feed-stop-order to the machine, which prevents further damage of the blank, tool or machine.

83-1254

Development of a Universal Monitoring Instrumentation (Entwicklung eines universellen Überwachungsgerätes)

M. Weck, L. Kühne, M. Pascher, and D. Vorsteher

Industrie Anzeiger, 104 (96), pp 42-44 (1982) 5 figs, 3 refs
(In German)

Key Words: Monitoring techniques, Machine tools

Three areas of a universal monitoring unit are discussed. They are: test conditions, calculability of data, and capability of correlating the calculated measurement results and predictions with each other and any further data. Based on these requirements a concept and a setup is developed and described. Using a milling machine as an example, a simple monitoring unit is presented and the necessary steps required in processing the data are explained. An important advantage of the system is that it is easily adaptable to other applications.

83-1255

Acoustic-Emission Monitoring of Steam Turbines. Final Report

L.J. Graham, R.L. Randall, and C. Hong
Energy Systems Group, Atomics Intl. Div., Canoga Park, CA, Rept. No. EPRI-CS-2367, 115 pp (Apr 1982)
DE82904663

Key Words: Monitoring techniques, Acoustic emission, Turbines, Steam turbines

The objective of this project was to develop a method for the on-line detection of crack growth in steam turbine rotors based on acoustic emission (AE) monitoring. This required a considerable extension of conventional techniques because of the high levels of background noise and the inaccessibility of the rotor for optimum transducer placement. A systematic study involving a number of tasks was performed to evaluate the potential for the detection and correct identification of crack growth AE signals during various turbine operating conditions.

ANALYSIS AND DESIGN

ANALYTICAL METHODS

83-1256

Application of Dynamic Substructuring Methods (Application des Methodes de Sous-Structuration Dynamique)

Y. Ousset
Centre Technique des Industries Mecaniques, Senlis, France, Rept. No. CETIM-11-E-301, 58 pp (Feb 1982)
N82-33047
(In French)

Key Words: Substructuring methods, Computer programs

A method of substructuring, which is precise in that it introduces no additional error, is presented. Computer programming of the method with the code, CASTOR-SD, is explained.

83-1257

Researching Frequency Stability Problems Using Stochastic Signal Processing Theory

Ning De Chang, et al
Acta Electronica Sinica, 10 (4), pp 1-11 (1982)
CSTA No. 621.382-82.54

Key Words: Frequency analysis, Stochastic processes

An approach to frequency stability analysis using signal processing models (or systems) based on the stochastic signal processing theory is proposed, and the following are derived: unit impulse responses, transfer functions, autocorrelations of the unit impulse responses, power or energy transfer functions of systems and subsystems; autocovariances and power spectral density of the stochastic signals at all points in the systems; formulas of evaluating N sampling variances for several main stochastic signals with the power law spectral type; and the theoretical, engineering and relative error formulas for the Allan variance.

83-1258

Inclusion of the Coherent Mass and Geometrical Stiffness in CASTOR-SD (Implantation de la Masse Coherente et de la Raideur Geometrique dans CASTOR-SD)

L. Vuquoc
Centre Technique des Industries Mecaniques, Senlis, France, Rept. No. CETIM-11-A-201, 150 pp (Aug 1981)
N82-33046
(In French)

Key Words: Modal analysis, Computer programs, Structural members, Stiffness effects

The possibilities of a modal analysis, based on a coherent discretization of the potential energy and of the kinetic energy of a structure, are presented. Determination of the critical factors of a one-parameter load with reference to Euler bifurcation is considered. These techniques are available through the computer code, CASTOR-SD.

83-1259

Design with Several Eigenvalue Constraints by Finite Elements and Linear Programming

P. Pedersen
Dept. of Solid Mechanics, The Technical Univ. of Denmark, Lyngby, Denmark, J. Struc. Mech., 10 (3), pp 243-271 (1982-83) 6 figs, 11 refs

Key Words: Eigenvalue problems, Finite element technique, Numerical analysis

A finite element discretization, combined with a powerful numerical eigenvalue procedure, has proved to be a unified approach to eigenvalue analysis of elastic solids. Treating the sensitivity analysis as an integrated part of this approach, gradients of the eigenvalues are obtained without any new eigenvalue analysis. This forms the necessary information for an optimal redesign which is formulated as a linear programming problem.

