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SVIC NOTES

Stress screening is controversial and has received a lot of publicity. How can we establish meaningful test levels? How much do stress screening tests cost? Do the results justify the cost? Who pays for it all? These are some of the questions raised in the controversy. The fact remains that the Department of Defense requires that certain complex systems be subjected to stress screening tests for the purpose of reducing the high early failure rates in some equipment. Low level random vibration and high/low temperature cycling tests appear to be the most useful stress inputs to screen out what are commonly called infant mortalities in equipment. It also appears that there is widespread agreement that stress screening tests are valuable, yet the controversy continues.

As I see it, poor communication is at the root of the problem. Consider that there are three separate and distinct groups involved in stress screening: (1) the electric component manufacturers, (2) the Automatic Test Equipment (ATE) community, and (3) the environmental testing community. Each of these communities has its own parochial view of what stress screening is all about. Furthermore, the three groups do not function the same way or use the same technical terms.

The environmental testing community, as typified by the Institute of Environmental Sciences (IES), are oriented to laboratory testing, often with an emphasis on structural performance. In some laboratories, testing is viewed primarily as a search for static or dynamic structural defects. On these occasions when environmental testing does not include functional testing of the equipment, the tests are go or no go. The equipment is either broken or unbroken. Many environmental test laboratories do relatively little electrical diagnostic work on the equipment under test; this would require that they have both specialized test sets and an intimate knowledge of the function of the equipment under test. They sometimes have neither. What they *do* have for sure, however, is a test laboratory with general purpose shakers, temperature chambers, test engineers, and a charter to perform ENVIRONMENTAL tests.

By contrast, the ATE community thinks of the world in electrical terms. They are extremely knowledgeable about the electrical performance of their units under test. They also have all the diagnostic and auxiliary units needed to make their units function while under stress. They usually do not have dedicated environmental test laboratories. They often lack the general purpose test equipment and the capability to do environmental testing.

Finally, the electrical component manufacturers produce the products that a good deal of the screening is all about. It is the *electronics* of a system that is of fundamental importance to this group. They are completely familiar with the types of early failures that can be expected in their equipment. It may be, for example, that stress screens should be optimized with integrated circuits (IC's) in mind. The IC manufacturers know that each component type has defects that can be best screened by specified tests. They emphasize that temperature burn-in is probably the best way to screen.

In summary, the information exchange among these separate groups needs to be improved. They need to talk to one another. Furthermore, considerable thought should be given to the problem of *who* should be developing stress screening test requirements. All interests should be represented. It shouldn't be dumped on the doorstep of the environmental test laboratories like an abandoned baby. Other options should be considered, such as organizing teams made up of representatives from all three groups. Since each of the three groups has a piece of the puzzle, they must combine their efforts in order to solve stress screening problems.

J.G.S.

EDITORS RATTLE SPACE

THE ROLE OF THE DIGITAL COMPUTER IN DESIGN AND DEVELOPMENT

After all the machine specifications, functions and constraints were agreed upon, the engineer entered in a dialog with the computer -- communicating by sight (cathode ray tube) and sound. He was presented several alternate designs of the new machine for approval. After selection, complete tapes for automatic manufacturing were sent to the production facility and a report on the details of the new machine was printed. In less time than it takes to explain the function of the machine, another new machine was designed by the computer.

The preceding paragraph appeared in my editorial of August 1973. At that time we were a long way from that scenario. Today, ten years later, we have the computational power to do fast, efficient design calculations and drafting on smaller computers than anyone believed possible. However, computer design calculations are still based on mathematical models of physical systems -- which at best are not perfect. In fact the "art" of modeling has not evolved as fast as the hardware and software of the computer -- principally because there is not much economic gain in quantification of physical phenomena. Therefore, there is a limit to what can be done in computer aided design so long as models are imperfect.

Despite these limitations the use of the digital computer in design has changed engineering practice significantly. In the vibration area, we can eliminate much exploratory testing by using computer models to eliminate nonworkable concepts. On the other hand I don't believe we can be confident of the end design without full-scale testing; unless, the equipment is grossly overdesigned. Therefore computer design can eliminate some of the work traditionally required in the development of equipment; however, in the final acceptance of the equipment, performance and structural integrity must be proven.

We are fortunate to have powerful, efficient computational tools to aid in design and development; however, we must not abuse these tools by attempting to substitute them for engineering judgment and rational thinking.

R.L.E.

RECENT RESEARCH ON DYNAMIC MECHANICAL PROPERTIES OF FIBER REINFORCED COMPOSITE MATERIALS AND STRUCTURES

R.F. Gibson*

Abstract. 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.

Research continues in many of the new areas identified in 1979 [1]. For example, significant gains have been achieved in analysis and testing of short (discontinuous) fiber composites, in assessment of environmental effects on dynamic properties of composites, and in finite element analysis of composite micromechanical and structural elements. In addition, experimental techniques have been improved and automated, and relationships between material damage and dynamic properties have been studied. New areas of emphasis during the last three years include analysis of bimodulus composites, finite element analysis with material damping, optimization of damping in discontinuous fiber composites, testing of new metal matrix composites and Kevlar composites, and new aerospace structural applications of composites. A new ASTM standard method for measuring material damping has also been released.

Because no survey article can completely cover a given field, it is appropriate to mention related survey articles that have been published during the last three years. Ross, Sierakowski, and Sun [2] have developed an introduction to the analysis and measurement of dynamic response of composites. Ting [3] has reviewed analytical approaches to predicting dynamic response of composites. Bert has surveyed recent work on damping of composites [4] and vibration of composite structures [5]. A survey of phenomenological damping of mechanical vibrations and acoustic waves has been published [6], as has a report on damping of filled plastics [7].

The proceedings of two recent conferences on damping in aerospace structures [8, 9] contain a wealth of information, some of which has strong implications for future composite materials research. Although these conferences were concerned with all possible means of achieving damping, it is recognized that the high strength-to-weight and stiffness-to-weight ratios and good damping properties of composites make them very attractive for many aerospace applications.

One such application is in large orbiting space structures now being planned [10]. In a survey of passive damping requirements and mechanisms for such structures, Trudell, Curley, and Rogers [11] have pointed out that "the development and optimization of damping composite materials appear to be a particularly fertile area for work when all of the property requirements for structural materials for Large Precision Space Structures are considered." Ashley [12] has stated that, even when active control of such structures is employed, passive structural damping is still necessary for system stability. For a number of reasons, therefore, the dynamic properties of composite materials and structures will continue to be of considerable interest in aerospace applications.

ANALYSIS

Finite element modeling. Dynamic behavior of composites can be modeled using finite element approaches at both the macromechanical and the micromechanical levels. At present, however, essentially all of the finite element modeling of dynamic

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behavior has been done at the macromechanical level; i.e., structural elements such as laminated plates and shells. A recent survey by Reddy [13], for example, shows that a considerable amount of work has been done on free vibration of layered, anisotropic composite plates and shells. The publications he reviewed [13] are concerned with both linear and nonlinear elastic response but not with damped response. The recent flurry of activity in finite element modeling of damped structures [14-18] has been oriented toward constrained viscoelastic layer (add-on) damping rather than integral composite material damping, but the technology appears ripe for application to both micromechanical and macromechanical analysis of composites. Soni and Bogner [18] have described the MAGNA-D finite element program for free vibration and steady-state vibration analysis of complex structures for which damping analysis by complex stiffness and frictional dissipation is appropriate. They provided an application of the program to a sandwich panel as well as other non-composite applications.

Beams and plates -- other analyses. Asymptotic solutions of the general three-dimensional elasticity equations for an anisotropic beam have been used by Sayir [19] to show that shear effects can be dominant even for wavelengths much larger than beam thickness. Shear effects have also been considered by others [20, 21]. The importance of fiber orientation and mode number in the torsion-flexure coupling effect in generally orthotropic beams has been investigated [22].

In a related static analysis, Sandorff [23] analyzed the short beam shear test and showed that Saint-Venant's principle might not apply in highly anisotropic beams; that is, high stresses and distortions in the stress distribution due to concentrated loads or discontinuities are not as localized for anisotropic beams as they are for isotropic ones. This finding has important implications for dynamic properties, especially damping due to interlaminar shear. Recent research in classical solutions for dynamics of composite and sandwich plates has been reviewed [24].

Bimodulus composites. The elastic properties of bimodulus composites differ, depending upon whether the strain along the fiber direction is tensile or compressive. Cord-rubber composites are the most common examples. A recent symposium was devoted to mechanics of bimodulus materials in general [25]. Most of the work in this area before 1979 was concerned with static properties and behavior, but dynamic behavior has been investigated in recent research. Bert and his colleagues [26-33] have contributed the bulk of the work. They have analyzed vibrations of thick bimodulus composite plates [31], dynamics of thick bimodulus beams [32], and vibrations of cylindrical shells [33]. In all of this work only elastic behavior and undamped natural frequencies and mode shapes have been investigated; damping has not been considered. Thus, damping in bimodulus composites would be a good topic for future investigations.

Discontinuous fiber composites. As reported in the previous survey [1] McLean and Reed [34] found that discontinuous fibers rather than continuous fibers could significantly increase damping. Similarly, Gibson and Yau [35] found that measured damping in short fiber-reinforced sheet molding compounds (SMC) was greater than the estimated upper bound from micromechanics. The predicted bounds did not take into account the actual stress distribution along a discontinuous fiber, however.

Recognizing that the shear stress concentration in the viscoelastic polymer matrix close to the fiber end could lead to additional dissipation, Gibson, Sun, and Chaturvedi [36] developed two analytical models. Both showed that an optimum fiber aspect ratio for maximum damping in a discontinuous aligned fiber composite exists and that predicted optimum aspect ratios lie in the range of actual whisker and microfiber aspect ratios. In a later paper [37] they showed that the predicted optimum aspect ratios are in the range of whisker and microfiber aspect ratios only when fiber damping is small. When fiber damping is great enough, however, the optimum fiber aspect ratio corresponds to continuous fiber reinforcement. Experimental verification of the analysis has been completed only for high aspect ratios.

For small fiber damping the predicted optimum aspect ratio also corresponds to the optimum constraining layer aspect ratio for constrained viscoelastic layers [38]. The correspondence results from similarities in stress distributions along discontinuous fibers and along discontinuous constraining layers.

In practical short fiber composites the fibers are often randomly oriented. The analysis of Chon and Sun [39] showed that the maximum shear stress close to the fiber end is increased still further by off-axis fiber orientation. Weng and Sun [40] also reported on the effects of fiber length on elastic moduli of randomly oriented chopped fiber composites. These results could explain some earlier observations [35] regarding damping in random short fiber SMC. Related elastostatic analyses of short fiber composites have been reported [41, 42].

Viscoelastic behavior. The previously mentioned Air Force conference proceedings [8] and a paper by Jones [43] provide state-of-the-art coverage of viscoelastic damping in polymers. The application to polymer matrix composites is not given adequate treatment, however; the emphasis is instead on such damping treatments as constrained viscoelastic layers that are added to existing structures. As has been pointed out work is needed to improve and optimize dynamic properties in composites; the damping and stiffness would be designed into the structure and not added on at the expense of added weight. This is particularly important for aerospace and transportation applications.

Kligman, Madigosky, and Barlow [44] used an extension of the self consistent field approach to derive general expressions for the dilatation modulus and density of viscoelastic composites. A comprehensive theory for dynamic response of structural members with constitutive relations in the form of the hereditary law has been developed [45]. A new nomogram for presenting viscoelastic damping data has been described [46]. The effects of hygrothermal exposure on viscoelastic response of composite laminates have been treated [47].

Lipatov [48] has discussed the importance of the interfacial fiber/matrix boundary layer that has different viscoelastic properties than the polymer matrix itself. He points out that this difference leads to a ternary system of matrix, filler, and boundary layer and that little work has been done on the viscoelastic behavior of such systems. The relaxation spectra of all three components need to be accounted for. Lipatov does not mention this need, but the implications for damping behavior are important because the boundary layer is the site of most of the energy dissipation. An energy method has been used to derive expressions for the complex viscoelastic modulus of fiber-reinforced composites [49] and particle-reinforced composites [50].

The complex viscoelastic modulus can be represented as a ratio of polynomials of fractional powers in the frequency; this simplifies experimental characterization [51, 52]. These relationships have been used in conjunction with the elastic-viscoelastic correspondence principle to develop finite element models of viscoelastically damped structures [53]. Again it appears that the technology developed for general viscoelastic damping analysis is ripe for application to composite material analysis.

Analysis of damage effects. As has been mentioned [1] damping is sensitive to microstructural damage. Although these early studies showed that damping measurements can be used qualitatively to detect damage, two major problems remain: damping has not been functionally related to the type, location, and extent of damage, and the experimental techniques used have not generally been suitable for in situ measurements on full-scale composite structures.

Regarding the first problem Plunkett [54] used a shear lag analysis to show that increased damping in a cracked cross-ply laminated beam bears a functional relationship to the maximum strain and resulting density of transverse matrix cracks. This relationship explains previous results [55].

Crack density has been related to a reduction in stiffness in a shear lag analysis [56]. These results are encouraging, but more work is needed, especially concerning the effects of type and location of damage on dynamic properties. The second problem, that of measurement, is discussed later in this article.

Closely related to damage effects is a study of the influence of small randomly distributed pores on the dynamic response of elastic structures [57]. Other investigators have derived expressions for the complex modulus of a porous material using Biot's theory for deformable poroelastic media [58].

MEASUREMENT

Techniques. After laboring through six drafts in three years, a Task Group within ASTM Committee

E-33 on Environmental Acoustics developed ASTM Standard E-756-80, "Standard Method for Measuring Vibration Damping Properties of Materials" [59]. The technique is based on resonant half-power band-width measurements on a cantilever Oberst-style test bar. Although the method has a number of limitations (all of which are not mentioned in the Standard), it is hoped that wide use of the Standard will lead to refinements and improvements as its limitations are better understood [60].

The apparatus for the Standard method is similar to that of several commercially available devices. It should be pointed out, however, that these devices were developed primarily for testing elastomers and polymers that generally have much higher damping than do metallic or composite materials. It is my opinion that, due to such parasitic losses as clamping friction in these machines, damping data for relatively low loss metallic and composite specimens could be in considerable error. The parasitic losses are not so significant for high loss elastomers and polymers.

Read and Dean [61] have published a useful book on test methods and data analysis. They emphasize analysis and correction of data from flexural, torsional, and longitudinal resonant tests of polymers and composites. This would be a good reference for those planning to use the ASTM Standard Method for testing composites because it contains details of the limitations of the various methods.

Several papers have been published on improving and automating various tests for dynamic properties. Gibson, Yau, and Riegner [62] described improvements in a resonant dwell flexure test. The original technique had been used to measure the complex moduli of automotive SMC materials [63] at room temperature and humidity. The improved technique was developed to test the same materials during exposure to various environmental conditions [64].

A progressive wave apparatus with an automated data processor has been described [65]. The Fourier transform of the waveform of damped torsional oscillation has been used instead of wave height analysis in a decay test [66]. With this improvement, such parasitic motions as flexural or precessional motions were separated from basic torsional motion.

The mechanical impedance of a specimen has been determined by using a harmonically excited rod equipped with strain gages [67]. A free-free flexure test for detecting cracks in composites has been developed [68]. Experimental determination of dynamic elastic moduli of composites has been discussed [69]. Hooker [70] developed an apparatus for measuring damping in metals under combined torsional and flexural vibrations. He and Mead [71] developed another apparatus for finding the effect of mean strain on damping in metals.

The effects of mean stress and combined stress on the dynamic properties of composites have received little attention to date. It would seem that the presence of various coupling effects in composite laminates would make this an appropriate topic for future study.

In the previous review [1] the impulse-transfer function technique was described as ripe for application to composite material testing. This technique also has the potential for solving the portability problem mentioned earlier (see ***Analysis of Damage Effects***). Thus far, however, the method has been used only to characterize stiffness. Damping and the sensitivity of damping to damage have not been characterized with this new method. The technique has been used to measure the elastic constants of automotive composites [72] and to relate the size of flaws in a metal bar to changes in stiffness [73].

Pritz reported on the use of transfer functions (not necessarily from impulsive excitation) to determine the complex moduli of spring-like specimens [74] and rod-like specimens [75] of acoustic materials. Additional papers on transfer function and frequency response methods have been published [76-80].

Environmental effects. The influence of elevated temperature, moisture absorption, and chemical attack on the vibration characteristics of automotive E-glass/polyester SMC materials has been reported [64]. Noteworthy was the definite statistical correlation between increased moisture content and increased damping. Tests were conducted over the range from fully dry to fully saturated; the effect was found to be reversible when specimens were re-dried. Two possible mechanisms were proposed: matrix swelling-induced changes in the interfacial stresses and moisture-induced changes in the matrix glass transition temperature. Moisture diffusion coefficients for these same materials have been measured [81].

The effects of temperature and moisture on dynamic properties of graphite/epoxy aerospace composites have been studied [82, 83]. The effects of environmental conditions in space on dynamic properties of graphite/epoxy have been measured [84].

A new damping peak above the glass transition temperature has been found for a unidirectional glass/epoxy composite [85]. The peak was possibly related to the resin characteristics in the interfacial region. Similar results have been reported [86]. In torsion pendulum tests of epoxy filled with glass, carbon or aramid fibers, or glass beads a new relaxation peak was again possibly related to matrix degradation in the interfacial region.

Greenberg and Kusy [87] measured the influence of temperature and volume fraction of aluminum oxide particles on the dynamic mechanical properties of polymer/aluminum oxide composites. Fiberglass cloth/epoxy composites have been tested at temperatures down to liquid nitrogen temperature [88]; damping varied inversely with the dynamic elastic modulus under these conditions. Flutter of composite panels has been related to environmental conditions, damping, and shear deformation [89].

In related work it has been found [90] that the rate of moisture absorption, the maximum moisture content, and the diffusion coefficient of glass/epoxy and graphite/epoxy composites increased with increasing external stress. The diffusion coefficient for moisture diffusion in epoxy resins was shown to increase if the epoxy was under tensile stress and to decrease if the epoxy was under compressive stress [91]. These results have important implications for further studies on the mechanisms for changes in damping and stiffness under changing environmental conditions.

Damage assessment. The use of dynamic mechanical property measurements to detect damage has received considerable attention. Thus far, however, definite correlations of the type, extent, and location of damage (type and location, in particular) with changes in such properties as damping have not generally been shown. Richardson [92] has surveyed the literature in the general area of damage detection by dynamic property measurement. Matrix cracking and delamination have received the most attention in composite material studies; e.g., the work of Plunkett [54] in matrix cracking referred to earlier.

Correlations have been reported between acoustic emissions and changes in damping and stiffness for E-glass/epoxy cross-ply laminates with matrix cracks [93]. Damping measurements have been made on graphite/epoxy specimens during the course of fatigue studies using both the log decrement and bandwidth techniques [94]. Vibration frequency has been found to be an important fatigue-life-limiting parameter for fiberglass composites [95]. As frequency increased, the temperature on the surface of the specimens increased and the number of cycles to failure decreased.

Additional findings on fatigue of unidirectional and laminated composites have been given [96, 97]. In related work on metallic materials, Pye and Adams [98] reported on a new technique for finding the stress intensity factor for notched specimens; they measured the natural frequency of the specimen before and after crack introduction.

The effect of delamination on the natural frequencies of a laminated beam has been studied [99]. It was found that delamination effects on natural frequencies were more pronounced for the higher modes and that measured effects were much smaller than those predicted by a finite element substructure analysis. Although this appears to be the only publication in the area of delamination/dynamic property relations, several relevant publications on impact-induced delamination are also of interest. For example, Takeda, Sierakowski, and Malvern have published extensively on delamination and cracking of E-glass/epoxy cross-ply laminates under ballistic impact (100-103). Rhodes, Williams, and Starnes [104] have reported on low velocity impact damage in graphite/epoxy laminates. Delamination growth under cyclic loading has been studied extensively [105-107].

Many composite materials researchers feel that delamination is the major concern regarding damage tolerance and durability of composite laminates for structural use. Thus, it appears that the use of dynamic property measurements to characterize delamination damage should be another area of active research. In view of the sensitivity of damping to damage, the delamination/damping connection seems particularly appropriate for future investigations.

Discontinuous fiber composites. Discontinuous fibers make it theoretically possible to improve and even optimize damping in composites [36, 37]. The theoretically optimum fiber aspect ratio for maximum damping has not yet been verified because verification requires testing of whisker and microfiber reinforced polymers. This means additional development work in specimen fabrication.

Initial experiments [36, 37] involved testing of E-glass/epoxy specimens made by cutting pre-preg tape to the appropriate length. The resulting fiber aspect ratios were well above the optimum range, however. The analysis predicted that higher modulus fibers would shift the optimum aspect ratio to higher values while also increasing the magnitude of damping at the peak. As a result, the authors have now shifted their attention to such higher modulus fibers as short graphite fibers [108] or whiskers and microfibers [109].

Measurements of the complex moduli of automotive SMC materials have been reported [35, 62-64]; the findings were summarized earlier in this article. Dynamic mechanical properties of SMC materials have been measured at various times during the molding cycle [110]. The properties changed substantially from initial non-crosslinked conditions to final cured conditions. Such testing was invaluable in demonstrating the role of various fillers and other constituents.