83-1260

Design Sensitivity Analysis in Structural Mechanics. III. Effects of Shape Variation

B. Rousselet and E.J. Haug
Departement de Mathematiques, Universite de Nice, 06034 Nice Cedex, France, J. Struc. Mech., 10 (3), pp 273-310 (1982-83) 17 refs

Key Words: Geometric effects, Eigenvalue problems

The dependence of static response and eigenvalues on the shape of plates and plane elastic solids is characterized. Shape of elastic bodies is taken as the design variable. The material derivative idea of continuum mechanics is used to obtain expressions for directional derivatives of displacement fields and eigenvalues with respect to a transformation function that defines a shape variation. The result is used to obtain explicit and computable expressions for variations of integral functionals that arise in structural optimization problems.

83-1261

A Numerical Method for the Solution of Static and Dynamic Three-Dimensional Elasticity Problems

P.S. Theocaris, N. Karayanopoulos, and G. Tsamasphyros
Dept. of Theoretical and Appl. Mech., The National Technical Univ. of Athens, 5, Heroes of Polytechnion Ave., Zographou, Athens 624, Greece, Computers Struc., 16 (6), pp 777-784 (1983) 7 figs, 28 refs

Key Words: Three dimensional problems, Dynamic structural analysis

Kupradze's functional equation, reduced to a regular Fredholm integral equation of the first kind, is solved by applying a new numerical method, based on numerical integration, whose collocation points are chosen in self-similar surfaces. An application of the method to a particular problem of elasticity demonstrates a sufficient accuracy and stability of the method. It is shown that the proposed method is faster, simpler and more easily programmable than the existing classical methods.

83-1262

Dynamic Response Analysis of Structures with Large Degrees of Freedom by Step-by-Step Transfer Matrix Method

H. Yamakawa and T. Ohnishi
Waseda Univ., 3-4-1 Okubo, Shinjuku-ku, Tokyo, Japan, Bull. JSME, 26 (211), pp 109-116 (Jan 1983) 13 figs, 3 refs

Key Words: Dynamic structural analysis, Transfer matrix method

A new method of dynamic response analysis, termed "step-by-step transfer matrix method," is presented which can be applied to general dynamic problems. This method requires only small degrees of freedom, nearly equal to those of elements for dynamic response analysis of structures even though the structures have large degrees of freedom.

83-1263

Calculation of Power Spectra from Response Spectra

D.D. Pfaffinger
Swiss Fed. Inst. of Tech., Zurich, Switzerland, ASCE

J. Engrg. Mech., 109 (1), pp 357-372 (Feb 1983) 8 figs, 2 tables, 16 refs

Key Words: Power spectral density, Response spectra

A method is presented to determine the power spectral density functions from given smooth response spectra. It is assumed that the underlying excitations constitute a stationary Gaussian random process. The relationship between the response spectrum and the power spectral density function is established by the probability distribution of the extreme values. The power spectral density function is discretized by parameters and piecewise polynomials and the free parameters are determined iteratively by a least square fit.

83-1264

Stationary and Transient Response Envelopes

S. Krenk, H.O. Madsen, and P.H. Madsen
Riso National Lab., Roskilde, Denmark, ASCE J. Engrg. Mech., 109 (1), pp 263-278 (Feb 1983) 6 figs, 2 tables, 16 refs

Key Words: Transient response

An envelope is introduced by using the Hilbert transform to define a complex conjugate to the excitation and response processes of a linear structure. Time-limited stationary excitation is treated in detail, and the complex correlation function is shown to follow from its stationary equivalent by use of a suitable differential operator. Simple expressions are derived for the case of rational spectral density, and a parametric study of the influence of the frequency content is carried out.