Dynamic tests of short steel fiber-reinforced silicone rubber have been carried out with both bonded and unbonded fiber/matrix interfaces [111, 112]. Interfacial slip had a significant effect on damping and stiffness, but it was concluded that the high shear stress at the end of the fiber with a bonded interface was the most viable mechanism for increasing damping. The lack of structural integrity of materials with unbonded interfaces outweighed the advantages of increased damping. Related research involves the possibility of improving damping with high damping inserts [113]. Inserts of cast iron, bakelite, or perspex were used in an aluminum strip.

Composite structures. Most of the experimental work on dynamic properties of composites is necessarily done on small specimens. The properties derived from small specimens should be related to corresponding properties of actual composite structures. One major problem is that, in structures, a number of damping mechanisms operate in addition to material damping.

A survey of dynamic stiffness and damping of composite beams, curved bars, rings, and panels has been published [5]. Georgi [114] reported the results of dynamic tests on composite I-beams, wing boxes, rotor blades, and sandwich panels. Included were boron, carbon, glass, and synthetic fiber composites. The parameters considered were amplitude, temperature, mode number, frequency, air pressure, aspect ratio, and fiber orientation. It was concluded that predicting system damping on the basis of damping measurements of simple and similar specimens is possible if the structure is not too complex.

Gibson [115] obtained limited data on extensional and flexural damping of small specimens of graphite/epoxy laminates that have been proposed for use in nestable columns for large space structures [116]. Comparison of small specimen damping values with measured damping of assembled composite columns indicated that, in this instance, material damping is possibly more important than frictional joint damping. Mansfield and Sobey [117] have commented on the prospects of aeroelastic tailoring of stiffness of composite helicopter blades. Soovere [118] found that a uniaxial high modulus graphite fiber composite is highly suited for use as the constraining layer of a constrained viscoelastic layer damping treatment.

Metal matrix composites. The damping mechanisms operating in metal matrix composites are entirely different from those that operate in polymer matrix composites. It appears that thermoelastic dissipation, while negligible in most polymers at practical vibration frequencies, is the predominant mechanism for metals. Thermoelastic damping of unidirectional metallic composites has been examined for possible application to space structures [12]. Single fiber tests have been used to determine the complex moduli of boron, silicon carbide, and alumina fibers [119]. Frequency and temperature dependence have been used to determine the complex moduli of boron/aluminum composites [120]. Damping of aluminum alloy/mica composites has been investigated [121].

Kevlar composites. Because Kevlar* aramid polymer reinforcing fibers are relatively new, not much information is available on the dynamic properties of composites made from these materials. A DuPont memorandum [122] indicates that damping in Kevlar 49/epoxy composites is three to five times greater than damping in glass or graphite fiber/epoxy composites. These results were based on decay tests of cantilever beam specimens of fabric and unidirectional reinforced composites. The tests were done in air, however, so that aerodynamic damping could have contributed to some of the differences.

Air damping of a cantilever beam is proportional to the amplitude of vibration and the ratio of air density to material density [123]. For example, Kevlar fibers have roughly half the density of glass fibers. Air damping of a Kevlar/epoxy beam would thus be approximately twice the air damping of a glass/epoxy beam having the same dimensions and fiber volume fraction and vibrating at the same amplitude. However, the Kevlar fiber itself has a polymeric microstructure; it is therefore possible that the fiber actually has better damping characteristics than glass or graphite fibers.

It is also known that strong interfacial bonds develop less easily between Kevlar fibers and various polymer matrices than with glass or graphite fibers; interfacial slip could thus be contributing some of the additional damping in Kevlar composites. Wallace and Bert [124] used the half-power bandwidth method to determine the complex moduli of Kevlar 49 fabric/polyester beams. Damping factors were considerably higher than those reported for Kevlar/epoxy [122], but the polyester resin could have had higher damping than the epoxy.

Obviously, much more work is needed on damping mechanisms in these materials before definite conclusions can be drawn. If the damping properties of Kevlar composites are truly superior to those of other composites, such properties could be worth considering in the optimization studies mentioned earlier. For example, discontinuous Kevlar fibers with the optimum fiber aspect ratio might substantially improve damping over present composites. Finally, such hybrid laminates as those with short Kevlar fibers for damping and continuous graphite fibers for stiffness would appear to offer almost unlimited design flexibility.

*Trademark of E.I. DuPont de Nemours and Company, Wilmington, Delaware

CONCLUSION

Many of the topics cited as needing further work in the previous review article have been researched in more detail, but much work remains to be done. As in any scientific endeavor, the more we learn, the more we find there is to learn. But it is particularly gratifying to see that research on dynamic behavior of composites now has a direct or indirect effect on so many different areas within the general scope of composite materials research. Though gratified, I am finding it increasingly difficult to keep up with all these direct and indirect effects. I therefore appeal to those working in these areas to relay their findings to me during the next three years, so that the next article in this series can be even more comprehensive than this one.

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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 helicopter vibration control and beam models for ship hull vibration analysis.

Dr. G.T.S. Done of The City University, London, UK has written an article describing advances that have been made since 1979 in the control of helicopter vibration and reviews the associated literature.

Dr. J.J. Jensen of The Technical University of Denmark, Lyngby, Denmark has written a paper reviewing beam models used for hull vibration analysis.

FURTHER ADVANCES IN HELICOPTER VIBRATION CONTROL

G.T.S. Done*

Abstract. 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.

Earlier articles [1, 2] reviewed progress in and literature on helicopter vibration control up to the end of 1979. The present paper covers the last three years. It is concerned only with airframe forced vibration and does not include consideration of instability phenomena o- noise.

One notable happening in the area of control of helicopter vibration was a three-day meeting in late 1981 devoted to the subject. The American Helicopter Society North-East Region National Specialists' Meeting on Helicopter Vibration was entitled "Technology for the Jet Smooth Ride." The 27 papers that were presented provide an important statement of the current state of the art.

In fact, the current scene has been well summarized by Reichert [3], who stresses that all manufacturers are aiming for the jet-smooth helicopter; it promises to become a reality before the end of the century. This paper surveys all aspects of helicpter vibration and its control and explains the basic mechanics behind the source of vibration and its suppression. The paper by Balke [4] also surveys achievements of the past and the current situation, although he tends to accentuate the successes of Bell and to ignore those of other firms.

The impression gained by studying the past three years of published material is that, in the area of mechanical isolation, advances have been made and a steadily increasing store of experience has been gained. Mechanical absorbers can be either rotor- or fuselage-borne; as in the case of isolators experience in the reliable operation of these devices continues to be built up. In the area of direct rotor control there has been steady progress although the final objectives still seem to be some way off.

Structural modification continues to attract interest although examples of practical applcation are scarce. Under this heading is the subject of rotor blade dynamic tailoring. It is an old idea but has increased possibilities of success due to advances in blade manufacture using composites and in numerical optimization techniques. Finally, it is clear that there has been some effort to improve the basic understanding of the nature of fuselage and coupled fuselage/rotor vibration; in the past papers in this area were almost nonexistent, but several have recently appeared. These areas are reviewed below.

VIBRATION ISOLATION

An account of the DAVI (Dynamic Antiresonant Vibration Isolator) system has appeared in published form [5] as has a description of its performance in isolating the floor and fuel tanks of a Boeing Vertol Chinook [6]. Experience gained more recently has been recounted [7]. The DAVI isolator balances the momentum of a large mass having a small displacement and the momentum of a small mass having a large displacement; the two masses are coupled mechanically.

The same principle is used in a new type of isolator in which the balancing mass for the momentum is provided by a dense liquid such as mercury. A diagram of such an isolator is given in the Figure. That used by Bell is termed a LIVE (Liquid Inertia Vibration Eliminator) system; its application and use have been described [8]. Details of a similar device have appeared [9]; in this case, however, the moving liquid also drives a solid mass.

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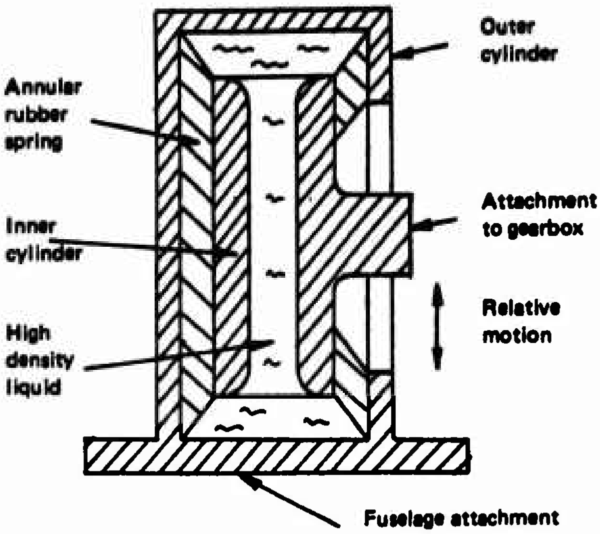

Figure 1. LIVE Isolator

The isolators mentioned above are passive, but the possibility exists for active or semi-active types. Kuczynski and Madden [10] have described a system in which low frequency loads are reacted actively; high frequency loads are reacted passively. Margolis [11] has described a system in which damping is controlled actively by means of a variable orifice in liquid-filled device. A fully active system has been described [12] in which the gearbox of a MBB BO 105 is supported by servo-actuators. Laboratory tests are also described. The usefulness of state feedback has been shown on system design [13].

ABSORBERS

An account of how fuselage sprung-mass and rotor-borne pendulum absorbers are used successfully to alleviate vibration is given by Gupta and Wood [14]. Although the latter have been used in several instances, the application appears to have been in advance of an overall theoretical knowledge of behavior. This can involve much complicated analysis as the papers by Murthy and Hammond [15] and Hamouda and Pierce [16] indicate. An interesting new pendulum-type absorber is the monofilar (see Figure 2) which has the ability, unlike the more familiar bifilar, to reduce vibration simultaneously at two frequencies. This is because the device has two main degrees of freedom. Its behavior is analyzed and performance assessed by Mouzakis [17].

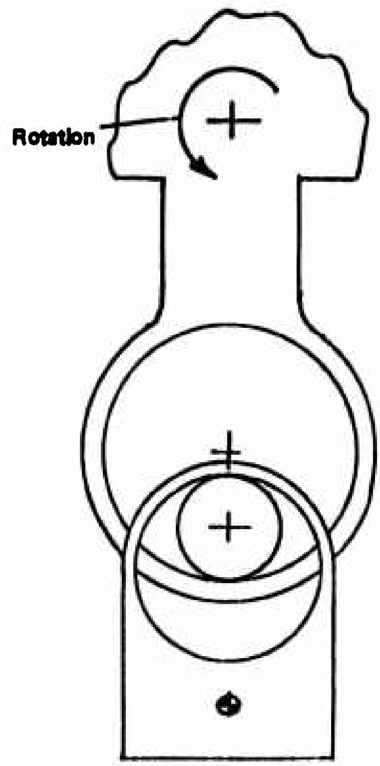

Figure 2. Monofilar Absorber

DIRECT ROTOR CONTROL

Interesting and thoughtful papers have been presented by Kretz and Larché [18] and McCloud [19] who have explored the potential of direct rotor control not only in suppressing vibration but in minimizing the effects of other sources such as gusts and blade stall. A practical application with wind-tunnel tests is described by Ham [20] and Ham and Quackenbush [21], who also discuss the dilemma of whether to control blade pitch directly or indirectly via the swash-plate. Papers which also present wind-tunnel test results are those of Shaw and Albion [22, 23]. In these tests the model is a four-bladed rotor with actuators below the swash-plate. A considerable reduction of resultant rotor hub forces and moments was achieved and despite some increase in blade fatigue loads under certain flight conditions, the authors suggest that the technology is ready for full scale implementation. An analytical study has been made by Yen [24] to compare the advantages gained in the cases of a two-bladed teetering rotor and a four-bladed hingeless rotor. Optimization techniques are used by Jacob and Lehmann [25] and

Biener [26, 27] to provide best performance in suppressing rotor vibration harmonics. Application of optimization to circulation controlled rotors has been made by Abramson and Rogers [28].

STRUCTURAL DESIGN AND MODIFICATION

An interesting study has been made in the area of structural design or modificaton of the fuselage to minimize vibration response [29]. Use of the Vincent circle technique was compared with the method of strain energy density. Vincent circles have also been utilized in other analyses [30, 31]. Sobey [32] extended the circle technique and suggested better ways in which to apply it; Gaukroger [33] indicated how the technique can be applied to undamped structures, thereby reducing some of the complexity. Walker [34] used the circle approach in an experimental investigation into the vibration characteristics of a helicopter tail-cone.

More conventional methods of mathematical optimization have been employed by Done [35] to determine ways to reduce fuselage vibration. An economic method of sensitivity analysis that relies neither on optimization nor on Vincent circles has been presented [36].

Blade design itself can have a profound influence on the level of forcing that is impressed on the fuselage. Design has tended to follow traditional methods, but with dynamic tailoring of blades a prospect due to advances in composites and optimization methods, the subject is beginning to be explored again. Wind-tunnel experiments [37] were partly concerned with investigating the effect of various parameters on vibratory force reduction; another paper [38] is devoted to the topic. Still another paper is that of Taylor [39].

VIBRATION STUDIES

Understanding the behavior of the fuselage and of the fuselage and rotor as a coupled system when oscillatory forcing is present is important in ultimately achieving suppression of vibration Several studies involving finite elements and experimental dynamic tests have recently appeared [40-46]. A significant development is the widening of interest in coupled fuselage/rotor system dynamics [47-52]. This aspect will eventually have to be completely understood if analytical methods are to help in achieving the goal of the jet-smooth helicopter.

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BEAM MODELS FOR SHIP HULL VIBRATION ANALYSIS

J.J. Jensen*

Abstract. 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.

It is appropriate to divide the problem areas in the analysis of ship vibration problems into four groups, depending on the types and extensions of the vibration modes [1]:

- beam-like hull vibration modes; 0.6 - 1.5 Hz < frequency < 3 - 6 Hz
- integrated hull vibration modes in which the hull modes interact with the vibration of such large subsystems as the double bottom or longitudinal bulkheads 3 - 6 Hz < frequency < 6 - 12 Hz
- superstructure vibration modes; 7 - 8 Hz < frequency < 12 - 14 Hz
- local vibration of plate panels and frames; 10 Hz < frequency < 40 Hz

The frequency ranges given above are to be considered typical for ordinary merchant ships. The present review is a follow-up of previous reviews [6, 12] and will therefore focus on beam-like hull vibrations. However, a short discussion of the various methods available for analyzing all of the above vibration problems is given below.

Pure hull vibration modes can be analyzed by modeling the hull as a single, non-prismatic beam. The analysis is usually treated as vertical vibration and coupled horizontal-torsional vibration. The various beam models used to predict these modes is reviewed in the following sections. It should be mentioned that the exciting forces for these modes are due mainly to waves; however, propeller-induced forces can be important in the highest region of the frequency range of interest. Reviews of current methods for estimating wave-induced forces are available [2-4], as are reviews of propeller-induced forces [4, 5].

Models consisting of a few coupled beams representing the hull and the subsystems have been used successfully to analyze integrated hull vibration modes. Examples of such models are available [1, 6]. It should be recognized, however, that determination of coupling coefficients between the beams involved is rather difficult; thus this approach is not generally accepted as a useful method.

The finite element method has been used by a number of authors [1, 7, 8]. Such studies have yielded useful results regarding choice of element type, mesh size, and two-dimensional versus three-dimensional models. However, general conclusions are not yet possible.

The most severe ship vibration problems today are probably superstructure vibrations. Excitation from propeller-induced forces can be extensive in such structures, and vibration levels in the superstructure can annoy ship crew and passengers and cause problems with electronic equipment. The finite element method seems to be the only method now available that yields sufficiently accurate results for free and, to some extent, forced vibrations of superstructures [5, 7-9]. It should be mentioned that it is at present not possible to perform accurate forced vibration analysis of ship structures even with the most elaborate finite element modeling. The reasons include lack of knowledge in propeller-induced force estima-

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tion [6] and inability to assess structural damping [10]. In addition, the effect of the surrounding water deserves a proper treatment [11] for these complex vibration modes.

The main problems in the determination of vibration characteristics for local vibrations of plate panels, transverse frames, and other minor substructures include estimating realistic boundary conditions and, for forced vibration, the damping and exciting forces. The methods most often used are the Rayleigh-Ritz method in the case of regular boundaries or the finite element method. Examples are available [8, 9] as is a review of current literature related to this field [4]. A complete survey, including 352 references, of the state of the art regarding ship hull vibration has been published [12].

VERTICAL HULL VIBRATIONS

The Timoshenko beam theory has been widely accepted as a suitable model for calculating vertical hull vibration modes up to about nine nodes [4]. In the Timoshenko beam equations governing free, undamped vibration modes, the hull is specified by sectional quantities. They are: hull stiffness, as represented by bending and shear rigidities; hull mass and mass moment of inertia; the so-called added or virtual mass of water; and the mass of the cargo. These quantities should be specified section by section; the accuracy of the resulting mode shapes and corresponding natural frequencies depend on the accuracy to which these quantities are determined.

It is straightforward but tedious to determine most of these sectional quantities. The exceptions are the shear rigidity and the added mass of water, both of which possess some fundamental problems. The following discussion therefore concentrates on these two quantities.

The shear rigidity. Present methods for calculating shear rigidity range from semi-empirical formulas based on projected (vertical) areas to relatively complicated formulas based either on integration of the equations of three-dimensional elasticity theory [13, 14] or on exact formulas for the natural frequencies and mode shapes for prismatic beam-like structures [15, 16]. The capability of these methods to give proper shear stiffnesses has been investigated [16]. The conclusion [16] was that the shear stiffnesses derived from formulas proposed by Cowper [13] or Stephen [14] are superior to more semi-empirical formulas, partly because they eliminate the need for mode-dependent reduction of the bending rigidity due to shear lag effects; as, for instance, the reduction performed by Carlsen [1]. This observation has also been noted elsewhere [7].

The evaluation of shear rigidities by formulas of Cowper [13] or Stephen [14] requires calculation of the exact shear stress distribution in complicated thin-walled cross sections such as are found in ship structures. Computer programs able to perform these calculations have been reported [17, 18]. For ship sections, it has been found [16] that the shear rigidities obtained by the methods of Cowper [13] and Stephen [14] would be almost equal and only about one half the value obtained by the semi-empirical approach. A reduction in the bending rigidity is thus necessary if a semi-empirical formula for shear rigidity is used.

Added mass of water. The frequency range relevant for ship hull vibrations is usually so high that the free surface condition can be neglected when the added mass of water is calculated. Methods based on either fluid finite elements [11, 20] or Green's function [19] have recently been reported; they can be used to calculate the correct three-dimensional added mass distribution. However, such calculations are very time consuming even on large computers; therefore, simpler methods, based on two-dimensional (strip theory) solutions that have been modified by a correction factor (J-factor) for three-dimensional effects, are still valuable [3, 6].

Results obtained by three-dimensional source methods have been compared with those found using two-dimensional Lewis formulas multiplied by a J-factor derived exactly for a vibrating ellipsoid [19]. Remarkably good agreements were found for modes with ten or more nodes [19]. Similar results have been reported [20] in which the classic J-factor, derived by Kumai for prismatic Lewis sections of finite length, were verified by results obtained using fluid finite elements. Thus it seems that the simple approach based on a two-dimensional added mass distribution corrected by a J-factor derived either for an ellipsoid (preferable for ships with fine lines) or using Kumai's formula for Lewis' forms of finite length (preferable for full form ships) will yield a sufficient accurate added mass distributions for ship hull vibration analysis using the Timoshenko beam equations.

HORIZONTAL-TORSIONAL HULL VIBRATIONS

For ships that lack or have only modest hatch openings, the lowest natural frequencies for coupled horizontal-torsional vibration modes will usually be much higher than the natural frequencies corresponding to the lowest vertical vibration modes. However, the recent trend has been toward building ships with larger hatch openings, especially container ships. The torsional rigidity of such ships can be so small that the lowest natural frequencies for the coupled horizontal-torsional modes decrease to the magnitude of those corresponding to the lowest vertical vibration modes [21, 22, 24, 25]. These vibrations can be excited by waves [2] when a ship is sailing in an oblique seaway.

Analysis of the problem requires inclusion of warping deflections in the open parts of the hull beam; various beam formulations have been suggested. The Timoshenko-Vlasov theory has been used [22, 23, 25]; solution of the governing equations for the free, undamped vibration is achieved using either a matrix formulation [22], the transfer matrix method [23], or the Myklestad method [25]. A more general beam theory for the coupled horizontal-torsional vibrations has been derived [21]. This beam theory reduces to the Kollbrunner-Hajdin theory [26] in the case of a beam with double symmetric cross sections.

Implicit in the derivation of these beam formulations is that hull geometry changes smoothly only in the longitudinal direction. For ship structures this assumption does not hold, especially at the transitions between a deck with large hatch openings and closed sections at the forward and aft parts of the ship. In such transition areas the warping displacement pattern changes abruptly, yielding a highly incompatible longitudinal displacement field. In some cases this effect has not been accounted for [22, 23, 25]. However, in one instance [21] discontinuity conditions were formulated at these transitions in an effort to reduce the gap in the warping displacements; some orthogonality conditions were proposed. These discontinuity conditions have been validated with a numerical example solved by the finite element method.

CONCLUSION

Beam theories for the determination of pure ship hull vibration modes and corresponding natural frequencies are available. They seem to be able to predict reliable results for mode shapes of practical interest. Problems involving forced vibration analysis are due to uncertainties in estimating structural damping and the exciting forces due to waves.

It should be recognized that a number of assumptions are inherent in the beam theories available. Among these assumptions are:

- variations of longitudinal components in the cross sections are assumed small compared to the variation in the displacements. A beam theory [27] suggested without this assumption results in an extremely complicated theory, mainly due to the large number of sectional constants and derivatives needed. No numerical examples were given [27].

- cross sectional shapes are assumed to be undistorted. The argument is that transverse stiffening will prevent such deformation, but the effect of this assumption deserves further investigation.

- large nonstructural masses due to cargo and the added mass of water are neglected in calculating shear rigidity. The validity of this simplification also should be investigated.

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BOOK REVIEWS

STRUCTURAL DYNAMICS -- AN INTRODUCTION TO COMPUTER METHODS

R.R. Craig, Jr.
John Wiley & Sons, New York, NY
1981, 527 pages, $31.95

Are you adept in using structural dynamics to solve problems? If you are, this book will supplement your knowledge. If you are not, this book will provide guidance.

A number of recent books on structural dynamics present some of the basics of vibration theory but make no reference to computer programs. This book contains information about many facets of structural dynamics as well as an excellent discussion of principles and a number of examples and computer applications. It is also a pleasure to read.

The book consists of three parts divided into 20 chapters. Chapter 1 is a discourse on the science and art of structural dynamics. Chapter 2 introduces Part I, single-degree-of-freedom (SDOF) systems. Included are the mathematical models describing SDOF and a discussion and applications of virtual displacements. Chapter 3 is about free vibration of undamped and damped SDOF systems, including experimental determination of fundamental natural frequencies, damping factors, and an explanation of the role of coulomb damping in SDOF systems.

The next chapter includes the response of undamped SDOF systems to harmonic excitation, damped system response, vibration isolation, and complex frequency response. The chapter concludes with an explanation of the use of frequency response data in determinations of the natural frequency and damping factor of lightly damped SDOF systems.

Chapter 5 considers the response of SDOF systems to various shock type inputs; i.e., step, ramp, rectangular pulse, and unit impulse response. The author makes no mention of step-triangular pulse (the most severe) or sawtooth pulse but does describe the response of SDOF systems to general dynamic excitation using the Duhamel integral method.

Chapter 7 has to do with numerical evaluation of dynamic response and the Wilson θ method; that is, step by step integration for both linear and nonlinear systems. The reviewer feels that Newmark's beta method and Houbolt's method should have been included because they are used in a number of computer programs.

Chapter 8 has to do with the response of SDOF systems to periodic excitation; simple and complex Fourier transforms are used. The author provides a short but interesting explanation of the fast Fourier transform (FFT) as it is applied to digital signal analysis. The reviewer feels that a more detailed explanation of FFT would have been helpful because most present-day spectrum analyzers use FFT.

Part II introduces continuous systems; included are Newton's laws, Hamilton's principle, and Timoshenko beam theory. The reviewer believes that Dunkerley's rule should have been included.

Part III on multiple-degree-of-freedom (MDOF) systems is the heart of the book. Chapter 11 on mathematical modeling includes a good explanation of Newton's Law and the Lagrangian equation and their application to lumped parameter systems. The chapter concludes with constrained coordinates and Lagrangian multipliers. Chapter 12 focuses on vibration of undamped two-DOF systems; Chapter 13 is about the vibration of MDOF systems and includes a discussion of some properties of natural frequencies and natural modes. An interesting consideration of the Rayleigh-Ritz approach for obtaining approximate frequencies of MDOF systems is presented.

Chapter 14 describes methods for solving algebraic eigenproblems and vector iteration methods. Many books neglect the iteration procedure, which is powerful when properly applied. The author introduces his program ISMIS for solving eigenvalue problems. A more detailed listing of the program would have been useful.

Chapter 15 introduces the reader to mode-superposition methods, including mode-displacement and mode-acceleration as applied to determining dynamic stresses.

Chapter 16 introduces the reader to the finite element method (FEM). Included are beam elements (two and three dimensional), consistent mass matrices, and assembly of system matrices. Not included is shear deformation in the derivation of stiffness matrices. The chapter concludes with an introduction to reduction of degrees of freedom systems.

Chapter 17 shows how FEM can be used in vibration analysis. The author utilizes his ISMIS program and the Guyan reduction method.

Chapter 18 extends the direct integration method for SDOF to MDOF. Again, the author considers only the Wilson θ method. The chapter concludes with applications of time integration schemes (direct integration of the equations) and the required numerical integration algorithm.

Chapter 19 is on component mode synthesis. This powerful method enables the analyst to solve large structural dynamic problems by dynamic reduction methods or substructure coupling. The author begins with the well known Hurty method and goes on to system synthesis for undamped free vibration, attachment, inertia-relief attachment modes, and residual attachment modes. The auhor and his students have been developers of the latter. The author states that this powerful tool can be employed in damped systems but furnishes no referenced examples.

The concluding chapter has to do with response spectra used in seismic analysis. The material is interesting but too brief. The author does provide an illustrative example.

This is an excellent book. The reviewer would have preferred a section on matrix analysis and a section on random vibration. Transfer matrices should have been included because many programs utilize them in determinations of natural modes, eigenvectors, and responses. The reviewer recommends this book to both the advanced analyst and the neophyte.

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STRUCTURAL DYNAMICS -- AN INTRODUCTION TO COMPUTER METHODS

R.R. Craig, Jr.
John Wiley & Sons, New York, NY
1981, 527 pages, $31.95

Two decades ago dynamic analyses of many complex structural systems were not possible due to a lack of fast computational means. The advent of digital computers has led to the development of several numerical algorithms and computer codes that can be used to analyze complex structures. The numerical analysis of vibrating structures now widely known as structural dynamics is an extension of mechanical vibration.

Professor Craig has written an excellent text on the computer methods of structural dynamics. The book takes the reader systematically from the fundamentals of mechanical vibration and concepts of discrete and continuous systems to advanced computational methods. The 20 chapters are divided into three parts: I, single-degree-of-freedom (SDOF) systems; II, continuous systems; and III, multi-degree-of-freedom (MDOF) systems. The first chapter is an overview of the science and art of structural dynamics. Each chapter has a uniform format that emphasizes mathematical modeling and numerous solved examples. The consistency of sign convention is rarely found in other texts.

The analysis of SDOF systems is covered in chapters 2 through 8. In Chapter 2 Newton's laws and the principle of virtual displacements are used to formulate mathematical models. Damped free vibration and forced vibration responses to harmonic excitation are treated in Chapters 3 and 4. Chapter 4 covers a number of topics including the complex frequency response, vibration isolation, vibration measuring instruments, and structural damping. Forced vibration response to special forms of excitation and to general dynamic excitations are introduced in Chapters 5, 6, and 7.

Chapter 5 treats step, rectangular pulse, ramp, and impulse forcing functions. Chapter 6 deals with the Duhamel integral method. Chapter 7 describes two methods for numerical solutions of complex forms of excitation. The first method, the interpolation of the excitation function, is convenient for linear systems. The second method, approximation of derivatives in the differential equation of motion, can be used for linear and nonlinear systems.

The response of SDOF systems to periodic and non-periodic excitations is analyzed in chapter 8. The author introduces the concepts of real and complex Fourier series and the Fourier transform for aperiodic arbitrary excitation. The Fourier transform for breaking the excitation function into its frequency spectrum provides a link between frequency response and impulse response. These relationships are used to introduce the reader to some concepts of statistical properties of random processes. The reviewer feels that Part I would have been more complete if the author had added a chapter on the response of SDOF systems to random excitations.

Part II pertains to the modeling and the free vibrations of continuous systems. Chapter 9 deals with the modeling of beams under axial vibration and bending (Euler and Timoshenko beams) vibration and of shafts under torsional vibration. Newton's laws and Hamilton's principle are used to derive the partial differential equations of motion of these elements. The exact solution for the eigenvalue problem is described in Chapter 10. Some properties of natural modes including normalization, orthogonality, and the Rayleigh quotient are introduced. Chapter 10 also contains the eigenvalue analysis of a flat plate with a pair of simply supported opposite edges.

Part III is a major subject of the book and consists of ten chapters. It deals mainly with the numerical methods of MDOF systems. Chapter 11 demonstrates the application of Newton's laws and Lagrange's equation for modeling lumped parameter and continuous systems. For continuous models the assumed-modes method is introduced. The free and forced vibrations of undamped two-degree-of-freedom systems are solved in Chapter 12. This chapter also includes semi-definite systems that exhibit rigid body modes (zero eigenvalues).

Chapter 13 introduces a number of properties and natural modes of MDOF systems. The Rayleigh-Ritz method is also outlined in Chapter 13. Chapter 14 contains a review of three categories for numerical evaluation of modes and frequencies, among which are the vector iteration methods. The author introduces his code ISMIS (Interactive Structures and Matrix Interpretive System) for obtaining modes and frequencies of MDOF systems.

Chapter 15 treats the dynamic response of undamped systems and systems with a special form of viscous damping. The normal mode method is utilized to transform the coupled equations of the system into a set of uncoupled equations in terms of the principal coordinates. The mode-acceleration solution for the response of undamped MDOF systems is introduced as a means for improving the convergence of the mode-displacement solution.

The finite element method is introduced in Chapter 16. The author should be commended for the clarity and excellent presentation of this chapter. The element stiffness and mass matrices as well as the load vector for axial, bending, and torsion vibrations are formulated in terms of the element coordinate reference. Transformation of element matrices into the global coordinate frame is established. Procedures for the assembly of system matrices by the direct stiffness method for unconstrained and constrained systems are outlined. The numerical solution for the eigenvalue problem by the finite element method together with the ISMIS program are discussed in Chapter 17.

Chapter 18 deals with nonlinear systems and systems the response of which cannot be properly determined from the normal mode method. This chapter describes a number of numerical integration algorithms. Chapter 19 presents a class of reduction methods known as component mode synthesis or substructure coupling for dynamic analysis. The last chapter briefly treats the response of structures to earthquake excitations. It includes the response of SDOF and MDOF systems to earthquake-type base motion.

As a first edition the book contains a number of printing mistakes that should be eliminated in the next edition. A complete manual solution is expected to be available very soon. This book is highly recommended for undergraduate and graduate courses in mechanical vibration or structural dynamics. It is also recommended for those involved in using structural dynamic computer programs. The book in general is readable and clearly written.

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VIBRATION AND SOUND

P.M. Morse
American Institute of Physics, New York, NY
1981, 468 pages, $15.00

This reprint, a paperback version of the second edition of a book that was written in 1936, contains a mathematical development of the basic physical concepts of vibration and sound. The volume consists of an introductory chapter mostly devoted to mathematics, four chapters on vibrations, and three chapters on sound. Also included are a bibliography, a glossary, tables and graphs of mathematical and physical functions, and an index.

The concise chapters clearly present sufficient theory and problems to make the reader aware of the scope of each topic treated. The 14-page section on mathematics, for example, covers the range from trigonometric functions to Fourier transformations. (Throughout the other sections, even more mathematics are introduced when needed to elaborate the physics involved.)

The chapters on vibration take the reader from the theory of free and forced vibrations of a single-degree-of-freedom discrete system to the complex free and forced motions of continuous systems. Morse thus provides concepts that are necessary for the analysis of noise and vibration control, musical instrument design, and microphone response. However, the treatment of vibrations is directed at an explanation of sound rather than vibration control. He does not even discuss longitudinal vibrations of elements.

In treating sound the author uses the vibration concepts he introduced earlier to study the equations of motion of plane waves. He advances to sound propagation, radiation, and scattering and concludes with an exposition of standing waves.

The example problems at the end of each chapter are clearly stated. It is obvious, however, that some questions were posed prior to the introduction of portable electronic calculators.

The style of writing is excellent: Morse provides elegant treatments of both mathematics and physics. Each chapter naturally evolves from the previous ones, so that information given earlier in the book is reinforced and expanded in later chapters.

It is clear that Morse wrote a book that will become a classic in the field. I hope every reader of the **Digest** and every person who works in the field has read one of the editions of Vibration and Sound. This inexpensive paperback edition will give those who were not able to acquire a copy the opportunity to do so.

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SHORT COURSES

MARCH

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

Dates: March 7-11, 1983
Place: Washington, DC
Objective: Topics to be covered are resonance and fragility phenomena, and environmental vibration and shock measurement and analysis; also vibration and shock environmental testing to prove survivability. This course will concentrate upon equipments and techniques, rather than upon mathematics and theory.

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

EXPLOSION HAZARDS EVALUATION

Dates: March 14-18, 1983
Place: San Antonio, Texas
Objective: Fundamentals of combustion and transition to explosion including recent experimentation on large-scale systems, current testing techniques and their utility, accidental explosions, and preventive measures are reviewed. Free-field explosions and their characteristics including definition of an explosion, characteristics of explosions, and the fallacy of "TNT" equivalence are defined. Loading from blast waves such as reflected waves -- both normal and oblique, diffraction and diffracted loads, internal blast loading, and effects of venting will be covered. Structural response to blast and non-penetrating impact including approximate methods,the P-i concept, Bigg's methods, numerical methods, and applicable computer codes will be reviewed. Fragmentation and missile effects (trajectories and impact conditions), thermal effects (fireballs from explosions and radiation propagation), damage criteria (buildings, vehicles, and people), and design for blast and impact resistance (general guidelines, design using approximate methods, and computer-aided design) will be reviewed.

Contact: Ms. Deborah Stowitts, Southwest Research Institute, P.O. Drawer 28510, 6220 Culebra Road, San Antonio, TX 78284 - (512) 684-5111.

DYNAMIC BALANCING SEMINAR/WORKSHOP

Dates: March 16-17, 1983
April 27-28, 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, where each student will be involved in hands-on problem-solving using actual armatures, pump impellers, turbine wheels, etc. with emphasis on reducing costs and improving quality in balancing operations.

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

MAY

ROTOR DYNAMICS

Dates: May 23, 27, 1983
Place: Syria, Virginia
Objective: The role of rotor/bearing technology in the design, development and diagnostics of industrial machinery will be elaborated. The fundamentals of rotor dynamics; fluid-film bearings; and measurement, analytical, and computational techniques will be presented. The computation and measurement of critical speeds vibration response, and stability of rotor/bearing systems will be discussed in detail. Finite elements and transfer matrix modeling will be related to computation on mainframe computers, minicomputers, and microprocessors. Modeling and

computation of transient rotor behavior and nonlinear fluid-film bearing behavior will be described. Sessions will be devoted to flexible rotor balancing including turbogenerator rotors, bow behavior, squeeze-film dampers for turbomachinery, advanced concepts in troubleshooting and instrumentation, and case histories involving the power and petrochemical industries.

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

JUNE

MACHINERY VIBRATION ANALYSIS

Dates: June 14-17, 1983
Place: Nashville, Tennessee
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 topcis 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 DAMPING

Dates: June 19-22, 1983
Place: Dayton, Ohio

Objective: The utilization of the vibration damping properties of viscoelastic materials to reduce structural vibration and noise has become well developed and successfully demonstrated in recent years. The course is intended to give the participant an understanding of the principles of vibration damping necessary for the successful application of this technology. Topics included are: damping fundamentals, damping behavior of materials, response measurements of damped systems, layered damping treatments, tuned dampers, finite element techniques, case histories, problem solving sessions.

Contact: Michael L. Drake, Kettering Laboratory 104, 300 College Park Avenue, Dayton, OH 45469 - (513) 229-2644.

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

Call for Papers

SECOND INTERNATIONAL CONFERENCE ON RECENT ADVANCES IN STRUCTURAL DYNAMICS

April 9-13, 1984
Southampton, England

The Second International Conference on Recent Advances in Structural Dynamics, sponsored by the Institute of Sound and Vibration Research, the University of Southampton, England and supported by the Air Force Wright Aeronautical Laboratories will be held April 9-13, 1984 in Southampton, England.

Papers are solicited in the following areas:

- Analytical/Numerical Methods -- including deterministic and random vibrations, nonlinear vibration, response to shock loads, structure-fluid and structure-acoustic interaction, finite element methods, boundary element methods.

- Experimental Techniques -- including development in testing techniques, acquisition and analysis of vibration data, system identification, interpretation of experimental data for vibration control.

- Materials and Fatigue – including composite structures, damping materials, fatigue life estimation.

- Structural Applications -- including aircraft, spacecraft, ships/submarines, off-shore structures, land vehicles, buildings, bridges, nuclear reactors, machinery, active and passive vibration control.

Authors wishing to offer a paper should mail 5 copies of a 500 word abstract of proposed papers for the Nonlinear Vibration session to Howard F. Wolfe, AFWAL/FIBED, Wright-Patterson AFB, OH 45433 - (513) 255-5229; and proposed papers to all other sessions to Dr. Maurice Petyt, Institute of Sound and Vibration Research, The University of Southampton, S09 5NH, England - (0703) 559122 Ext 2297.

Abstracts must be received by April 4, 1983. The abstract must include the name, company affiliation, telephone number and complete mailing address for each author. Authors will be notified of acceptance/rejection of their papers by June 6, 1983. Final manuscripts are to be prepared by mid August.

FLUID POWER LABORATORY ESTABLISHED BY OHIO STATE UNIVERSITY

The Department of Mechanical Engineering at The Ohio State University is establishing a Fluid Power Laboratory whose primary goal is to conduct research and educate undergraduate and graduate students in the field of fluid power. This laboratory has been initiated through a recent grant from the Fluid Power Educational Foundation; however, the bulk of its support will be derived from an industrial consortium of fluid power companies in the state of Ohio. The laboratory activities will be governed by the recommendations of the Advisory Board consisting of industrial sponsors and participating faculty.

The Department of Mechanical Engineering is already heavily involved in fluid power research and development activities supported by industry and government. Typical projects deal with positive displacement pumps and compressors, power actuators and shock absorbers, digital control of hydraulic systems, robotic applications, and fluid transients. The Department also operates two other industrial consortiums -- Advanded Design Methods Laboratory, and Gear Dynamics and Gear Noise Research Laboratory, which have acquired national leadership roles.

The "kick-off" meeting of the Laboratory took place on December 17, 1982 with representatives from a number of industrial organizations. At this meeting the objectives and structure of the Fluid Power Laboratory were discussed. A tour of the Mechanical Engineering facilities and laboratories, with emphasis on the fluid power research projects, was also conducted. The next organizational meeting will be held in the spring of 1983.

For more information contact: Professor Rajendra Singh, Director, Fluid Power Laboratory, Department of Mechanical Engineering, The Ohio State University, 206 W. 18th Avenue, Columbus, OH 43210 - (614) 422-9044/2289.

ABSTRACTS FROM THE CURRENT LITERATURE

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

ABSTRACT CONTENTS

MECHANICAL SYSTEMS

ROTATING MACHINES

(Also see Nos. 306, 307)

83-239
Rotor Wake Characteristics Relevant to Rotor-Stator Interaction Noise Generation
L.M. Shaw and J.R. Balombin
NASA Lewis Res. Ctr., Cleveland, OH, J. Aircraft, 19 (11), pp 954-962 (Nov 1982) 16 figs, 2 tables, 24 refs

Key Words: Interaction: rotor-stator, Noise generation

Mean and turbulence wake properties at three axial locations behind the rotor of an aerodynamically loaded 1.2 pressure ratio fan were measured using a stationary cross-film anemometer in an anechoic wind tunnel. Wake characteristics at four radial immersions across the duct at four different fan speeds were determined utilizing a signal enhancement technique. The shapes of the waveforms of the mean rotor relative and mean upwash velocities were shown to change significantly across the span of the blades. An increase in fan rotational speed caused an increase in the maximum wake turbulence intensity levels near the hub and tip. Spectral analysis was used to describe the complex nature of the rotor wake.

83-240
The Stability of a Rigid Rotor in Ruptured Finite Journal Bearings
W.A. Crosby
Mech. Engrg. Dept., Faculty of Engrg., Univ. of Alexandria, Alexandria, Egypt, Wear, 80 (3), pp 333-346 (Sept 1, 1982) 9 figs, 20 refs

Key Words: Rotors, Rigid rotors, Bearings, Journal bearings, Fluid film bearings, Unbalanced mass response

The plane motion stability of a rigid rotor supported in fluid film journal bearings having a finite length and subjected to a steady external load and an unbalance load is theoretically analyzed. Oil whirl is investigated for a ruptured film under separation boundary conditions. The nonlinear equations of motion are solved by using numerical methods. Journal center trajectories are obtained for different conditions of loading and speed.