83-1265

Fission of Solitons in a Symmetric Triangular Channel with Variable Cross Section

Xi-Chang Zhong and M.C. Shen
Univ. of Wisconsin-Madison, Madison, WI 53706, Wave Motion, 5 (2), pp 167-176 (Apr 1983) 4 figs, 11 refs

Key Words: Wave propagation, Wave forces

The disintegration of a soliton in a symmetric triangular channel when it propagates from one uniform cross section of the channel into another through a transition region is studied. A criterion under which a soliton is split into n solitons is given. Numerical results for n = 3 are presented to confirm the analytical predictions.

83-1266

The Phase Configuration of the Waves Around an Accelerating Disturbance in a Rotating Stratified Fluid

T.J. Woodhead
Dept. of the Mechanics of Fluids, Univ. of Manchester, UK, Wave Motion, 5 (2), pp 157-165 (Apr 1983) 6 figs, 7 refs

Key Words: Wave propagation, Fluids

Ray theory is extended to consider the case of an accelerating disturbance which is producing waves in a rotating stratified fluid. Starting from the equations of motion, dispersion relations are derived for surface gravity waves, capillary waves, Rossby waves and internal-inertial waves. The wave system is studied in each case for the problem of a body starting impulsively from rest and for a body starting from rest and moving with constant acceleration.

83-1267

A Study of Resonant Interactions Between Internal and Surface Waves Based on a Two-Layer Fluid Model

Yan-Chow Ma
Fluid Mechanics Dept., TWR Space and Tech. Group, Redondo Beach, CA 90278, Wave Motion, 5 (2), pp 145-155 (Apr 1983) 3 figs, 13 refs

Key Words: Wave propagation, Resonant response

Equations describing resonant interactions between long internal waves and short surface waves are discussed. The stability of a short surface wavetrain subject to small perturbation from the long internal waves is studied. The stability of a homogeneous random surface wave spectrum and the energy transfer from surface to internal waves are examined.

83-1268

Scattering of a Pulsed Rayleigh Wave by a Spherical Cavity in an Elastic Half Space

A. Boström and G. Kristensson
Inst. of Theoretical Physics, Chalmers Univ. of Tech., S-412 96 Goteborg, Sweden, Wave Motion, 5 (2), pp 137-143 (Apr 1983) 8 figs, 9 refs

Key Words: Time-dependent excitation, Wave diffraction, Cavity-containing media

The time-dependent scattering by a spherical cavity in an elastic half space is considered. The incoming wave is a pulsed Rayleigh wave. The stationary part of the problem is solved by the T-matrix method, and an integration in frequency is performed with a modified gaussian weight function. The displacement components at some points on the surface of the half space are computed and shown in a number of plots.

83-1269

Scattering of Scalar Waves from a Rough Interface Using a Single Integral Equation

J.A. DeSanto

Dept. of Mathematics and Computer Science, Univ. of Denver, Denver, CO 80208, Wave Motion, 5 (2), pp 125-135 (Apr 1983) 22 refs

Key Words: Boundary value problems, Wave diffraction

Using Green's function methods the problem of scattering from a rough interface separating two semi-infinite homogenous media is considered. A single coordinate-space integral equation of the first kind for the generalized reflection coefficient R is derived. A second integral equation of the first kind is derived for the generalized transmission coefficient T. The two equations are new results.

MODELING TECHNIQUES

83-1270

The Dynamics and Control of Large Flexible Space Structures - V

P.M. Bainum, A.S.S.R. Reddy, C.M. Diarra, and V.K. Kumar

Dept. of Mech. Engrg., Howard Univ., Washington, DC, Rept. No. NASA-CR-169360, 83 pp (Aug 1982) N82-33423

Key Words: Mathematical models, Spacecraft

A general survey of the progress made in the areas of mathematical modeling of the system dynamics, structural analysis, development of control algorithms, and simulation of environmental disturbances is presented. The use of graph theory techniques is employed to examine the effects of inherent damping associated with LSST systems on the number and locations of the required control actuators.

NUMERICAL METHODS

83-1271

Numerical Techniques for Dynamic Stochastic Structural Analysis

M.R. Button

Ph.D. Thesis, Univ. of California, Berkeley, 180 pp (1982)

DA8300394

Key Words: Numerical analysis, Dynamic structural analysis, Stochastic processes, Buildings, Seismic response

Although the theory for dynamic structural analysis, using a stochastic description of the input excitation, has been around for a number of years now, it has not gained wide acceptance among the profession. In the first part of this work, dealing with earthquake ground motion as input, this theory is applied in a new manner designed to aid in the teaching of this material, allowing students to follow the major steps in a typical computer analysis for the case of uni-directional ground shaking. A new method is then presented for the analysis of three-dimensional structures subjected to multi-component earthquake motions. The second part of the work deals with the oncoming wind as the excitation. A brief description of the atmospheric boundary layer is presented, and the theory for structural along wind response is described.

PARAMETER IDENTIFICATION

(Also see No. 1112)

83-1272

Further Investigations of the Dynamic Data System Modeling Strategy by Simulations

C. Kunpanitchakit

Ph.D. Thesis, The Univ. of Wisconsin-Madison, 314 pp (1982)

DA8224054

Key Words: Dynamic Data System technique, System identification techniques

A sequential modeling approach and an emphasis on discrete-continuous relationships are the key features of the Dynamic Data System (DDS) methodology. Further investigations of the DDS modeling strategy in the applications to system identification cover five related topics.

83-1273
Identification of Linear Mechanical Oscillator Systems in Condition of Incomplete Observation
S. Korabliov and N. Krylov
Vibrotechnika, 4 (38), pp 33-43 (1981) 1 fig, 3 refs
(In Russian)

Key Words: System identification techniques

An identification method for the vibrational condition vector of linear mechanical oscillator system is presented. The parameters of the observing device are set up to be insensitive to variations of mechanical system parameters. The method is very accurate and simple for use with digital computers.

DESIGN TECHNIQUES
(See Nos. 1111, 1157, 1170)

COMPUTER PROGRAMS
(Also see No. 1256)

83-1274
I. DELIGHT.STRUCT: A Computer-Aided Design Environment for Structural Engineering. II. Optimal Design of Seismic-Resistant Planar Steel Frames
R.J. Balling
Ph.D. Thesis, Univ. of California, Berkeley, CA 226 pp (1982)
DA8300425

Key Words: Frames, Steel, Earthquake resistant structures, Computer programs

The first report describes an expandable software system for optimization-based, interactive computer-aided design of structures. This system can be used for the design of statically and/or dynamically loaded structures which exhibit linear or nonlinear response. The second report presents a method for the seismic-resistant design of planar, rectangular braced or unbraced steel frames. An important feature of the method is that nonlinear step-by-step integration is used as the analysis technique within the design process itself.

83-1275
Engine Dynamic Analysis with General Nonlinear Finite Element Codes. Part 2: Bearing Element Implementation Overall Numerical Characteristics and Benchmaking
J. Padovan, M. Adams, J. Fertis, I. Zeid, and P. Lam
Akron Univ., OH, Rept. No. NASA-CR-167944, 229 pp (Oct 1982)
N82-33390

Key Words: Computer programs, Finite element techniques, Rotors, Turbine engines

Finite element codes are used in modeling rotor-bearing-stator structure common to the turbine industry. Engine dynamic simulation is used by developing strategies which enable the use of available finite element codes.

GENERAL TOPICS

CRITERIA, STANDARDS, AND SPECIFICATIONS
(See No. 1244)

BIBLIOGRAPHIES
(See Nos. 1109, 1129, 1131, 1149, 1150, 1233)

USEFUL APPLICATIONS

83-1276
Synchronization of Centrifugal Vibrators in a Two-Mass Shock Vibratory Machine
K. Bauer
Vibrotechnika, 3 (33), pp 109-116 (1981) 2 figs, 10 refs
(In Russian)

Key Words: Vibrators (machinery)

The synchronization of centrifugal vibrators in a vibratory machine under impact loading is investigated. The load is considered as a solid body which completely nonelastically impacts with the working part of the machine. The equations for calculation of synchronous-synphase regime and the conditions of its stability are obtained. A numerical example is given.