83-241
A Discrete Model for Nonlinear Structural Dynamics of Rotating Cantilevers
M. El-Essawi
Ph.D. Thesis, Duke Univ., 262 pp (1982)
DA8221143

Key Words: Rotors, Cantilever beams, Rotating structures, Geometric imperfection effects, Computer programs

A general geometrically nonlinear discrete mathematical model governing the dynamic behavior of a rotating cantilever with initial geometric imperfections, and with arbitrary orientation with respect to the axis of rotation, is developed. The model consists of a set of second order quasi-linear ordinary differential equations of motions for coupled axial-bending-torsion deformations. The derivation of the model is based on the extended Hamilton principle for elastodynamics. A general purpose computer program for the systematic generation and application of the discrete model is described.

RECIPROCATING MACHINES

(Also see No. 426)

83-242
Analysis and Control of Mechanical Noise in Internal Combustion Engines
N.E. Parsons, R.G. DeJong, and J.E. Manning
Cambridge Collaborative, Inc., MA, Rept. No. EPA-550/9-82-334, 96 pp (July 1982)
PB82-247925

Key Words: Internal combustion engines, Noise reduction, Noise source identification, Diagnostic techniques, Elastomeric bearings, Acoustic linings

This report reviews the state-of-the-art for internal combustion engine noise reduction and presents new techniques for reducing engine block vibration and radiated noise. A vibration analysis technique based on measured mobilities was developed as a diagnostic tool for identifying noise sources and vibration transmission paths. This technique makes it possible to identify and rank order the sources of noise within the engine. New design techniques using resilient bearings and modified cylinder liners are also described.

METAL WORKING AND FORMING

(See No. 408)

STRUCTURAL SYSTEMS

BRIDGES

83-243

The Vibrational Behaviour of Three Composite Beam-Slab Bridges

P.J. Moss, A.J. Carr, and G.C. Pardoen
Dept. of Civil Engrg., Univ. of Canterbury, Christchurch, New Zealand, Engrg. Struc., 4 (4), pp 277-288 (Oct 1982) 11 figs, 9 tables, 7 refs

Key Words: Bridges, Beams, Prestressed concrete, Vibration analysis

Field measurements of the vibrational frequencies of three bridges with prestressed concrete beams and in situ concrete deck slabs are described. In each bridge, the beams are simply supported over each span while the composite deck is continuous over three or four spans with short, full width, crumple slabs between the beam diaphragms over each pier. Analytical analyses were also carried out and compared with the field measurements. Values are also given for the damping determined from the tests.

83-244

Dynamic Tests and System Identification of Bridges

B.M. Douglas and W.H. Reid
Dept. of Civil Engrg., Univ. of Nevada, Reno, NV 89557, ASCE J. Struc. Div., 108 (ST10), pp 2295-2312 (Oct 1982) 10 figs, 4 tables, 34 refs

Key Words: Bridges, Reinforced concrete, System identification techniques, Dynamic tests, Seismic response, Interaction: soil-structure

A five-span, four-hundred-foot long, reinforced concrete box girder bridge supported on single column piers that are pile-founded was subjected to extensive dynamic tests. The pullback and quick-release method of excitation was used. Two D-8 crawler tractors were used to apply total release loads that had a magnitude of about one-quarter of the earthquake design loads. The transverse mode shapes and natural frequencies obtained from these tests were used in conjunction with the system identification procedure outlined herein. By using these techniques, it is possible to identify the in situ dynamic stiffnesses of the pier foundations as well as the abutment structures.

BUILDINGS

83-245

A Scale Model Investigation of Sound Radiation from a Large Aperture in a Building

D.J. Oldham and Y. Shen
Dept. of Bldg. Science, Univ. of Sheffield, Sheffield S10 2TN, UK, Appl. Acoust., 15 (6), pp 397-409 (Nov 1982) 7 figs, 2 tables, 7 refs

Key Words: Buildings, Openings, Sound waves, Model testing

A scale model study of sound radiated from the most severe acoustic point of a facade of a building; namely a large aperture, is described. Measurements were made on a 1:20 scale model and the experimental results were compared with the predictions of a simple theoretical model.

83-246

Cross-Wind Response of Tall Buildings

K.C.S. Kwok
School of Civil and Mining Engrg., The Univ. of Sydney, Sydney, Australia, Engrg. Struc., 4 (4), pp 256-262 (Oct 1982) 5 figs, 3 tables, 16 refs

Key Words: Buildings, Wind-induced excitation, Random vibration, Displacement analysis, Acceleration analysis, Design procedures

A design procedure was developed using random vibration theory and uses mode-generalized cross-wind force spectra and aerodynamic data to calculate the cross-wind displacement and acceleration responses of tall buildings. The force spectra of a number of building shapes and sizes in both suburban and city center type wind flow are presented. The proposed design procedure gives reasonable estimates of the

cross-wind response, compared with wind tunnel measurements, at reduced wind velocities and at structural damping values consistent with modern habitable tall building design.

83-247
Modal Damping for Torsionally Coupled Buildings on Elastic Foundation
T. Balendra, C.W. Tat, and S.-L. Lee
Dept. of Civil Engrg., Natl. Univ. of Singapore, Singapore, Intl. J. Earthquake Engrg. Struc. Dynam., 10 (5), pp 735-756 (Sept/Oct 1982) 8 figs, 4 tables, 23 refs

Key Words: Buildings, Elastic foundations, Modal damping, Normal modes, Seismic response

A method to determine the approximate normal modes and the modal damping for torsionally coupled buildings on an elastic foundation is presented. The modal damping is determined by an iterative procedure which matches the approximate normal mode solution with the rigorous solution. The response quantity to be matched is selected in a consistent and logical manner. The normal modes and the damping ratios thus found are then used to determine the seismic response of the interaction system by the response spectrum technique.

83-248
Torsional Provisions in Building Codes
W.K. Tso and V. Meng
McMaster Univ., Hamilton, Ontario, Canada L8S 4L7, Can. J. Civil Engrg., 9 (1), pp 38-46 (Mar 1982) 12 figs, 14 refs

Key Words: Buildings, Seismic response, Torsional response, Standards and codes

A study is made of the accuracy of the static code provisions on torsional effects, with special reference to the National Building Code of Canada of 1977. A uniform frame type monosymmetric 12-story building is used as an example. The static story torque is compared with the dynamic torque computed using the response spectrum technique as outlined in Commentary K of the Code.

83-249
Motions of Rigid Bodies and Criteria for Overturning by Earthquake Excitations
Y. Ishiyama
Intl. Inst. of Seismology and Earthquake Engrg., Bldg. Res. Inst., Ministry of Construction, Govt. of Japan, Tatehara 1, Oho-Machi, Tsukuba-Gun, Ibaraki-Ken, Japan, Intl. J. Earthquake Engrg. Struc. Dynam., 10 (5), pp 635-650 (Sept/Oct 1982) 15 figs, 3 tables, 16 refs

Key Words: Buildings, Floors, Earthquake response

This investigation deals with motions of rigid bodies on a rigid floor subjected to earthquake excitations and criteria for overturning of the bodies. The motions are classified into six types: rest, slide, rotation, slide rotation, translation jump and rotation jump. The equations of motion, transitions of motion, and motions after impact between the body and the floor are studied. One of the features of this investigation is the introduction of the tangent restitution coefficient which enables one to estimate the magnitude of the tangent impulse at the instant of impact. A computer program was developed to simulate the motions of bodies subjected to horizontal and vertical ground motions, numerically solving the non-linear equations of motion.

TOWERS

83-250
Structural Reliability and Cross-Wind Response of Tall Chimneys
R.V. Milford
Natl. Bldg. Res. Inst., CSIR, Pretoria, South Africa, Engrg. Struc., 4 (4), pp 263-270 (Oct 1982) 9 figs, 3 tables, 23 refs

Key Words: Chimneys, Wind-induced excitation

The structural safety of tall industrial chimneys at lock-in is investigated in terms of upcrossing probabilities. In this manner the inherent random nature of the load, as well as the uncertainties in the description of the load, are accounted for. Peak factors and load factors in excess of those currently used in codes of practice are obtained.

FOUNDATIONS

83-251
Reliability Procedure for Fixed Offshore Platforms
W.D. Anderson, M.N. Silbert, and J.R. Lloyd

Exxon Co. USA, New Orleans, LA, ASCE J. Struc. Div., 108 (ST11), pp 2517-2538 (Nov 1982) 14 figs, 3 tables, 13 refs

Key Words: Pile foundations, Foundations, Off-shore structures, Drilling platforms, Wave forces

A method of calculating the "notional" risk of overload associated with fixed offshore platforms subjected to random wave loading is presented. The lifetime exposure of the structure to potentially damaging storms is treated within a rigorous mathematical framework. The procedure used to establish the long term extreme wave load distribution is emphasized. This procedure utilizes presently available oceanographic information in a statistical model of the wave environment. The composite probability of exceedance associated with all significant loading events is computed for a lifetime exposure to the ocean environment.

83-252
Dynamic Behaviour of Rigid Foundations of Arbitrary Shape on a Halfspace
W. Rücker
Bundesanstalt f. Materialprüfung (BAM), Berlin, W. Germany, Intl. J. Earthquake Engrg. Struc. Dynam., 10 (5), pp 675-690 (Sept/Oct 1982) 12 figs, 1 table, 25 refs

Key Words: Plates, Rigid foundations, Viscoelastic halfspace, Approximation methods, Green function

An approximate method for computation of the compliance functions of rigid plates resting on an elastic or visco-elastic halfspace excited by forces and moments in all degrees of freedom is presented. The method is based on a Green's function approach. These functions are given for all degrees of freedom in form of well-behaved integrals.

83-253
Convolution Analysis in the Seismic Soil-Structure Interaction
G. Marmureanu
Ctr. of Earth Physics and Seismology, Bucharest, Romania, Rev. Roumaine Sci. Tech., Mecanique, Appl., 27 (3), pp 373-389 (May/June 1982) 7 figs, 2 tables, 6 refs

Key Words: Interaction: soil-structure, Seismic response, Convolution analysis

The use of the convolution analysis enabled the identification of the amplification spectrum (amplification function) of a system site consisting of horizontally stratified layers overlying a homogeneous half-space. The amplification spectrum obtained by using dynamic parameters (shear modulus, damping ratio, etc.) for each layer from the resonant column apparatus for shear strain amplitudes between 0.0001% and 0.55% is different from that found by classical methods when constant dynamic parameters are assumed for each layer from the system.

83-254
The Effects of Anisotropy and Strain on the Dynamic Properties of Clay Soils
G.F. Bianchini
Ph.D. Thesis, Case Western Reserve Univ., 327 pp (1982)
DA8217676

Key Words: Clays, Dynamic properties

The dynamic behavior of clay has been intensively investigated in the last twenty years in the framework valid only for isotropic materials. Recently researchers have started thinking in terms of the fabric anisotropy resulting from the deposition and the one-dimensional consolidation of clay in nature. It is well established that this process results in clay particles being arranged, and bonds being created, such that the material is cross anisotropic with the axis of symmetry along the direction of consolidation. In this study a specially designed resonant column is used in which thin long hollow cylinders can be K_0-consolidated. Both longitudinal and torsional vibrations can be performed to determine the specimens moduli and damping ratios. Testing both horizontal and vertical specimens results in enough information to determine the elastic stress-strain equation for the cross-anisotropic material.

UNDERGROUND STRUCTURES

(Also see No. 293)

83-255
Seismic Behavior and Design of Urban Area Tunnel Linings
S.C. Anand and J.C. Parekh
Dept. of Civil Engrg., Clemson Univ., SC, Rept. No.

NSF/CEE-82022, 103 pp (Jan 1982)
PB82-249038

Key Words: Tunnel linings, Seismic response

Research to ascertain the influence of superimposed concentrated footing loads of buildings on shallow, buried rigid pipes in urban areas in the event of an earthquake is summarized. Static analyses using the finite element technique are performed for various loading conditions, and dynamic analyses are performed on the finite element model of the system using both linear and nonlinear soil properties.

HARBORS AND DAMS

83-256

Natural Frequencies of Arch Dam Reservoir Systems -- By a Mapping Finite Element Method

B. Nath
Faculty of Engrg., Queen Mary College, Univ. of London, London, UK, Intl. J. Earthquake Engrg. Struc. Dynam., 10 (5), pp 719-734 (Sept/Oct 1982) 11 figs, 1 table, 20 refs

Key Words: Dams, Natural frequencies, Mode shapes, Finite element technique

A simple mapping finite element method is used to calculate the coupled natural frequencies and mode shapes of realistic arch dam reservoir systems in which the dam is circular cylindrical with non-uniform cross-section. This method, in which both the dam and the reservoir domains are mapped into geometrically simpler shapes using cylindrical-polar transformations, is found to give accurate results, achieved simply and economically.

ROADS AND TRACKS

83-257

The Prediction of Track Performance under Dynamic Traffic Loading

H.E. Stewart
Ph.D. Thesis, Univ. of Massachusetts, 365 pp (1982)
DA8219853

Key Words: Railroad tracks, Moving loads

Track performance was assessed in terms of vertical track settlement, and the factors that contribute to these settlements at specific field sites. The sites consisted of in-service revenue track having concrete and wood cross-ties and wood and concrete tie sections from the DOT Facility for Accelerated Service Testing. Field tests were conducted to assess the physical states of the ballast materials prior to a track maintenance operation. The physical state tests were repeated after the surfacing to determine the resulting changes in the ballast properties. Standard penetration tests, Dutch cone tests, and undisturbed tube sampling for laboratory tests were used to investigate the subgrade. The dynamic wheel load distributions at each site were measured. A method was presented to account for the mix of wheel loads that contributed to the track deformations.

POWER PLANTS

(Also see No. 409)

83-258

Seismic Analysis of PWR-RCC Fuel Assemblies

A. Preumont, P. Thomson, and J. Parent
Belgonucleaire S.A., Rue du Champ de Mars 25, B-1050 Bruxelles, Belgium, Nucl. Engrg. Des., 71 (1), pp 103-119 (July 1982) 15 figs, 8 tables, 15 refs

Key Words: Nuclear reactor components, Nuclear fuel elements, Seismic excitation, Natural frequencies, Computer programs

The dynamic behavior of PWR-RCC fuel assemblies under seismic excitation is investigated. A simple vibrational model of the fuel assembly is proposed, which leads to natural frequencies whose spacing agree with experimental data. Available experimental results are reviewed. Impact characteristics of Zircaloy spacer grids are also discussed.

83-259

Computation of Hydraulic Resonance for Hydroelectric Plants in the Case of Complex Schemes

A. Halanay and M. Popescu
Univ. of Bucharest, Romania, Rev. Roumaine Sci. Tech., Mecanique Appl., 27 (3), pp 325-345 (May/June 1982) 4 figs, 4 refs

Key Words: Power plants (facilities), Hydroelectric power plants, Hydraulic resonance, Resonant frequencies

Resonance in hydroelectric plants is studied for the case of the basic hydraulic scheme with two surge tanks in the system and for the following complex hydraulic schemes:

parallel system of surge tanks, complex hydraulic system with two accumulations and three surge tanks, complex hydraulic system with n surge tanks on the admission gallery, and complex hydraulic system with n accumulations and one surge tank.

83-260
Advantages of Using a Node-Oriented Sparse-Matrix Solver in Nuclear Plant Dynamic Analyses
K.R. Leimbach and C. Zeller
Institut f. Konstruktiven Ingenieurbau, Ruhr-Universität, Postfach 102148, D-4630 Bochum, W. Germany, Nucl. Engrg. Des., 70 (1), pp 85-100 (June 1982) 7 figs, 5 tables, 4 refs

Key Words: Nuclear power plants

Nuclear plant dynamic analyses are commonly carried out by directly integrating the equations of motion of the model or by using the free vibration characteristics with methods based on modal decomposition. In both approaches a large system of linear equations with little or no change in the coefficient matrix has to be solved repeatedly, either in the eigensolver or in the time integrator. The efficiency of the linear equation solver determines, to a large extent, the cost of the numerical production. The present linear equation solver has been designed to meet a number of objectives. The system matrices are assembled in terms of node-oriented submatrices instead of individual coefficients. Nodal quantities considered are not restricted to displacements. The Gauss elimination scheme is geared to sparseness rather than bandedness of the coefficient matrix. Matrix decomposition, and forward and backward substitutions, are separated.

OFF-SHORE STRUCTURES

83-261
Wave and Earthquake Response of Offshore Structures: Evaluation of Modal Solutions
S.A. Anagnostopoulos
Inst. of Engrg. Seismology and Earthquake Engrg., Hapsa 1, Thessaloniki, Greece, ASCE J. Struc. Div., 108 (ST10), pp 2175-2191 (Oct 1982) 7 figs, 5 tables, 12 refs

Key Words: Off-shore structures, Wave forces, Seismic response, Modal analysis

Direct numerical integration of the equations of motion is used to evaluate the adequacy of modal solutions, as applied to the analysis and design of large offshore structures under wave and earthquake loadings. Two such solutions are considered: mode acceleration and simple modal superposition.

VEHICLE SYSTEMS

GROUND VEHICLES

(Also see Nos. 295, 302, 364, 405)

83-262
Plastic Hinge Approach to Vehicle Crash Simulation
P.E. Nikravesh, I.S. Chung, and R.L. Benedict
Ctr. for Computer Aided Design, College of Engrg., Univ. of Iowa, Iowa City, IA 52242, Computers Struc., 16 (1-4), pp 395-400 (1983) 10 figs, 17 refs

Key Words: Collision research (automotive), Simulation

This paper presents a computer-based method for formulation and efficient solution of nonlinear, constrained differential equations of motion for spatial dynamic analysis of mechanical systems and its application to vehicle crash simulations. The program can be used to analyze plastic deformations of structures by employing a plastic hinge concept.

83-263
Engine Compartment Encapsulation on the VW Golf (Karosserieseitige Geräuschkapsel am VW Golf)
H. Hartwig and B. Staudinger
Gaussstrasse 4, 3180 Wolfsburg 1, Automobiltech. Z., 84 (9), pp 411, 412, 415, 416, 421 (Sept 1982) 9 figs, 3 refs
(In German)

Key Words: Noise reduction, Ground vehicles

Some standard VS Golf models with different engine units (petrol engine with manual and automatic gearbox and Diesel engine with manual gearbox) were encapsulated by enclosing the bottom of the engine compartment with a sheet panel. Using absorbing materials on the sheet and under the bonnet and a quieter muffler system, the exterior drive

noise (excluding tire noise) could be reduced by up to 8 dB(A) depending on the engine unit used.

83-264

Development and Testing of Passenger Car Seats (Entwicklung und Erprobung von Sitzen für Personenkraftwagen)

H.-G. Haldenwanger

Automobiltech. Z., 84 (9), pp 437-442, 445 (Sept 1982) 14 figs, 9 refs

(In German)

Key Words: Automobile seats, Vibration tests, Design techniques

The effects of vibration, ergonomics, orthopedics, temperature and humidity on the economic and functional shaping and design of seats in cars are investigated using an Audi all-foam seat as an example.

83-265

Identification of the System Vehicle-Road Parameters

O. Kropáč and J. Šprinc

Aeronautical Res. and Test Inst., Prague-Letnany, Czechoslovakia, Vehicle Syst. Dynam., 11 (4), pp 241-249 (Sept 1982) 2 figs, 1 table, 5 refs

Key Words: Ground vehicles, Interaction: wheel-pavement, Interaction: road-vehicle, Parameter identification technique

A simple and quick method for estimating the parameters governing vehicle motion caused by road vehicle interaction is presented.

83-266

Track Train Dynamics Analysis and Test Program: Methodology Development for the Derailment Safety Analysis of Six-Axle Locomotives

P.P. Marcotte and K.J.R. Mathewson

Martin Marietta Aerospace, Denver, CO, Rept. No. NASA-CR-162026, 161 pp (May 1982)

N82-26047

Key Words: Locomotives, Railroad tracks, Interaction: rail-vehicle, Suspension systems (vehicles)

The operational safety of six-axle locomotives is analyzed. A locomotive model with corresponding data on suspension characteristics, a method of track defect characterization, and a method of characterizing operational safety are used. A user oriented software package is developed as part of the methodology and used to study the effect (on operational safety) of various locomotive parameters and operational conditions such as speed, tractive effort, and track curvature.

83-267

Digital Simulation of the Dynamic Response of a Vehicle Carrying Liquid Cargo on a Random Uneven Surface

R.S. Khandelwal and N.C. Nigam

Dept. of Mech. and Industrial Engrg., Univ. of Roorkee, Roorkee, 247672, India, Vehicle Syst. Dynam., 11 (4), pp 195-214 (Sept 1982) 7 figs, 2 tables, 7 refs

Key Words: Tank cars, Railroad cars, Containers, Fluid-filled containers, Rail transportation, Sloshing, Digital simulation, Track roughness

The dynamic response of a railway wagon carrying liquid cargo on a railway track is investigated. The dynamic behavior of the sloshing liquid-mass is considered through its mechanical model. Two vehicle-liquid system models are considered to determine the dynamic response of the system moving with constant acceleration.

83-268

Structural Optimization, Dynamic Performance and Stress Analysis of a Bulkhead Flat Car

Y.L. Wang

Ph.D. Thesis, Illinois Inst. of Tech., 146 pp (1982)

DA8220269

Key Words: Railroad cars, Freight cars

A study was made of a particular design of 100-ton bulkhead flat car. The first part was devoted to the statical optimization. A finite element model and mathematical optimization technique were developed and used to find the most practical engineering design of the car. The second part was devoted to a study of the dynamic performance of the car, including the roll angle, lateral acceleration, center plate loads, side bearing loads, wheel loads and spring deflection.

In the third section, a dynamic stress analysis of the car's underframe was performed.

SHIPS

83-269

Experimental Program for the Determination of Hull Structural Damping Coefficients

P.Y. Chang and T.P. Carroll

Res. Lab., U.S. Steel Corp., Monroeville, PA, Rept. No. SSC-306, 85 pp (Sept 1981)

AD-A117 058

Key Words: Ship hulls, Damping coefficients, Vibration damping, Testing techniques

A program of full-scale and model experiments for the determination of hull damping coefficients is outlined. A literature survey discusses available data for ship vibration damping, and assesses analytical and experimental techniques used in the past.

AIRCRAFT

(Also see Nos. 365, 366)

83-270

Advanced Facility for Processing Aircraft Dynamic Test Data

D.J. Stouder

Douglas Aircraft Co., Long Beach, CA, J. Aircraft, 19 (11), pp 990-998 (Nov 1982) 14 figs, 2 tables, 2 refs

Key Words: Aircraft, Dynamic tests, Experimental test data, Data processing

An advanced facility has been developed to meet future requirements for processing aircraft dynamic test data. The capabilities of this facility are described using examples from a variety of flight and laboratory tests of commercial and military transport airplanes.

83-271

Designing for Aircraft Structural Crashworthiness

R.G. Thomson and C. Caiafa

NASA Langley Res. Ctr., Hampton, VA, J. Aircraft, 19 (10), pp 868-874 (Oct 1982) 11 figs, 1 table, 34 refs

Key Words: Aircraft, Crash research (aircraft), Dynamic tests, Computer programs, Crashworthiness

This report describes structural aviation crash dynamics research activities being conducted on general aviation aircraft and transport aircraft. The report includes experimental and analytical correlations of load-limiting subfloor and seat configurations tested dynamically in vertical drop tests and in a horizontal sled deceleration facility. Computer predictions using a finite-element nonlinear computer program, DYCAST, of the acceleration time histories of these innovative seat and subfloor structures are presented.

83-272

Attenuation of Propeller-Related Vibration and Noise

J.F. Johnston and R.E. Donham

Lockheed-California Co., Burbank, CA, J. Aircraft, 19 (10), pp 858-867 (Oct 1982) 20 figs, 3 tables, 17 refs

Key Words: Aircraft, Propeller induced excitation, Interior noise, Interior vibration, Noise reduction, Vibration control

The potential sources and paths by which a propeller produces structural responses resulting in vibration and noise in the cabin of a transport aircraft are discussed. New low-cost, convenient experimental and analytical techniques are described for evaluating the excitations -- propeller airborne pressures on the fuselage shells, slip-stream-induced forces on the wing and tail, and oscillatory forces on the propeller.

83-273

In-Flight Structural Dynamic Characteristics of the XV-15 Tilt-Rotor Research Aircraft

J.M. Bilger, R.L. Marr, and Z. Zahedi

Bell Helicopter Textron, Fort Worth, TX, J. Aircraft, 19 (11), pp 1005-1011 (Nov 1982) 24 figs, 3 refs

Key Words: Aircraft, Tilt rotor aircraft, Airframes, Natural frequencies, Flight test data

The XV-15 tilt-rotor research aircraft has recently completed a contractor flight test program. During these development and envelope expansion flights, the aircraft has been tested up to a maximum true airspeed of 557 km/h (346 mph, 301 knots). Results of the structural characteristics obtained during this testing are presented. Included is a discussion concerning the rotor and airframe loads, natural frequency placements, airframe control system interaction, and wing/rotor/pylon aeroelastic stability. Measured data are compared with predicted values for many cases.

83-274

Dynamics and Control of a Heavy Lift Airship Hovering in a Turbulent Cross Wind

B.L. Nagabhushan and N.P. Tomlinson
Goodyear Aerospace Corp., Akron, OH, J. Aircraft, 19 (10), pp 826-830 (Oct 1982) 11 figs, 7 refs

Key Words: Aircraft, Vertical takeoff aircraft, Wind-induced excitation

Dynamics and control characteristics of a quadrotor heavy lift airship with a sling load are determined while the vehicle is hovering in a turbulent cross wind. Results are presented which show the significance of the dynamic coupling between the vehicle and payload in their response to wind disturbances and control inputs. Typical characteristics of a closed-loop control system and its ability to limit the excursions of the vehicle and payload during loading or unloading are also examined.

83-275

Nonlinear Transonic Flutter Analysis

C.J. Borland and D.P. Rizzetta
Boeing Military Airplane Co., Seattle, WA, AIAA J., 20 (11), pp 1606-1615 (Nov 1982) 6 figs, 41 refs

Key Words: Aircraft wings, Flutter

A numerical procedure is presented for predicting the static and dynamic aeroelastic characteristics of thin, clean swept wings in transonic flow. The method is based upon the simultaneous time integration of the equations governing the coupled nonlinear fluid dynamic and structural aeroelastic system. Governing equations for the system are developed and the numerical algorithm, including the coupling procedure for their solution, is discussed.

83-276

Prediction of Transonic Flutter for a Supercritical Wing by Modified Strip Analysis

E.C. Yates, Jr., E.C. Wynne, M.G. Farmer, and R.N. Desmarais
NASA Langley Res. Ctr., Hampton, VA, J. Aircraft, 19 (11), pp 999-1004 (Nov 1982) 9 figs, 15 refs

Key Words: Aircraft wings, Flutter, Finite strip method

It is shown that use of a supercritical airfoil can adversely affect wing flutter speeds in the transonic range. A modified strip analysis is used to predict the transonic flutter boundary for the supercritical wing. The steady-state spanwise distributions of the section lift-curve slope and aerodynamic center, required as input for the flutter calculations, were obtained from pressure distributions.

83-277

Sensitivity Analysis and Optimization of Aeroelastic Stability

A.P. Seyranian
Inst. for Problems in Mechanics, USSR Academy of Sciences, Moscow 117526, USSR, Intl. J. Solids Struc., 18 (9), pp 791-807 (1982) 12 figs, 42 refs

Key Words: Aircraft wings, Flutter, Optimization

This paper deals with problems concerning sensitivity analysis and optimization of aeroelastic stability of distributed systems. The optimization problem of aeroelastic stability of a slender wing in incompressible flow is formulated and solved. The problem of determining the optimal distribution of nonstructural mass along the wing span is considered.

83-278

Application of Modal Control to Wing-Flutter Suppression

A.J. Ostroff and S. Pines
NASA Langley Res. Ctr., Hampton, VA, Rept. No. NASA-TP-1983, 73 pp (May 1982)
N82-24209

Key Words: Aircraft wings, Active flutter control

A discrete modal control design approach that is applied to a single control surface, unswept aircraft wing subject to bending torsion flutter is described. The modal approach is a mathematical method to decouple the equations of motion into isolated differential equations. In this paper, a pole-placement approach is then applied to determine stability gains in the discrete plane using only the two complex-conjugate flutter-mode equations.

83-279

Analysis and Flight Data for a Drone Aircraft with Active Flutter Suppression

J.R. Newsom and A.S. Pototzky
NASA Langley Res. Ctr., Hampton, VA, J. Aircraft, 19 (11), pp 1012-1018 (Nov 1982) 13 figs, 1 table, 16 refs

Key Words: Aircraft, Active flutter control, Flight test data

A comparison of analysis and flight test data for a drone aircraft equipped with an active flutter suppression system is presented. Emphasis is placed on the comparison of modal dampings and frequencies as a function of Mach number. Results are presented for both symmetric and antisymmetric motion with flutter suppression off. Only symmetric results are presented for flutter suppression on.

83-280

Eigenspace Techniques for Active Flutter Suppression

W.L. Garrard
Inst. of Tech., Univ. of Minnesota, Minneapolis, MN, Rept. No. NASA-CR-168931, 116 pp (Mar 31, 1982) N82-24206

Key Words: Aircraft, Active flutter control, Wind-induced excitation, Computer programs

Mathematical models to be used in the control system design were developed. A computer program, which takes aerodynamic and structural data for the ARW-2 aircraft and converts these data into state space models suitable for use in modern control synthesis procedures, was developed. Reduced order models of inboard and outboard control surface actuator dynamics and a second order vertical wind gust model were developed. An analysis of the rigid body motion of the ARW-2 was conducted.

83-281

Comparison of Analytical and Wind-Tunnel Results for Flutter and Gust Response of a Transport Wing with Active Controls

I. Abel, B. Perry, and J.R. Newsom
NASA Langley Res. Ctr., Hampton, VA, Rept. No. L-15099, NASA-TP-2010, 47 pp (June 1982) N82-26703

Key Words: Aircraft wings, Flutter, Active flutter control

Two flutter suppression control laws were designed and tested on a low speed aeroelastic model of a DC-10 derivative wing. Both control laws demonstrated increases in flutter speed in excess of 25 percent above the passive wing flutter speed. In addition, one of the control laws was effective in reducing loads due to turbulence generated in the wind tunnel. The effect of variations in gain and phase on the closed-loop performance was measured and is compared with predictions.

83-282

Active Control of Forward-Swept Wings with Divergence and Flutter Aeroelastic Instabilities

K.E. Griffin and F.E. Eastep
U.S. Air Force Academy, Colorado Springs, CO, J. Aircraft, 19 (10), pp 885-891 (Oct 1982) 12 figs, 5 refs

Key Words: Aircraft wings, Flutter, Active flutter control

A study is made of simple active control laws to suppress aeroelastic flutter and divergence on forward-swept advanced composite wings. Two selected wing designs are used as examples where leading- and trailing-edge flaps are used as control devices. These flaps are actuated using simple feedback signals from acceleration, velocity, and displacement sensors. The analysis method uses root locus plots of the characteristic roots from the transformed equations of motion to determine the aeroelastic stability of each feedback controlled configuration.

83-283

A Research Program to Reduce Interior Noise in General Aviation Airplanes. Influence of Depressurization and Damping Material on the Noise Reduction Characteristics of Flat and Curved Stiffened Panels

R. Navaneethan, B. Streeter, S. Koontz, and J. Roskam
Ctr. for Research, Inc., Univ. of Kansas, Lawrence, KS, Rept. No. NASA-CR-169035, 310 pp (Oct 1981) N82-27088

Key Words: Panels, Aluminum, Aircraft, Interior noise, Material damping, Noise reduction

Some 20 x 20 aluminum panels were studied in a frequency range from 20 Hz to 5000 Hz. The noise sources used were a swept sine wave generator and a random noise generator.

83-284
On the Design and Test of a Low Noise Propeller
G.P. Succi
Bolt, Beranek and Newman, Inc., Cambridge, MA, Rept. No. NASA-CR-165938, 52 pp (Nov 1981)
N82-27089

Key Words: Aircraft propellers, Noise generation, Design techniques

An extensive review of noise and performance of general aviation propellers was performed. Research was done in three areas: acoustic and aerodynamic theory of general aviation propellers, wind tunnel tests of three one-quarter scale models of general aviation propellers, and flight test of two low noise propellers. The design and testing of the second propeller is reviewed. General aerodynamic considerations needed to design a new propeller are described.

83-285
Effects of Filter Response on Analysis of Aircraft Noise Data
L.C. Sutherland
Wyle Labs., El Segundo, CA, Rept. No. WR-81-59, FAA/EE-82-2, 83 pp (May 1982)
AD-A116 458

Key Words: Aircraft noise, Noise measurement, Data processing, Filters

This report analyzes the effects of non-ideal filter transmission characteristics upon the measurement, correction, or extrapolation of aircraft noise data. The report is based primarily upon, and represents an abbreviated summary of, two previously published, more detailed reports on this topic.

83-286
Executive Summary of Systems Analysis to Develop Future Civil Aircraft Noise Reduction Alternatives
L.A. Robinson
PEER Consultants, Inc., Rockville, MD, Rept. No. FAA-EE-82-3, 75 pp (May 1982)
AD-A116 467

Key Words: Aircraft noise, Noise reduction

This executive summary contains the results of the study, "System Analysis to Develop Future Civil Aircraft Noise Reduction Alternatives." The original study first developed and examined a set of projected scenarios of U.S. carrier aircraft fleet compositions for three planning years: 1980, 1990, and 2000. An analysis of the costs and benefits of alternative methods of achieving noise reductions around airports was then made.

83-287
Experimental Verification of Propeller Noise Prediction
G.P. Succi, D.H. Munro, and J.A. Zimmer
Massachusetts Inst. of Tech., Cambridge, MA, AIAA J., 20 (11), pp 1483-1491 (Nov 1982) 21 figs, 14 refs

Key Words: Aircraft noise, Propeller noise, Noise prediction

An experimental study of the sound field of ¼-scale general aviation propellers has been completed. The results of these experiments, along with a comparison of the wake surveys and pressure signatures to the theoretical calculations, are presented. The calculations are both aerodynamic and acoustic. Given the airfoil section properties, the blade loading is calculated using a modified strip analysis procedure.

83-288
Evaluation of Noise Control Technology and Alternative Noise Certification Procedures for Propeller-Driven Small Airplanes
D. Brown and L.C. Sutherland
Wyle Labs., El Segundo, CA, Rept. No. WR-82-4, FAA/EE-82-14, 224 pp (May 1982)
AD-A116 495

Key Words: Aircraft noise, Regulations

This report considers the effectiveness of current noise regulations, examines the potential effectiveness of future technology to achieve further noise reduction, and evaluates a number of new concepts for noise certification procedures for propeller-driven small aircraft.

83-289
Helicopter Noise Definition Report UH-60A, S-76, A-109, 206-L
J.S. Newman, E.J. Rickley, and D.W. Ford

Office of Environment and Energy, Fed. Aviation Admn., Washington, DC, Rept. No. DOT-FAA-EE-81-16, 687 pp (Dec 1981)
AD-A116 363

Key Words: Helicopter noise, Noise measurement, Experimental test data

This document presents noise data for the Sikorsky UH-60A Blackhawk, the Sikorsky S-76 Spirit, the Agusta A-109 and the Bell 206-L. The acoustical data are accompanied by phototheodolite tracking data, cockpit instrument panel photo data, and meteorological data acquired from radiosonde balloons. Acoustical metrics include both noise certification metrics as well as community/airport noise assessment metrics.

83-290

Quantification of Helicopter Vibration Ride Quality Using Absorbed Power Measurements

D.D. Hollenbaugh

Army Res. and Tech. Labs., Fort Eustis, VA, 18 pp (June 18, 1982) (Presented at Army Sciences Conf., June 15-18, 1982)
AD-A117 290

Key Words: Helicopters, Vibration absorption (equipment), Ride dynamics

The absorbed power concept offers certain advantages over pure acceleration for helicopter ride quality evaluation. It takes into account multi-frequency, multi-axial vibration across a broad frequency range and it provides proper weighting functions for all frequencies and axes according to body response. It is applicable to random as well as periodic accelerations.

83-291

Aerodynamic Interactions between a 1/6-Scale Helicopter Rotor and a Body of Revolution

M.D. Betzina and P. Shinoda

NASA Ames Res. Ctr., Moffett Field, CA, Rept. No. NASA-TM-84247, 15 pp (June 1982)
AD-A117 063

Key Words: Helicopters, Rotors, Propeller blades, Aerodynamic loads

A wind-tunnel investigation was conducted in which independent, steady-state aerodynamic forces and moments were measured on a 2.24-m-diam, two-bladed helicopter rotor and a body of revolution. The objective was to determine the interaction of the body on the rotor performance and the effect of the rotor on the body aerodynamics for variations in velocity, thrust, tip-path-plane angle of attack, body angle of attack, rotor/body position, and body nose geometry.

83-292

Helicopter Vibration Suppression Using Simple Pendulum Absorbers on the Rotor Blade

M.-N. Hamouda

Ph.D. Thesis, Georgia Inst. of Tech., 186 pp (1982)
DA8221808

Key Words: Helicopter vibration, Vibration control, Pendulums, Vibration absorption (equipment), Propeller blades

A comprehensive analytical design procedure for the installation of simple pendulums on the blades of a helicopter rotor to suppress the root reactions is presented. To achieve this goal, a frequency response analysis is conducted of typical rotor blades excited by a harmonic variation of spanwise airload distributions as well as a concentrated load at the tip.

MISSILES AND SPACECRAFT

83-293

Response of MX Horizontal Shelter Models to Static and Dynamic Loading

V.T. Cost and G.E. Albritton

Army Engineer Waterways Experiment Station, Vicksburg, MS, 15 pp (June 18, 1982) (Proc. Army Sciences Conf., June 15-18, 1982)
AD-A117 098

Key Words: Missile silos, Hardened installations, Underground structures, Dynamic tests

A concept considered for basing the Missile X System was to emplace the missile in a buried, horizontal shelter. In support of the MX Horizontal Shelter Component Test Program, a program of static and dynamic model tests was developed and performed so that response data on specific structural details and shelter components could be obtained. The objectives of the test program were to evaluate the load capacity merits of various shelter soil-structure design concepts and to optimize certain parameters, while providing a design team with timely data necessary for structure survivability verification and construction economy comparisons.

83-294
Interaction of Oscillations of Channel Flow and Flow Separation at Duct Discontinuities

E.W. Price, J.E. Hubbartt, W.C. Strahle, E.A. Oguz, and P.M. Sagdeo

Georgia Inst. for Res., Athens, GA, Rept. No. NWC-TP-6302, 34 pp (Aug 1981) (Presented at JANNAF Combustion Meeting, 17th, Sept 1980, NASA Langley Research Center, Hampton, VA)
AD 116 801

Key Words: Ducts, Rocket motors, Discontinuity-containing media, Stability

The subject of vortex flow and coupling between vortices and acoustic wave motions in rocket motor chambers has become a topic of high interest to rocket motor stability specialists in the past several years. Although the phenomenon was first noted to be a significant factor in the stability of very large booster motors, recent experiences in tactical-sized motors indicate that vortex-acoustic wave interactions can become an important factor in determining acoustic wave amplitudes in all solid-propellant rocket motors, regardless of size. A two-dimensional experiment was used to study the flow fluctuations in the separated region resulting from a wall-slot-step (convergent step). This geometry corresponds to the geometry present in a segmented solid rocket motor in the region of the ends of adjoining segments.

BIOLOGICAL SYSTEMS

HUMAN

83-295
Possibility of Hearing Loss from Exposure to Interior Aircraft Noise

K.S. Pearsons and J.F. Wilby

Bolt Beranek and Newman, Inc., Los Angeles, CA, Rept. No. FAA-AEE-81-15, 81 pp (Nov 1981)
PB82-231804

Key Words: Aircraft noise, Interior noise, Human response

This report reviews criteria for hearing damage developed by the Committee on Hearing, Bioacoustics and Biomechanics of the National Academy of Science. It presents noise levels occurring in narrow and wide body commercial aircraft, business jet aircraft and short takeoff and landing aircraft. It presents estimates of time exposure for pilots and crews based on FAA permitted flight times. It also provides estimations of possible hearing damage resulting from different exposures to interior noise of various aircraft types.

83-296
Community Annoyance from Aircraft and Ground Vehicle Noise

K.D. Kryter

SRI International, 333 Ravenswood Ave., Menlo Park, CA 94025, J. Acoust. Soc. Amer., 72 (4), pp 1222-1242 (Oct 1982) 16 figs, 7 tables, 44 refs

Key Words: Aircraft noise, Human response

Data from published noise-annoyance surveys are related to a common measure of noise exposure L_{dn}. The results provide means for predicting the annoyance (experienced by percentages of people of normal and of supersensitivity) attributable to noise from aircraft and from street and road traffic.

83-297
Reliability of Social Survey Data on Noise Effects

F.L. Hall and S.M. Taylor

McMaster Univ., Hamilton, Ontario, L8S 4K1, Canada, J. Acoust. Soc. Amer., 72 (4), pp 1212-1221 (Oct 1982) 2 figs, 10 tables, 26 refs

Key Words: Aircraft noise, Traffic noise, Human response

The results of household interviews provide essential data for the formulation of noise control policies. This paper investigates four topics: the equivalence of three commonly used annoyance scales; the test-retest reliability of two such scales, for aircraft and overall noise as well as for road traffic noise; the repeatability of measures of average response, such as percent highly annoyed; and the effect on reliability estimates of the range of noise levels included in a survey.

MECHANICAL COMPONENTS

ABSORBERS AND ISOLATORS

(Also see No. 292)

83-298

Silencers for I.C. Engines -- from Absorption Silencers up to Wool-Free Silencers (Schalldämpfer für Verbrennungsmotoren -- Vom Absorptionsschalldämpfer bis zum wollelosen Schalldämpfer)

W. Seeger

Automobiltech. Z., 84 (9), pp 401-405 (Sept 1982) 18 figs

(In German)

Key Words: Silencers, Mufflers

The demands made upon an exhaust silencer and a complete silencer unit used in I.C. engines are investigated.