83-1277

The Rational Model Choice of Large-Gabarit Vibro-Machine Container

V. Povidaylo and I. Zanevsky
Lvov Politechnical Inst., Lvov Ukr. SSR, Vibrotechnika, 3 (33), pp 23-29 (1981) 2 figs, 7 refs
(In Russian)

Key Words: Vibrators (machinery)

The unwanted vibrations of a large-gabarit vibro-machine container is investigated theoretically. The container is simulated by a thin-walled open cross-section beam applying basic distortional hypothesis and analyzed using power evaluation method.

83-1278

Magnetic Recording Using Vibrating Magnetic Heads

P. Varanauskas and V. Nenorta
Kaunas Politechnical Institute, Kaunas, Lithuanian SSR, Vibrotechnika, 1 (39), pp 11-13 (1981) 4 figs, 4 refs
(In Russian)

Key Words: Vibratory techniques

The quality of magnetic recordings using magnetic heads were tested experimentally. The results are presented by graphs and oscillograms.

AUTHOR INDEX

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8-11 West Coast International Meeting [SAE] Vancouver, B.C. *(SAE Hqs.)*

SEPTEMBER 1983

11-13 Petroleum Workshop and Conference [ASME] Tulsa, OK *(ASME Hqs.)*

11-14 Design Engineering Technical Conference [ASME] Dearborn, MI *(ASME Hqs.)*

12-15 International Off-Highway Meeting & Exposition [SAE] Milwaukee, WI *(SAE Hqs.)*

14-16 International Symposium on Structural Crashworthiness [University of Liverpool] Liverpool, UK *(Prof. Norman Jones, Dept. of Mech. Engrg., The Univ. of Liverpool, P.O. Box 147, Liverpool L69 3BX, England)*

25-29 Power Generation Conference [ASME] Indianapolis, IN *(ASME Hqs.)*

28-30 Rotating Machinery Vibration Symposium [Vibration Institute] Worcester, MA *(Dr. Ronald L. Eshleman, Director, The Vibration Institute, 101 W. 55th St., Suite 206, Clarendon Hills, IL 60514 - (312) 654-2254)*

OCTOBER 1983

3-7 Advances in Dynamic Analysis and Testing [SAE Technical Committee G-5] SAE Aerospace Congress and Exposition, Long Beach, CA *(Roy W. Mustain, Rockwell Space Transportation and Systems Group, Mail Sta. AB97, 12214 Lakewood Blvd., Downey, CA 90241)*

3-7 SAE Aerospace Congress and Exposition [SAE] Long Beach, CA *(SAE Hqs.)*

17-19 Stapp Car Crash Conference [SAE] San Diego, CA *(SAE Hqs.)*

17-20 Lubrication Conference [ASME] Hartford, CT *(ASME Hqs.)*

18-20 54th Shock and Vibration Symposium [Shock and Vibration Information Center, Washington, DC] Pasadena, CA *(Mr. Henry C. Pusey, Director, SVIC, Naval Research Lab., Code 5804, Washington, DC 20375)*

31-Nov 4 John C. Sowdon Vibration Control Seminar [Applied Research Lab., Pennsylvania State Univ.] University Park, PA *((Mary Ann Solic, 410 Keller Conference Center, University Park, PA 16802 - (814) 865-4591)*

NOVEMBER 1983

6-10 Truck Meeting and Exposition [SAE] Cleveland, OH *(SAE Hqs.)*

7-11 Acoustical Society of America, Fall Meeting [ASA] San Diego, CA *(ASA Hqs.)*

13-18 American Society of Mechanical Engineers, Winter Annual Meeting [ASME] Boston, MA *(ASME Hqs.)*

MARCH 1984

20-23 Balancing of Rotating Machinery Symposium [Vibration Institute] Philadelphia, Pennsylvania *(Dr. Ronald L. Eshleman, Director, The Vibration Institute, 101 W. 55th St., Suite 206, Clarendon Hills, IL 60514 - (312) 654-2254)*

APRIL 1984

9-12 Design Engineering Conference and Show [ASME] Chicago, IL *(ASMe Hqs.)*

9-13 2nd International Conference on Recent Advances in Structural Dynamics [Institute of Sound and Vibration Research] Southampton, England *(Dr. Maurice Petyt, Institute of Sound and Vibration Research, The University of Southampton, S09 5NH, England - (0703) 559122, ext. 2297)*