83-299

Behavior of Elastomeric Materials under Dynamic Loads -- III

E.C. Hobaica

General Dynamics, Electric Boat Div., Dept. 443, R&D Annex, Eastern Point Rd., Groton, CT 06340, Shock Vib. Dig., 14 (10), pp 13-16 (Oct 1982) 30 refs

Key Words: Elastomers, Periodic excitation, Small amplitudes, Reviews

This is a review of literature published since 1979 on the behavior of rubber materials under small amplitude, sinusoidal forces. Advances in the field in the past three years were most significant when applied to the field of damping.

83-300

Passive and Active Seismic Isolation for Gravitational Radiation Detectors and Other Instruments

N.A. Robertson, R.W.P. Drever, I. Kerr, and J. Hough

Dept. of Natural Philosophy, Univ. of Glasgow, Glasgow G12 8QQ, UK, J. Phys.: E. Sci. Instrum., 15 (10), pp 1101-1105 (Oct 1982) 5 figs, 10 refs

Key Words: Vibration isolation, Active isolation, Seismic isolation, Instrumentation mounts

Some new passive and active methods for reducing the effects of seismic disturbances on suspended masses are described, with special reference to gravitational radiation detectors in which differential horizontal motions of two or more suspended test masses are monitored.

83-301

Motor Vehicle Suspension Systems: Vibrational Effects and Stability. 1973 - July, 1982 (Citations from Information Services in Mechanical Engineering Data Base)

NTIS, Springfield, VA, 133 pp (July 1982)

PB82-871773

Key Words: Suspension systems (vehicles), Bibliographies

This bibliography contains citations concerning the effects of vibration and ride stability, uneven tire wear, and resulting steering difficulties associated with motor vehicle suspension systems. Hydropneumatic leveling, independent suspension, and active suspension systems are discussed.

83-302

Active Vibration Isolation of Driver's Seat in Unsprung Vehicles (Aktive Schwingungsisolierung des Fahrerplatzes ungefederter Fahrzeuge)

W. Kauss and H. Gohlich

Automobiltech. Z., 84 (9), pp 425-428, 431, 432, 434 (Sept 1982) 16 figs, 24 refs

(In German)

Key Words: Vibration isolation, Active isolation, Off-highway vehicles, Automobile seats

The insulation of low frequency vibration in unsprung, off-road vehicles by means of conventional passive seat suspension is limited. Nevertheless it is possible to protect the driver from dangerous and uncomfortable vibration by using active hydraulic vibration insulation. In this case the disadvantages of conventional suspension can be avoided. Systematic investigations of the closed loop transmissibility and stability of active insulation systems resulted in an electrohydraulic laboratory model. The results of experiments which are presented confirm the theoretical model and moreover show the possibility to insulate vibrations of off-road vehicles with realistic amount of power.

83-303
Air Bag Impact Attenuation System for the AQM-34V Remote Piloted Vehicle
C.T. Turner and L.A. Girard, Jr.
Teledyne Ryan Aeronautical, San Diego, CA, J. Aircraft, 19 (11), pp 984-989 (Nov 1982) 10 figs, 4 refs

Key Words: Landing gear, Airbags (soft landing), Energy absorption

This paper describes the air bag impact attenuation system for the AQM-34V remote piloted vehicle. The developed hardware, consisting of the main bag, tail bag, and inflation systems, is described. Operation of the system from electrical initiation through cover deployment, main and tail bag inflation, and ground impact is discussed. Development ground drop tests, environmental tests, structural tests, and the contractor flight tests are summarized. Test results substantiated system performance.

SPRINGS

83-304
Pneumatic Toroidal Springs
F. Koutny
Strojnícky Časopis, 33 (4), pp 477-486 (1982) 4 figs, 11 refs
(In Czech)

Key Words: Springs, Pneumatic springs, Tires, Pneumatic tires, Stiffness coefficients

The pneumatic toroidal spring is, essentially, a pneumatic tire under specific exploitation conditions. The stiffness coefficients are defined by means of the theory of the equilibrium shape and the symmetric deformations. The spring construction enters into calculations through these coefficients, which is shown by asymmetric radial deflection. Numerical results and a comparison between pneumatic spring and elastic ring are given.

TIRES AND WHEELS
(See No. 304)

BLADES

83-305
An Experimental Investigation of Gapwise Periodicity and Unsteady Aerodynamic Response in an Oscillating Cascade. 1: Experimental and Theoretical Results
F.O. Carta
United Technologies Res. Ctr., East Hartford, CT, Rept. No. NASA-CR-3513, 103 pp (June 1982)
N82-26229

Key Words: Blades, Airfoils, Cascades, Aerodynamic damping, Aerodynamic loads

Tests were conducted on a linear cascade of airfoils oscillating in pitch to measure the unsteady pressure response on selected blades along the leading edge plane of the cascade, over the chord of the center blade, and on the sidewall in the plane of the leading edge. The pressure data were reduced to Fourier coefficient form for direct comparison, and were also processed to yield integrated loads and, particularly, the aerodynamic damping coefficient. Results from the unsteady Verdon/Caspar theory for cascaded blades with nonzero thickness and camber were compared with the experimental measurements.

83-306
On the Operating Characteristics of the Variable Geometry Wind Turbine
C. Teodorescu-Tintea, H. Dumitrescu, St.N. Savulescu
INGREST, Bucharest, Romania, Rev. Roumaine Sci. Tech., Mecanique Appl., 27 (3), pp 347-360 (May/June 1982) 6 figs, 3 refs

Key Words: Turbines, Wind turbines, Blades, Turbine blades, Aerodynamic loads

Functional characteristics (power and torque) versus tip velocity ratio of a new type of vertical wind turbine are determined. A simplified global theory of the vertical wind turbines is presented, and an introduction is made into the aerodynamic study of the blades.

83-307

Aerodynamic Forces Acting on the Blades of Stall Regulated Propeller Type Windmills

F. Rasmussen

Risoe Natl. Lab., Roskilde, Denmark, Rept. No. RISO-M-2316, 37 pp (Aug 1981)

DE82901178

(In Danish)

Key Words: Windmills, Propeller blades, Blades, Aerodynamic loads, Shafts

This report deals with aerodynamic forces acting on the blades of stall regulated propeller type windmills. General considerations of the expected dynamic behavior of the loads are outlined.

BEARINGS

83-308

Effects of Injected Fuel Mass Non-Uniformity on the Hydrodynamic Behaviour of Diesel Engine Bearings

T. Turcoiu, N. Apostolescu, St. Nedelcu

The Natl. Inst. for Thermal Engines, Bucharest, Romania, Rev. Roumaine Sci. Tech., Mecanique Appl., 27 (3), pp 417-426 (May/June 1982) 17 figs, 1 table, 5 refs

Key Words: Bearings, Diesel engines, Lubrication, Hydrodynamic response

The influence of the injected mass non-uniformity upon the minimum lubricant film thickness, the side-leakages flow and the friction torque on the journal and bushing surfaces are analyzed for the bearings of a diesel engine crankshaft. A special calculation program for bearings loaded by variable loads and speeds is used.

83-309

A Study on Characteristics of Externally Pressurized Gas Thrust Bearings with Surface-restriction Compensation (Continued Report; Dynamic Bearing Characteristics)

H. Yabe, H. Mori, and H. Tanahashi

Faculty of Engrg., Kyoto Univ., Yoshida-Honmachi, Sakyo-ku, Kyoto, Japan, Bull. JSME, 25 (207), pp 1451-1456 (Sept 1982) 8 figs, 3 refs

Key Words: Bearings, Gas bearings, Hydrodynamic bearings, Damping coefficients, Stiffness coefficients

An externally pressurized gas-lubricated thrust bearing with surface-restriction compensation is analyzed theoretically for hydrodynamic bearing characteristics such as dynamic stiffness and damping coefficient applying two kinds of gas flow models. One considers an equivalent recessed thrust bearing neglecting the circumferential flow in the bearing clearance, and the other takes into account the effect of the circumferential flow by a simple evaluation. Theoretical results are discussed and compared with experimental results.

GEARS

83-310

Noise and Transmission Efficiency under Deformation of Tooth Form of Nylon Gear

N. Tsukamoto, T. Yano, and H. Sakai

Chiba Inst. of Tech., Narashino, Japan, Bull. JSME, 25 (207), pp 1465-1473 (Sept 1982) 11 figs, 3 refs

Key Words: Gear teeth, Plastics, Geometric effects, Noise generation

In this investigation changes in noise and transmission efficiency are investigated when the tooth form of nylon gear is deformed during operation.

83-311

On the Effect of the Tooth Profile Modification on the Dynamic Load and the Sound Level of the Spur Gear

Y. Terauchi, H. Nadano, and M. Nohara

Hiroshima Univ., Shitami, Saijo-cho, Higashi-hiroshima-shi, Hiroshima, Japan, Bull. JSME, 25 (207), pp 1474-1481 (Sept 1982) 3 tables, 7 refs

Key Words: Gears, Spur gears, Structural modification effect, Noise generation

Measurements of gear noise and dynamic load acting on the meshing teeth of gears with and without profile modification which are shifted by different amounts of addendum modification were carried out using power-circulating gear test rigs until a surface failure caused by scoring was observed.

FASTENERS

83-312

Fatigue Crack Propagation Rates and Threshold Stress Intensity Factors for Welded Joints of HT80 Steel at Several Stress Ratios

A. Ohta, E. Sasaki, M. Nihei, M. Kosuge, M. Kanao, and M. Inagaki

Natl. Res. Inst. for Metals, 2-3-12, Nakameguro, Meguro-Ku, Tokyo 153, Japan, Intl. J. Fatigue, 4 (4), pp 233-237 (Oct 1982) 8 figs, 3 tables, 24 refs

Key Words: Joints (junctions), Welded joints, Fatigue life, Crack propagation

Fatigue crack propagation rates and threshold stress intensity factors were measured for welded joints and base metal by using 200 mm wide center-cracked specimens. The fatigue crack propagation properties of welded joints were similar in spite of the different zones in which the cracks propagated and the different welding processes used. They were, however, inferior to those of the base metal.

STRUCTURAL COMPONENTS

STRINGS AND ROPES

(See No. 417)

CABLES

(Also see No. 397)

83-313

Validation of Finite Segment Cable Models

R.L. Huston and J.W. Kamman

Dept. of Mech. and Industrial Engrg., Mail Location No. 72, Univ. of Cincinnati, Cincinnati, OH 45221, Computers Struc., 15 (6), pp 653-660 (1982) 5 figs, 4 tables, 18 refs

Key Words: Cables, Mathematical models

Analytical and experimental data is presented validating a finite segment cable model. The model consists of a series of pin-connected rigid rods which may have different lengths, diameters, and masses. The model is capable of simulating large, three-dimensional motion of flexible cables. Its principal areas of application are expected to be with the simulation of long, heavy, towing and hoisting cables.

83-314

Strand-Break-Detection System for Fatigue Tests of Overhead Conductors

G.E. Ramey

Dept. of Civil Engrg., Auburn Univ., Auburn, AL 36849, Exptl. Techniques, 6 (5), pp 12-14 (Oct 1982) 4 figs

Key Words: Cables, Transmission lines, Wind-induced excitation, Fatigue tests, Vibratory stresses

Aeolian vibrations are high-frequency vibrations caused by steady winds moving across a conductor. Fatigue failures caused by these vibrations are a long standing problem in the design of electrical transmission lines. Rational aeolian fatigue design of overhead conductors requires a knowledge of their fatigue-endurance capabilities, i.e., their S-N curves. Because of interstrand slippage and fretting, the curves for conductors are significantly different from those of individual aluminum strands. A laboratory testing program was developed to generate S-N curves for conductors and is briefly described.

83-315

On the Analytical Modeling of the Nonlinear Vibrations of Pretensioned Space Structures

J.M. Housner and W.K. Belvin

NASA Langley Res. Ctr., Hampton, VA 23665, Computers Struc., 16 (1-4), pp 339-352 (1983) 12 figs, 10 refs

Key Words: Cables, Nonlinear theories, Cable stiffened structures, Periodic excitation

Linear, quasi-linear and nonlinear analyses have been used to investigate a relatively simple two-dimensional cable-stiffened structure under sinusoidal excitation. For linear vibrations, both an exact and a simplified analysis in which each cable is modeled as a spring with its mass lumped at the ends have been compared. The exact analysis, which accounts for distributed cable inertia, indicates a mass lumping procedure which is valid for both low and high ratios of cable to joint mass and represents an improvement to using a consistent mass lumping.

BARS AND RODS

83-316
Analysis of Vibrating Bar-Systems by Means of Graphs and Structural Numbers
J. Wojnarowski
Inst. Fundamentals of Machine Des., Tech. Univ. of Silesia, Gliwice, Poland, Strojnicky Casopis, 33 (4), pp 457-474 (1982) 20 figs, 8 refs

Key Words: Bars, Graphical analysis, Axial vibration, Flexural vibration

A method of analysis of the vibrations of plane bar systems is presented by means of graphs and structural numbers. Axial vibrations of or segments with constant extensional stiffness are described by a three-vertices loaded graph of the secondary category. Flexural vibrations are described by a five-vertices graph.

BEAMS

83-317
A Variable Cross Section 3-D Beam Finite Element for Static and Free Vibration Analyses
L. Resende and W.S. Doyle
Dept. of Civil Engrg., Cape Town Univ., South Africa, Rept. No. TR-806S, 38 pp (Oct 1980)
N82-27766

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

The development of a nonprismatic (variable cross section) 3-D beam finite element is discussed. The validity and advantages of the variable cross section formulation are investigated in the cases of static and free vibration analyses of structures consisting of members whose constitutive relationship is linear elastic. The formulation of the element is based on the quadratic isoparametric class of finite elements. The three noded element is versatile in that it can be used for thick as well as thin beam analysis.

83-318
Certain Discussions in the Finite Element Formulation of Nonlinear Vibration Analysis
B.S. Sarma and T.K. Varadan
Defence Res. and Dev. Lab., Hyderabad, India, Computers Struc., 15 (6), pp 643-646 (1982) 2 tables, 19 refs

Key Words: Beams, Nonlinear vibration, Finite element technique, Equivalent linearization method

The finite element formulation and equivalent linearization technique used in the study of nonlinear vibrations of beams are reexamined. Errors present in the equivalent linearization procedure, in the substitution of inplane boundary conditions at the element level instead of at the system level, and in the use of different connotation for the frequency, are discussed. A simply-supported beam with immovable ends is considered as an example to evaluate these errors. A formulation in terms of transverse displacement alone is also presented based on the assumption of average nonlinear stretching force.

83-319
Vibration of Beams on Partial Elastic Foundations
P.F. Doyle and M.N. Pavlovic
Allot & Lomax, Consulting Engineers, Sale, Cheshire, UK, Intl. J. Earthquake Engrg. Struc. Dynam., 10 (5), pp 663-674 (Sept/Oct 1982) 4 figs, 7 refs

Key Words: Beams, Pile structures, Elastic foundations, Natural frequencies, Mode shapes

The natural response of a beam or pile having only a portion of its span supported by an elastic foundation is investigated for two cases when both ends are either simply supported or free. The derivation of the shape functions and the computed natural frequencies are compared with the extreme cases where the element is either completely supported by, or fully detached from, the elastic foundation.

83-320
Coupling Loss Factors at a Beam L-Joint Revisited
M.J. Sablik
Southwest Res. Inst., San Antonio, TX 78284, J. Acoust. Soc. Amer., 72 (4), pp 1285-1288 (Oct 1982) 5 figs, 12 refs

Key Words: Beams, Joints (junctions), Structure-borne vibration

Transmission coefficients and coupling loss factors are obtained for an L-joint between two beams when incident flexural waves are vibrating out of the plane of the L-joint.

In the analysis, it is found that torsional waves develop at the L-joint and that flexural-to-torsional transmission can be more efficient than flexural-to-flexural transmission. Also treated are the cases of an incident torsional wave at the L-joint and an incident torsional wave at a butt joint. The expressions developed in this paper may be utilized in a statistical energy analysis of a beam network.

CYLINDERS

83-321

Torsional Impact Response of a Flat Annular Crack in a Finite Elastic Cylinder

Y. Shindo
Dept. of Mech. Engrg. II, Faculty of Engrg., Tohoku Univ., Sendai 980, Japan, J. Acoust. Soc. Amer., 72 (4), pp 1258-1263 (Oct 1982) 7 figs, 8 refs

Key Words: Cylinders, Crack propagation, Impact response, Torsional response

The torsional impact response of a flat annular crack in an elastic cylinder of finite radius is investigated in this study. Laplace and Hankel transforms are used to reduce the problem to the solution of a set of triple integral equations. These equations are solved by using an integral transform technique and the result is expressed in terms of a singular integral equation of the first kind. The singular stress field near the crack tip and the dynamic stress-intensity factor are determined. Numerical results on the dynamic stress-intensity factor are obtained to show the influence of inertia, geometry, and their interactions on the load transmission to the crack tip.

FRAMES AND ARCHES

(Also see No. 346)

83-322

Natural Frequencies of Circular Arcs with Varying Cross Section

T. Irie, G. Yamada, and Y. Fujikawa
Hokkaido Univ., Sapporo, 060 Japan, Exptl. Mech., 22 (11), pp 407-411 (Nov 1982) 5 figs, 13 refs

Key Words: Arches, Variable cross section, Natural frequencies, Mode shapes, Transfer matrix method

This paper presents a transfer matrix method for conveniently predicting the natural frequencies of circular arcs with varying cross section. The numerical results obtained by the method are compared with the experimental results for free-clamped arcs with tapered breadth and are in good agreement.

83-323

Shakedown Load and Hysteresis Phenomena of Portal Frames

S. Singh
Ph.D. Thesis, Illinois Inst. of Tech., 153 pp (1982)
DA8220272

Key Words: Frames, Shakedown theorem, Hysteretic damping, Cyclic loading

The energy imparted to and recovered from a structure during cyclic loading is investigated as a means of predicting the alternating plasticity load, the shakedown load, and the general incremental collapse load envelope for plane frame structures. During the repeated loading cycles, a step-by-step procedure is used to perform an inelastic analysis of the frame, and the energy imparted to the structure is obtained in terms of the hysteresis energy dissipated during each cycle of loading.

83-324

The Transcendental Eigenvalue Problem of the Exact Dynamic Stiffness Matrix of Linearly Elastic Plane Frames

G.H. Sotiropoulos
Lab. of Structural Anal., Univ. of Thessaloniki, Thessaloniki, Greece, Z. angew. Math. Mech., 62 (7), pp 313-319 (July 1982) 2 figs, 2 tables, 14 refs

Key Words: Frames, Eigenvalue problems, Stiffness methods, Matrix methods

A new iterative procedure is proposed to solve the transcendental eigenvalue problem of the exact dynamic stiffness matrix of linearly elastic plane frames. According to the presented algorithm the exact solution; i.e., natural frequencies and mode shapes of the structure, is found in a number of cycles with an algebraic eigenvalue problem to be solved within each cycle.

MEMBRANES, FILMS, AND WEBS

83-325
The Physics of Kettledrums
T.D. Rossing
Sci. American, 247 (5), pp 172-178 (Nov 1982) 9 figs

Key Words: Membranes (structural members), Musical instruments, Harmonic response

The frequencies of vibrating ideal membranes, unlike those of an ideal string, are not harmonics. Yet a carefully tuned kettledrum, correctly struck, sounds a strong principal tone and two or more harmonics. The author shows that in the kettledrum the inharmonic modes of an ideal membrane are coaxed by the effect of air mass loading into a harmonic relationship. The drumhead frequencies are further fine-tuned by the air enclosed in the kettle and by the stiffness in shear of the membrane.

83-326
Dynamic Loading of a Viscoplastic Membrane
W. Idczak and T. Wierzbicki
Inst. of Fundamental Technological Res., Polish Acad. of Sci., Warsaw, Poland, Bull. Acad. Polon. Sci., Ser. Sci. Tech., 29 (7-8), pp 115-122 (1981) 7 figs, 10 refs

Key Words: Membranes (structural members), Viscoplastic properties, Plates

The linearized theory of thin viscoplastic shells is modified to get a more accurate description of the large deflection dynamic response of plates. The modification consists of replacing the nonlinear stress-strain rate curve with a straight line which is tangent rather than secant to the original curve at a chosen point. The problem of impulsively loaded clamped circular membrane is treated in detail. Results are compared with other approximate solutions of the same problem based on the method of quasi-iteration and perturbation.

83-327
Some Vibrating Membrane Equations for the Linear Estimation of Two-Dimensional Isotropic Random Fields
B.C. Levy and J.N. Tsitsiklis
Lab. for Information and Decision Systems, Massachusetts Inst. of Tech., Cambridge, MA, Rept. No. LIDS-P-1192, 39 pp (Mar 1982)
AD-A116 959

Key Words: Membranes (structural members), Random parameters

This paper considers the problem of estimating a two-dimensional isotropic random field given some noisy observations of this field over a disk of finite radius. By expanding the field and observations in Fourier series, and exploiting the covariance structure of the resulting Fourier coefficient processes, some vibrating equations are obtained for estimating the random field.