MAY 1984

7-11 Acoustical Society of America, Spring Meeting [ASA] Norfolk, VA *(ASA Hqs.)*

CALENDAR ACRONYM DEFINITIONS AND ADDRESSES OF SOCIETY HEADQUARTERS

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

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

ASTM: American Society for Testing and Materials
1916 Race St.
Philadelphia, PA 19103

ICF: International Congress on Fracture
Tohoku University
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

IMechE: Institution of Mechanical Engineers
1 Birdcage Walk, Westminster,
London SW1, UK

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

SAE: Society of Automotive Engineers
400 Commonwealth Drive
Warrendale, PA 15096

SEE: Society of Environmental Engineers
Owles Hall, Buntingford, Hertz.
SG9 9PL, England

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

PUBLICATION POLICY

Unsolicited articles are accepted for publication in the Shock and Vibration Digest. Feature articles should be tutorials and/or reviews of areas of interest to shock and vibration engineers. Literature review articles should provide a subjective critique/summary of papers, patents, proceedings, and reports of a pertinent topic in the shock and vibration field. A literature review should stress important recent technology. Only pertinent literature should be cited. Illustrations are encouraged. Detailed mathematical derivations are discouraged; rather, simple formulas representing results should be used. When complex formulas cannot be avoided, a functional form should be used so that readers will understand the interaction between parameters and variables.

Manuscripts must be typed (double-spaced) and figures attached. It is strongly recommended that line figures be rendered in ink or heavy pencil and neatly labeled. Photographs must be unscreened glossy black and white prints. The format for references shown in DIGEST articles is to be followed.

Manuscripts must begin with a brief abstract, or summary. Only material referred to in the text should be included in the list of References at the end of the article. References should be cited in text by consecutive numbers in brackets, as in the example below.

> Unfortunately, such information is often unreliable, particularly statistical data pertinent to a reliability assessment, as has been previously noted [1].
>
> Critical and certain related excitations were first applied to the problem of assessing system reliability almost a decade ago [2]. Since then, the variations that have been developed and the practical applications that have been explored [3-7] indicate that . . .

The format and style for the list of References at the end of the article are as follows:

- each citation number as it appears in text (not in alphabetical order)
- last name of author/editor followed by initials or first name
- titles of articles within quotations, titles of books underlined
- abbreviated title of journal in which article was published (see Periodicals Scanned list in January, June, and December issues)
- volume, number or issue, and pages for journals; publisher for books
- year of publication in parentheses

A sample reference list is given below.

1. Platzer, M.F., "Transonic Blade Flutter - A Survey," Shock Vib. Dig., 7 (7), pp 97-106 (July 1975).
2. Bisplinghoff, R.L., Ashley, H., and Halfman, R.L., Aeroelasticity, Addision-Wesley (1955).
3. Jones, W.P., (Ed.), "Manual on Aeroelasticity," Part II, Aerodynamic Aspects, Advisory Group Aeronaut. Res. Devel. (1962).
4. Lin, C.C., Reissner, E., and Tsien, H., "On Two-Dimensional Nonsteady Motion of a Slender Body in a Compressible Fluid," J. Math. Phys., 27 (3), pp 220-231 (1948).
5. Landahl, M., Unsteady Transonic Flow, Pergamon Press (1961).
6. Miles, J.W., "The Compressible Flow Past an Oscillating Airfoil in a Wind Tunnel," J. Aeronaut. Sci., 23 (7), pp 671-678 (1956).
7. Lane, F., "Supersonic Flow Past an Oscillating Cascade with Supersonic Leading Edge Locus," J. Aeronaut. Sci., 24 (1), pp 65-66 (1957).

Articles for the DIGEST will be reviewed for technical content and edited for style and format. Before an article is submitted, the topic area should be cleared with the editors of the DIGEST. Literature review topics are assigned on a first come basis. Topics should be narrow and well-defined. Articles should be 1500 to 2500 words in length. For additional information on topics and editorial policies, please contact:

Milda Z. Tamulionis
Research Editor
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