PANELS
(See No. 283)

PLATES
(Also see No. 326)

83-328
Note on the Vibration Analysis of a Rectangular Plate Subjected to a Thermal Gradient
C. Massalas and G. Leondaris
Univ. of Ioannina, Greece, Rev. Roumaine Sci. Tech., Mecanique Appl., 26 (6), pp 909-916 (Nov/Dec 1981) 1 table, 4 refs

Key Words: Plates, Rectangular plates, Temperature effects

The free response of a thin rectangular plate subjected to a constant thermal gradient is investigated. The mathematical analysis is based on a perturbation technique and general analytical expressions for the dynamic characteristics of a plate are derived.

83-329
Dynamic Response of a Rectangular Plate to a Bending Moment Distributed along the Diagonal
D.J. Gorman
Univ. of Ottawa, Ottawa, Canada, AIAA J., 20 (11), pp 1616-1621 (Nov 1982) 9 figs, 5 refs

Key Words: Plates, Rectangular plates, Harmonic excitation

An exact analytical solution is developed for the steady-state response of an undamped, simply supported rectangular plate subjected to a harmonic bending moment distributed along the diagonal. The solution obtained is shown to be composed of remarkably simple analytical expressions. A number of verification tests have been conducted in order to demonstrate the validity of the results. In addition to resolving an engineering problem of classical interest, it is expected that this solution will play a vital role in the free-vibration analysis of triangular, quadrilateral, and other irregularly shaped plates.

83-330

Research on Dynamics of Composite and Sandwich Plates, 1979-81

C.W. Bert

School of Aerospace, Mech. and Nucl. Engrg., Univ. of Oklahoma, Norman, OK 73019, Shock Vib. Dig., 14 (10), pp 17-34 (Oct 1982) 3 tables, 167 refs

Key Words: Plates, Composite structures, Sandwich structures, Reviews

This paper presents a survey of the literature concerning dynamics of plate-type structural elements of either composite material or sandwich construction. Papers from mid-1979 through early 1982 are reviewed. Particular attention is given to experimental research and to linear and nonlinear analysis. Configurations include rectangularly orthotropic, cylindrically orthotropic, and anisotropic plates; laminated plates; and thick and sandwich plates. Free and forced vibration, flutter, and impact are considered.

83-331

The Statics and Dynamics of the Sound Box of Stringed Instruments

B. Skalmierski

Inst. of Theoretical Mechanics, Silesian Polytechnic, Gliwice, Poland, Bull. Acad. Polon. Sci., Ser. Sci Tech., 29 (7-8), pp 169-173 (1981) 2 figs, 4 refs

Key Words: Plates, Sound generation, Box-type structures, Strings, Violins

The paper analyzes the problem of statics and dynamics of the sound box of stringed instruments. In the dynamic aspect, the author discusses the vibrations of the top plate of the body, which is mainly responsible for the color and emission of sound by a stringed instrument.

83-332

Improved Method of Static and Free Vibration Analysis of Thin Rectangular Plates

I.M. Basci, T.G. Toridis, and K. Khozeimeh

Swales & Associates, Inc., Greenbelt, MD 20770, Computers Struc., 16 (1-4), pp 433-440 (1983) 4 figs, 3 refs

Key Words: Plates, Rectangular plates, Stiffness methods, Mass matrices, Matrix methods, Free vibration

The objective of this paper is to develop more accurate procedures in the generation of the stiffness and mass matrices of a thin rectangular plate which can then be embedded in a usual finite element program. This is accomplished by the use of exact displacement functions for the element, rather than approximate ones, obtained from the solution of the differential equations governing the statical and free vibrational behavior of the element.

83-333

An Efficient Triangular Plate Bending Finite Element for Crash Simulation

H. Garnet and A.B. Pifko

Grumman Res. and Dev. Ctr., Bethpage, NY 11714, Computers Struc., 16 (1-4), pp 371-379 (1983) 8 figs, 25 refs

Key Words: Plates, Finite element technique, Crashworthiness, Computer programs

Computer costs for structural dynamics rise an order of magnitude over those associated with static analysis. To reduce these costs significantly, a computationally economical triangular plate bending element was developed. This element, designated as the TRP2 element, while simpler than existing high-order accuracy elements, yields results that are sufficiently accurate for engineering analysis.

83-334

Low Velocity, Transverse Normal Impact of a Clamped Plate

R.E. Llorens and L.W. Gause

Aircraft and Crew Systems Tech. Directorate, Naval Air Dev. Ctr., Warminster, PA, Rept. No. NADC-81250-60, 60 pp (Oct 1981)
AD-A115 760

Key Words: Plates, Impact response, Finite element technique, Viscoelastic damping

A finite element solution for the response of a clamped plate subjected to central low speed transverse impact is presented. The solution is empirically corrected, on the basis of viscoelastic beam analysis, to admit damping. Comparisons of the numerical predictions of the corrected theory with central impact test results on graphite-epoxy composite laminates show excellent agreement for two of the three test studies.

SHELLS

83-335
Post-Buckling Dynamic Behavior of Periodically Supported Imperfect Shells
D.F. Lockhart
Dept. of Math. and Computer Sciences, Michigan Technological Univ., Houghton, MI 49931, Intl. J. Nonlin. Mech., 17 (3), pp 165-174 (1982) 2 figs, 1 table, 11 refs

Key Words: Shells, Dynamic buckling

A circular cylindrical shell, periodically supported and subjected to step-loading in the form of lateral or hydrostatic pressure, is studied. Using the time-dependent von Kármán-Donnell equations, its imperfection sensitivity is examined and a simple asymptotic expression for the dynamic buckling load, valid for small imperfections, is obtained.

83-336
Vibrations of Conical Shells with Variable Thickness
S. Takahashi, K. Suzuki, E. Anzai, and T. Kosawada
Faculty of Engrg., Yamagata Univ., Yonezawa, Japan, Bull. JSME, 25 (207), pp 1435-1442 (Sept 1982) 10 figs, 1 table, 15 refs

Key Words: Shells, Conical shells, Variable material properties, Free vibration

This paper is concerned with an investigation of free vibrations of a truncated conical shell by means of the improved theory of shells. The equations of vibration and the boundary conditions are in general form developed from stationary conditions of Lagrangian of a conical shell. These equations are solved in the conical shell with linearly varied thickness along axis; and the effects of boundary conditions, number of nodal generators, thickness and semi-vertex angle on frequencies are discussed.

83-337
Influence of Initial Geometric Imperfections on Vibrations of Thin Circular Cylindrical Shells
L. Watawala and W.A. Nash
Dept. of Civil Engrg., Univ. of Massachusetts, Amherst, MA 01003, Computers Struc., 16 (1-4), pp 125-130 (1983) 5 figs, 10 refs

Key Words: Shells, Cylindrical shells, Circular shells, Geometric imperfection effects, Seismic excitation

The influence of initial geometric imperfections (out-of-roundness) on vibrations of a rigid circular cylindrical shell is investigated on the basis of nonlinear large deformation shell theory. Both free and forced motions (due to base excitation caused by seismic effects) are treated. An extension to the case of the cylindrical shell with vertical geometric axis and completely filled with a perfect liquid is also studied. Numerical results are presented for various initial imperfections and vibratory configurations.

83-338
Dynamic Instability of Suddenly Heated Angle-Ply Laminated Composite Cylindrical Shells
H. Ray
Dept. of Mech. and Aerospace Engrg., Rutgers Univ., New Brunswick, NJ 08903, Computers Struc., 16 (1-4), pp 119-124 (1983) 7 figs, 8 refs

Key Words: Shells, Cylindrical shells, Layered materials, Composite materials, Temperature effects

The instability of the motion of thin elastic circular cylindrical shells made of angle-ply laminated fiber-reinforced composite materials and subjected to a suddenly developed temperature is investigated. The excitation of unstable modes are identified by the short-term analysis, whereas the long-term analysis shows that the initially unstable circumferential flexural modes exchange energy with the circular mode in a cyclic manner.

83-339
Free Torsional Vibration of Thick Isotropic Incompressible Circular Cylindrical Shell Subjected to Uniform External Pressure
A. Dasgupta
Dept. of Math., Hooghly Mohsin College, P.O. Chinsurah, Dist. Hooghly, West Bengal, India, Intl. J. Engrg. Sci., 20 (10), pp 1071-1076 (1982) 7 refs

Key Words: Shells, Circular shells, Cylindrical shells, Torsional vibration

The problem of torsional vibration of a cylindrical shell superposed on an initial nonhomogeneously deformed state which is caused by a uniform external pressure, is investigated. Using Green's formulation and a perturbation technique, the frequency equation for free torsional vibrations is obtained. Numerical results are presented which shows the effect of pressure.

PIPES AND TUBES

83-340
Modal Recovery Methods for Solution of Fluid-Structure Problems with Rigid Wall Loads
T. Belytschko and J.I. Lin
Departments of Civil and Mech. and Nuclear Engrg., The Technological Inst., Northwestern Univ., Evanston, IL 60201, Nucl. Engrg. Des., 71 (1), pp 67-78 (July 1982) 14 figs, 1 table, 19 refs

Key Words: Interaction: structure-fluid, Water hammer, Piping systems

A method is presented which enables the acoustic modes of a fluid to be recovered in an analysis based on rigid wall loads of a structure or portion of a structure. It is shown that the method leads to a structural solution which is identical to the coupled fluid-structure solution provided that the fluid is discretized sufficiently to retain the requisite spectral fidelity. An application of this method to the water-hammer response of a pipe segment is given, which in addition to validating the method, shows that the coupled response differs significantly from the structural behavior predicted by added mass, or incompressible, representations of the fluid.

83-341
Inelastic Cyclic Analysis of Pin-Ended Tubes
S. Toma and W.F. Chen
Faculty of Engrg., Hokkaigakuen Univ., W-11, S-26, Chunouku, Sapporo, Japan, ASCE J. Struc. Div., 108 (ST10), pp 2279-2294 (Oct 1982) 13 figs, 16 refs

Key Words: Tubes, Cyclic loading

An analytical study of the inelastic cyclic load-deflection behavior and load-shortening behavior of axially loaded steel tubular bracing members subject to cyclic loading is presented. Expressions are first derived for the moment and axial strain expressed explicitly in terms of curvature and thrust for tubular sections with geometric imperfections and residual stresses. For the case of reversed loading, several approximations of the moment-thrust-curvature curves and moment-thrust-axial strain curves are made. Using these relations, cyclic solutions of pin-ended columns subjected to one cycle of axial loading are obtained and compared with some available experimental tests.

83-342
A Consideration on Dynamic Characteristics of Pneumatic Conduit Systems with a Cylindrical Choke -- Influence of the Position of a Cylindrical Choke
Y. Noda and N. Sugai
Faculty of Science and Engrg., Ritsumeikan Univ., 56-1, Tojiinkita-machi, Kita-ku, Kyoto, Japan, Bull. JSME, 25 (207), pp 1443-1450 (Sept 1982) 19 figs, 7 refs

Key Words: Pneumatic lines

Consideration is given to pressure wave propagation with a strain under the influence of the relative position of a cylindrical choke in a pneumatic conduit system. The pneumatic conduit system is treated as a lossless fluid line. It is shown that the shape of the pressure wave is easily obtained by the graphical method; that is, the figure of the reflection or transmission of the wave to the cylindrical choke.

83-343
Tube Vibration in Industrial Size Test Heat Exchanger (30 exp 0 Triangular Layout -- Six Crosspass Configuration)
M.W. Wambsganss
Argonne Natl. Lab., IL, Rept. No. ANL-CT-81-42, 91 pp (Oct 1981)
DE82008578

Key Words: Tubes, Tube arrays, Heat exchangers, Fluid-induced excitation, Experimental test data

Tube vibrations in heat exchangers are being systematically studied in a series of tests performed with an industrial-size test exchanger. Results from flow tests of nine different tube bundles, in a basic 5-baffle, 6-crosspass configuration on a 30 expo 0 -triangular layout with a pitch-to-diameter ratio of 1.25, are reported. The test cases include a full tube bundle, no-tubes-in-window bundle, finned tube bundle, and several proposed field fixes.

DUCTS

(Also see No. 294)

83-344

Development of an Analytical Technique for the Optimization of Jet Engine and Duct Acoustic Liners

B.T. Zinn and W.L. Meyer

School of Aerospace Engrg., Georgia Inst. of Tech., Atlanta, GA, Rept. No. NASA-CR-169002, 159 pp (Feb 28, 1982)

N82-25256

Key Words: Ducts, Acoustic linings, Jet noise, Noise reduction, Optimization

A new method was developed for the calculation of optimum constant admittance solutions for the minimization of the sound radiated from an arbitrary axisymmetric body. This method utilizes both the integral equation technique used in the calculation of the optimum non-constant admittance liners and the independent solution generated as a by product of these calculations. The results generated by both these methods are presented for three duct geometries: a straight duct; the QCSEE inlet; and the QCSEE inlet less its centerbody.

83-345

Acoustic Finite Element Analysis of Duct Boundaries

R.J. Bernhard

Ph.D. Thesis, Iowa State Univ., 231 pp (1982)

DA8221174

Key Words: Ducts, Sound propagation, Finite element technique, Substructuring methods

The finite element method has been found to be useful for problems in acoustics. The method as presently applied is not efficient for several common acoustic geometries. This dissertation investigates problems associated with applying the finite element method to acoustic geometries with repeated or standard features and to geometries involving open boundary segments. Substructuring methods are modified and applied to problems involving internal acoustic propagation.

BUILDING COMPONENTS

83-346

Large Displacement, Interactive-Adaptive Dynamic Analysis of Frames

M. Gattass

Ph.D. Thesis, Cornell Univ., 328 pp (1982)

DA8219312

Key Words: Frames, Structural members, Beam-columns, Lagrange equations, Buildings, Computer-aided techniques

Computer-aided nonlinear and dynamic methods of analysis are in increased demand as engineers search for more rational methods of design. There are, however, two main difficulties in the use of these analyses in practical design: the mechanics background of most nonlinear analysis methods lacks in generality, consistency, or simple physical interpretations, and nonlinear and dynamic analysis performed in large computers without interactive graphic techniques are difficult to perform and do not actively promote understanding of the behavior of the structure. This thesis is divided in two parts corresponding to these two problems. Part I of the thesis investigates the updated Lagrangian formulation for two-dimensional beam-column elements. Part II of this thesis presents a study in computer-aided structural analysis of buildings and frames with 32-bit, virtual-memory minicomputers and vector refresh graphics terminals.

DYNAMIC ENVIRONMENT

ACOUSTIC EXCITATION

(Also see Nos. 283, 401)

83-347

Theoretical Outdoor Noise Propagation Models: Application to Practical Predictions

H.T. Tuominen and T. Lahti

LVI-tekniikan Lab., Valtion Teknillinen Tutkimuskeskus, Espoo, Finland, Rept. No. ISBN-951-38-1433-5, VTT/RN-78, 37 pp (1982)
PB82-245705

Key Words: Sound propagation

A brief review is presented on the theoretical calculation approaches for outdoor noise propagation available today. Possibilities for their application to practical engineering calculations are outlined.

83-348
Effect of Inlet/Outlet Locations on Higher Order Modes in Silencers
L.J. Eriksson
Nelson Industries, Inc., P.O. Box 428, Stoughton, WI 53589, J. Acoust. Soc. Amer., 72 (4), pp 1208-1211 (Oct 1982) 7 figs, 5 refs

Key Words: Silencers, Noise reduction

A series of insertion loss measurements was made using an impedance tube with a broadband noise generator and anechoic termination as well as a small, four-stroke, single cylinder gasoline engine on a variety of expansion chambers to determine the effect of inlet/outlet locations on higher order mode propagation. Higher order mode excitation was evaluated for a variety of chamber diameters, outlet offsets, combined inlet and outlet offsets, and inlet and outlet angular positions.

83-349
Coherent Structure and Jet Noise
R.E.A. Arndt and D.F. Long
St. Anthony Falls Hydraulic Lab., Univ. of Minnesota, Mississippi River at Third Ave. S.E., Minneapolis, MN 55414, Shock Vib. Dig., 14 (10), pp 3-10 (Oct 1982) 5 figs, 1 table, 40 refs

Key Words: Sound propagation, Reviews

This review on aeroacoustics research focuses on the existence of coherent structures in turbulent flow. Their possible influence on sound radiation is also described.

83-350
Generation of Noise by Turbulence
R. Legendre
Office National d'Etudes et de Recherches Aerospatiales, Paris, France, Rept. No. ONERA-P-1981-3, ISSN-0078-379X, 35 pp (1981)
N82-24946
(In French)

Key Words: Noise generation, Turbulence

The notion of noise source is elaborated, distinguishing between turbulent agitation, which is a cause, and acoustic agitation which is a minor effect or subproduct whose essential particularity is its propagation at the speed of sound. This allows for a precise definition of noise, derived from acoustic potential and apart from pseudo-noise linked to turbulence. The equation, valid for this potential, is established by an almost complete elimination of state variables and is linearized. This enables a study of convection and refraction effects and shows that generated noise is in proportion to the density relative variation rate.

83-351
Source Identification by the Coherence Analysis of Transient Sound Radiation
T. Lahti
LVI-tekniikan Lab., Valtion Teknillinen Tutkimuskeskus, Espoo, Finland, Rept. No. VTT/RR-48/1981, ISBN-951-38-1371-1, 63 pp (1981)
PB82-240946

Key Words: Noise source identification

Recent theoretical development in the field of partial coherence analysis of multiple input systems is reviewed. Relevant computational procedures for applying this theory to identifying sound radiation from transient noise sources are presented briefly. The procedures are used to analyze a tape recording of the surface acceleration and radiated noise of a punch press. Several multiple input systems are formed and analyzed both with and without time delay compensation.

83-352
Dependence of Acoustic Emission Signal Statistic Characteristics in Brittle Rocks on the Change of Uniaxial Compressive Load
C. Radu, I. Rugina, G. Winter, and V. Winter

Center of Earth Physics and Seismology, Bucharest-Magurele, Romania, Rev. Roumaine Sci. Tech., Mecanique Appl., 27 (3), pp 391-400 (May/June 1982) 9 figs, 4 refs

Key Words: Acoustic emission, Rocks, Statistical analysis

The paper is devoted to the study of statistic characteristics of acoustic emission signals obtained during the microfracturing process of limestone and granite samples. The time and amplitude distribution of acoustic emission signals and also the distribution of spectral power density obtained during uniaxial compressive tests with several loading speeds are studied. Their dependence and the change of loading parameters are pointed out.

83-353

Acoustic Scattering Analysis for Remote Sensing of Manganese Nodules

Y. Ma

Ph.D. Thesis, Virginia Polytechnic Inst. and State Univ., 181 pp (1982)

DA8220660

Key Words: Acoustic scattering, Spheres

The theory of the scattering of plane waves in a fluid medium by an isotropic elastic sphere representing a manganese nodule is developed. Scattering cross sections were computed using the theory and the results are presented graphically. The scattering cross section and the reflectivity factor govern the characteristic acoustic signature of the Pacific where manganese nodules are present. Preliminary experimental data for the compressional and shear wave speeds in nodule material is given. This data was used in the scattering computations. Limiting cases of Rayleigh scattering and scattering from fixed rigid and fluid spheres are also shown for comparison. It is shown that the rigidity of the nodules dominates the high frequency response.

83-354

Optimization Techniques and Inverse Problems: Probing of Acoustic Impedance Profiles in Time Domain

D. Lesselier

Laboratoire des Signaux et Systémes, Group d'Electromagnétisme, C.N.R.S. -- E.S.E., Plateau du Moulon 91190 Gif-sur-Yvette, France, J. Acoust. Soc. Amer., 72 (4), pp 1276-1284 (Oct 1982) 7 figs, 1 table, 14 refs

Key Words: Acoustic impedance, Time domain method

A method of acoustic probing of an inhomogeneous plane stratified medium is discussed. The impedance profile is reconstructed from a time-domain analysis of the pressure reflected when this medium is illuminated by a known pulse. This analysis is made from an exact integral formulation in an iterative manner by means of the optimization theory. At each step, the direct problem (scattered pressure computation) and its related adjoint problem are solved for a given impedance profile. The behavior of this probing procedure is examined particularly in comparison with known approximated techniques based on a deconvolution process.

83-355

The Inverse Scattering Problem for Acoustic Waves

D.L. Colton

Applied Mathematics Inst., Univ. of Delaware, Newark, DE, Rept. No. AFOSR-TR-82-0543, 22 pp (Mar 1982)

AD-A117 048

Key Words: Sound waves, Elastic waves, Wave diffraction

A distinction is made between scattering and diffraction; the latter is basically a high frequency phenomena whereas the former is more accurately applied to low and intermediate values of the frequency. Attention is given to the scattering of a plane time harmonic wave by a fixed bounded obstacle situated in a homogeneous medium and particularly to determine information about this obstacle from a knowledge of the asymptotic behavior of the scattered wave.

83-356

Frequency Dispersion of Sound in Undersea Propagation

A.A. Gerlach, K.D. Flowers, R.B. Johnson, Jr., W.L. Anderson, and E.L. Kunz

Naval Res. Lab., Washington, DC, Rept. No. NRL-8600, 53 pp (June 17, 1982)

AD-A116 105

Key Words: Underwater sound, Sound propagation

Acoustic dispersion in a deep ocean channel is characterized by the dependence of sound propagation speed on signal frequency along the axial propagation path. A model normal-mode solution of the wave equation is employed to compute the acoustic field for sinusoidal signals as a function of both axial range and frequency. A virtual propagation time is defined, which reflects the range-dependent phase of the acoustic field.

83-357
The Barrier Attenuation of Garden Fences
C.G. Don and J.G. Wegner
Dept. of Appl. Physics, Caulfield Inst. of Tech., Caulfield East, Victoria 3145, Australia, Appl. Acoust., 15 (6), pp 429-444 (Nov 1982) 8 figs, 5 tables, 6 refs

Key Words: Noise barriers, Traffic noise

A study has been undertaken of the barrier attenuation produced by 40 different finite garden fences shielding suburban homes from traffic noise. Two alternative techniques of measuring barrier attenuation were used and an empirical relationship between the results is obtained.

83-358
Attenuation of Noise by Windbreaks
T.A. Omran, K.A. Elshorbagy, and A.B. El-Sayed
Dept. of Forestry and Wood Tech., Dept. of Mech. Engrg., Univ. of Alexandria, Alexandria, Egypt, Appl. Acoust., 15 (6), pp 389-395 (Nov 1982) 2 figs, 4 tables, 9 refs

Key Words: Traffic noise, Noise barriers, Trees (plants)

Sound attenuation by narrow forest belts, under quasi-line source conditions has been investigated. Experiments were conducted on windbreaks of Casuarina and Eucalyptus belts, along three sites at Nobria. Windbreaks of Casuarina were found to act as sound barriers, which reduce the highway noise resulting from trucks, cars and other traffic. Reduced or even negative attenuation is, however, recorded in some locations behind mixed windbreaks of Eucalyptus and Casuarina as a result of downward scattering of acoustic propagation.

SHOCK EXCITATION

83-359
Infinite Elements for Elastodynamics
F. Medina and J. Penzien
Earthquake Engrg. Res. Ctr., Univ. of California, Berkeley, CA 94720, Intl. J. Earthquake Engrg. Struc. Dynam., 10 (5), pp 699-709 (Sept/Oct 1982) 5 figs, 2 tables, 11 refs

Key Words: Elastic waves, Wave propagation, Infinite element technique, Frequency domain method

An axisymmetric infinite element and a three-dimensional infinite element are developed to solve three-dimensional elastic wave propagation problems in unbounded media. The elements are capable of transmitting Rayleigh, shear and compressional waves in the frequency domain. A scheme to integrate numerically the characteristic matrices of the elements is formulated based upon Gauss-Laguerre quadrature.

83-360
Contact Transmission of Wave Motion between Two Solids with an Initial Gap
J.R. Barber, M. Comninou, and J. Dundurs
Dept. of Mech. Engrg. and Appl. Mech., Univ. of Michigan, Ann Arbor, MI, Intl. J. Solids Struc., 18 (9), pp 775-781 (1982) 3 figs, 5 refs

Key Words: Wave transmission, Coulomb friction, Elastic waves, Pulse excitation

This paper treats the transmission of wave motion from one solid to another when the bodies are initially separated by a small gap. If a pulse of elastic waves strikes the surface of one of the solids and the amplitude of the pulse is large enough, the solids can come into contact and interact locally. The dynamic interaction is treated using Coulomb's friction law, and a method is presented for finding the slip and stick zones in the contact region when the incidence angle of the pulse is subcritical. Unusual results are encountered for large friction coefficients.

83-361
Shock Waves in Deformable Dielectrics with Polarization Gradients
B. Collet
Universite Pierre et Marie Curie, Paris VI, Laboratoire de Mecanique Theorique, Tour 66, 4 place Jussieu,

75230 Paris Cedex 05, France, Intl. J. Engrg. Sci., 20 (10), pp 1145-1160 (1982) 16 refs

Key Words: Shock wave propagation

The behavior of 1-dimensional shock waves in deformable dielectric materials with polarization gradients, which are non-conductors of heat, is analyzed in the case of quasi-electrostatics. The differential equation governing the amplitude of wave and criteria concerning the polarization gradient and temperature changes across the shock are deduced.

83-362

Velocity Effects in Domestic Water Systems

A. Steele

Harza Engrg. Co., Chicago, IL, Heating/Piping/Air Cond., 54 (10), pp 45-48 (Oct 1982) 3 figs, 1 table

Key Words: Hydraulic shock, Water hammer, Cavitation, Water pipelines, Pipelines

Hydraulic shock, water hammer, whistling, erosion, and cavitation associated with velocity in domestic water systems are discussed.

83-363

Simultaneous Airblast and Ground Motion Response

C.H. Dowding, C.S. Fulthorpe, and R.T. Langan

Northwestern Univ., Evanston, IL 60201, ASCE J. Struc. Div., 108 (ST11), pp 2363-2378 (Nov 1982) 11 figs, 2 tables, 16 refs

Key Words: Air blast, Ground motion, Explosions, Structural response

A single-degree-of-freedom approach is used to model structural response to superimposed airblast and ground vibration from conventional explosions. A method is used whereby the force applied to the structure by the airblast is combined with the force due to the ground motion into a single exciting force. The use of field data permits comparison of model response to actual measured structural response.

83-364

Three Dimensional Rigid Body Dynamics Using Euler Parameters and Its Application to Structural Collapse Mechanisms

I.S. Chung

Ph.D. Thesis, Univ. of Iowa, 145 pp (1982)
DA8222220

Key Words: Dynamic analysis, Rigid bodies, Collision research (automotive)

A computer-based method is presented for formulation and efficient solution of nonlinear, constrained differential equations of motion for spatial dynamic analysis of mechanical systems and its application to plastically deformable structures. Nonlinear holonomic constraint equations and differential equations of motion are written in terms of a maximal set of Cartesian generalized coordinates.

VIBRATION EXCITATION

83-365

Transonic Flutter and Response Analyses of Two 3-Degree-of-Freedom Airfoils

T.Y. Yang and C.H. Chen

Purdue Univ., West Lafayette, IN, J. Aircraft, 19 (10), pp 875-884 (Oct 1982) 19 figs, 33 refs

Key Words: Airfoils, Flutter

Flutter and time-response analyses are performed for a NACA 64A006 conventional and a MBB A-3 supercritical airfoil, both oscillating with plunge, pitch, and aileron pitch degrees-of-freedom in small-disturbance transonic flow. The aerodynamic coefficients are calculated using the transonic code LTRAN2-NLR. The effects of various kinds of aeroelastic parameters on flutter speeds for the bending-torsion, bending-aileron, and torsion-aileron branches are studied.

83-366

A Harmonic Analysis Method for Unsteady Transonic Flow and Its Application to the Flutter of Airfoils

F.E. Ehlers and W.H. Weatherill

Boeing Commercial Airplane Co., Seattle, WA, Rept. No. NASA-CR-3537, 151 pp (May 1982)
N82-25194

Key Words: Airfoils, Flutter, Harmonic analysis, Finite difference method

A finite difference method for solving the unsteady transonic flow about harmonically oscillating wings is investigated. The procedure is based on separating the velocity potential into steady and unsteady parts and linearizing the resulting unsteady differential equation for small disturbances.

83-367
Weakly Nonlinear High Frequency Waves
J. Hunter
Mathematics Res. Ctr., Univ. of Wisconsin, Madison, WI, Rept. No. MRC-TSR-2381, 60 pp (May 1982) AD-A116 246

Key Words: High frequency response

A method is derived for finding small amplitude high frequency solutions to hyperbolic systems of quasilinear partial differential equations.

83-368
Analysis of Mirnov Oscillations on PDX
G. Hammett and K. McGuire
Plasma Physics Lab., Princeton Univ., NJ, Rept. No. PPPL-1854, 37 pp (Feb 1982)
DE82009816

Key Words: Magnetic coils, Magnetohydrodynamics

Mirnov coils have been used to study MHD oscillations in PDX. The information obtained from Mirnov coils concerning the amplitude of these oscillations and their toroidal and poloidal mode numbers is reviewed.

83-369
Third Overtone Quartz Resonator
R.D. Mindlin
Intl. J. Solids Struc., 18 (9), pp 809-817 (1982) 3 figs, 7 refs

Key Words: Quartz resonators, Plates, Equations of motion

The Lee-Nikodem equations of motion of elastic plates are solved for the case of vibrations of an AT-cut quartz strip with free faces and edges at frequencies up to and including the third harmonic thickness-shear overtone.

83-370
The Resonance Behaviour of a Non-linear, Harmonically Excited Two-Mass Oscillator as a Function of the System Parameters. Mathematical Studies Using the Example of the Cubic Return Functions (Das Resonanzverhalten des nichtlinearen, harmonisch erregten Zweimassenschwingers in Abhängigkeit von den Systemparametern. Mathematische Untersuchungen am Beispiel der kubischen Rückführfuktionen)
R. Klingenberg and C. Troeder
VDI-Z., 124 (14), pp 539-548 (1982) 20 figs, 2 tables, 8 refs
(In German)

Key Words: Two degree of freedom systems, Torsional vibration, Harmonic excitation, Resonant response

Using as an example a harmonically excited two-mass torsional oscillator with a cubic return function, on the basis of a parameter study, information is provided on the influences exerted on the resonance behavior of the oscillator on stationary operation by nonlinearity, damping and degree of excitation. The differential equation of motion is given a mathematically closed solution.

83-371
Eigenfrequency Changes of Structures Due to Cracks, Notches or Other Geometrical Changes
P. Gudmundson
BBC Brown Boveri Res. Ctr., CH-5405 Baden, Switzerland, J. Mech. Phys. Solids, 30 (5), pp 339-353 (Oct 1982) 9 figs

Key Words: Natural frequencies, Cracked media, Geometric imperfection effects

A first order perturbation method is presented which predicts the changes in resonance frequencies of a structure resulting from cracks, notches or other geometrical changes. The eigenfrequency changes due to a crack are shown to be dependent on the strain energy of a static solution which is easily obtainable for small cracks and other small cut-outs. The method has been tested for three different cases, and the predicted results correlate very closely to experimental and numerical results.

83-372
On the Reliability of the Linear Oscillator and Systems of Coupled Oscillators
L.A. Bergman and J.C. Heinrich

Dept. of Theoretical and Appl. Mech., Univ. of Illinois at Urbana-Champaign, Urbana, IL, Intl. J. Numer. Methods Engrg., 18 (9), pp 1271-1295 (Sept 1982) 20 figs, 1 table, 23 refs

Key Words: Oscillators, Boundary value problems, Finite element technique

The reliability of the linear, single-degree-of-freedom oscillator subjected to stationary Gaussian white noise is determined via direct numerical solution of an initial-boundary value problem by a Petrov-Galerkin finite element method. Also included is the extension to a modulated white noise excitation and the determination of the reliability of systems of coupled oscillators having certain prescribed damping characteristics.

83-373
Dynamics of Two Strongly Coupled Van der Pol Oscillators
D.W. Storti and R.H. Rand
Dept. of Theoretical and Appl. Mech., Cornell Univ., Ithaca, NY 14853, Intl. J. Nonlin. Mech., 17 (3), pp 143-152 (1982) 5 figs, 1 table, 15 refs

Key Words: Oscillators, Van der Pol method, Perturbation theory

A perturbation method is used to study the steady state behavior of two Van der Pol oscillators with strong linear diffusive coupling. It is shown that a bifurcation occurs which results in a transition from phase-locked periodic motions to quasi-periodic motions as the coupling is decreased or the detuning is increased. The analytical results are compared with a numerically generated solution.

83-374
Mode Analysis of a System of Mutually Coupled Van der Pol Oscillators with Coupling Delay
A. Kouda and S. Mori
Tokyo Univ. of Agriculture and Tech., Tokyo 184, Japan, Intl. J. Nonlin. Mech., 17 (4), pp 267-276 (1982) 6 figs, 13 refs

Key Words: Oscillators, Van der Pol method, Modal analysis

A system of mutually coupled van der Pol oscillators containing fifth-order conductance characteristic, with the coupling delay, are analyzed using the nonlinear mode analysis. It is demonstrated that zero state, two single modes, and one double mode are stable only for sufficiently small τ. Analytical results are verified using the digital simulation.

83-375
On the Coupling between a Vibrating Mechanical System and the External Forces Acting on It
M. Roseau
Université Pierre et Marie Curie, Mecanique Theo-rique, 4 Place Jussieu-Tour 66, 75230 Parix, Cedex 05, France, Intl. J. Nonlin. Mech., 17 (3), pp 211-216 (1982) 2 figs, 5 refs

Key Words: Periodic excitation, Vibrating structures, Coupled response

A theoretical model is proposed to investigate the coupling effects between a mechanical system acted upon by periodic forces and the exciting device; application to the Bouasse-Sarda regulator is presented.

MECHANICAL PROPERTIES

DAMPING

(Also see Nos. 269, 299)

83-376
Angular Region: A Measure of Underdamped Behavior
F.M. Reza
Dept. of Elec. Engrg., Concordia Univ., Sir George Williams Campus, 1455 de Maisonneuve Blvd West, Montreal, Quebec H3G 1M8, Canada, J. Franklin Inst., 314 (3), pp 191-202 (1982) 2 figs, 5 refs

Key Words: Underdamped structures, Mode shapes

The natural modes of an underdamped dynamical system are given. The paper is motivated by Duffin-Krein-Gohberg's earlier mathematical contributions.

83-377

Linear and Nonlinear Analysis of Fluid Slosh Dampers

B.A. Sayar and J.R. Baumgarten
South Dakota State Univ., Brookings, SD, AIAA J., 20 (11), pp 1534-1538 (Nov 1982) 10 figs, 12 refs

Key Words: Damped structures, Vibration dampers

A vibrating structure and a container partially filled with fluid are considered coupled in a free vibration mode. To simplify the mathematical analysis, a pendulum model to duplicate the fluid motion and a mass-spring dashpot representing the vibrating structure are used. The equations of motion are derived by Lagrange's energy approach and expressed in parametric form.

83-378

Anelastic Damping in Aluminum

R.J. Austin
Ph.D. Thesis, Stanford Univ., 135 pp (1982)
DA8220422

Key Words: Damping, Aluminum

Anelastic damping of metals is attributable to several types of crystalline defects. Some of these imperfections have a capacity for absorbing energy which is detectable using a torsion pendulum. At frequencies near one Hertz, and at temperatures above twenty percent of the homologous temperature, damping was observed which increases monotonically with increasing temperature and reaches values greater than any known anelastic spectral lines. The object of this dissertation is to rationalize this damping phenomenon in terms of arrays of mobile dislocations.

FATIGUE

(Also see No. 314)

83-379

A Theoretical Study on Fatigue Life Distribution of Metallic Materials Based on the Distribution of Surface Defects

T. Sakai and T. Tanaka
Faculty of Science and Engrg., Ritsumeikan Univ., Kyoto, Japan, Bull. JSME, 25 (207), pp 1347-1353 (Sept 1982) 10 figs, 18 refs

Key Words: Fatigue (materials), Fatigue life, Initial deformation effects, Cyclic loading

Fatigue cracks of metallic materials are initiated at surface defects such as inclusions, fine flaws, slip bands in individual grains and grain boundaries; and the final failure is caused through the propagation process of these cracks under subsequent cyclic loading. By introducing the probabilistic distribution of surface defects, the fatigue life distribution of the metallic materials is theoretically derived.

83-380

Multiaxial Fatigue Criteria for AISI 304 and 2-1/4 Cr-1 Mo Steel at 538 exp 0 C with Applications to Strain-Range Partitioning and Linear Summation of Creep and Fatigue Damage

J.J. Blass
Oak Ridge Natl. Lab., TN, Rept. No. CONF-820121-1, 33 pp (1982) (Presented at DOE/PNC specialists' meeting on structural material data, Tokyo, Japan, Jan 25, 1982)
DE82010195

Key Words: Fatigue life, Steel

An improved multiaxial fatigue failure criterion was developed based on the results of combined axial-torsional strain cycling tests of AISI 304 and 2-1/4 Cr-1 Mo steel conducted at 538 exp 0 C (1000 exp 0 F). The formulation of this criterion involves the shear and normal components of inelastic strain range on the planes of maximum inelastic shear strain range.

83-381

A Phenomenological Approach for the Analysis of Combined Fatigue and Creep

T. Bui-Quoc and A. Biron
Dept. of Mech. Engrg., Ecole Polytechnique, Montreal, Quebec, Canada, Nucl. Engrg. Des., 71 (1), pp 89-102 (July 1982) 22 figs, 26 refs

Key Words: Fatigue life

An approach is proposed for the life prediction, under cumulative damage conditions, for fatigue and creep. An interaction effect is introduced to account for a modification in the material behavior due to previous loading. A predictive technique is then developed which is applied to several materials for fatigue and which could potentially be used for creep.

83-382

International Symposium on Fatigue Thresholds

A.F. Blom and J. Baecklund

Aeronautical Res. Inst. of Sweden, Stockholm, Sweden, Rept. No. FFA-TN-HU-2274, 121 pp (Nov 1981)

N82-25548

Key Words: Fatigue life, Proceedings

The proceedings of a conference on fatigue thresholds are reported. The following topics are included: case studies, computation experimental techniques and high temperature applications of fatigue thresholds, environmental conditions, low crack growth rates, micromechanics and mixed mode thresholds, nondestructive testing, nonmetallic materials, short cracks and spectrum loading.

83-383

Methodology for Evaluation of Fatigue Crack Growth Resistance of Aluminum Alloys under Spectrum Loading

G.R. Chanani, I. Telesman, P.E. Bretz, and G.V. Scarich

Aircraft Div., Northrop Corp., Hawthorne, CA, Rept. No. NOR-82-54, 148 pp (Apr 1982)

AD-A116 500

Key Words: Fatigue life, Crack propagation

The purpose of this program is to obtain guidelines and test methodologies for selection and development of spectrum resistant, higher strength aluminum alloys for application to aircraft structures. The results described in this report present baseline characteristics of a number of high strength aluminum alloys for use in the future phases of this investigation.

83-384

A Study of Cumulative Fatigue Damage in 2011-T3 Aluminum Alloy

S. Jeelani and P.A. Reddy

School of Engrg., Tuskegee Inst., AL, Rept. No. TI-NAVY-3, 70 pp (Aug 1981)

AD-A116 513

Key Words: Fatigue life, Test facilities, Experimental data

This report describes the experimental facility developed at Tuskegee Institute, Tuskegee, Alabama, to study the effect of cumulative fatigue damage in selected materials. Analysis of the data indicates that the predicted cumulative fatigue damage and fatigue life are in close agreement for low-high and low-high mixed stress sequences under all stress ratios as compared with those obtained experimentally, whereas the theoretical values for high-low and high-low mixed stress sequences under all stress ratios are more conservative than those obtained experimentally.

83-385

Determination of Threshold Stress Intensities: Fatigue of Low Alloy Steel BS4360-50D

J.C. Radon

Dept. of Mech. Engrg., Imperial College of Science and Tech., Exhibition Rd., London SW7 2BX, UK, Intl. J. Fatigue, 4 (4), pp 225-232 (Oct 1982) 12 figs, 2 tables, 10 refs

Key Words: Fatigue life, Steel

An experimental method for obtaining the effective stress intensities necessary for cyclic crack growth prediction is described. The threshold values obtained compare well with the experimentally observed values for a structural steel BS 4360-50D and for other steels.

83-386

Cyclic Response of a 1Cr-Mo-V Low Alloy Steel

W.J. Plumbridge and R.A. Bartlett

Dept. of Mech. Engrg., Univ. of Bristol, Queen's Bldg., Univ. Walk, Bristol, BS8 1TR, UK, Intl. J. Fatigue, 4 (4), pp 209-216 (Oct 1982) 9 figs, 22 refs

Key Words: Fatigue life, Steel

The high strain fatigue behavior of a bainitic (non-heat-treated) and a tempered bainitic (heat-treated) alloy steel has been studied at room temperature and 565°C. Cyclic softening is observed in all cases and is associated with dislocation redistribution, alignment and channelling of precipitates, and their growth at 565°C. Comparison of the appropriate monotonic and cyclic stress/strain curves enables a tentative estimate of the relative significance of these mechanisms to be made.

83-387

Fracture of Fatigue-Loaded Composite Laminates

K.L. Reifsnider and R. Jamison

College of Engrg., Virginia Polytechnic Inst. and State Univ., Blacksburg, VA, Intl. J. Fatigue, 4 (4), pp 187-197 (Oct 1982) 21 figs, 1 table, 18 refs

Key Words: Layered materials, Fatigue life

While the quasi-static fractu e load of many composite laminates can be estimated with engineering accuracy, the fracture event itself has not been clearly characterized and is incompletely understood. When cyclic loading is present, the pre-fracture damage state is altered significantly, so that estimating strength (or residual strength) is greatly complicated. The present paper examines this complexity and attempts to assess the manner in which prefracture fatigue damage affects residual strength and the fracture event.

83-388

Cumulation of the Fatigue Damage and Calculation of Fatigue Life under Random Environmental Loading

V. Kliman

Inst. of Materials and Machine Mechanics of the Slovak Academy of Sciences, Bratislava, Czechoslovakia, Strojnícky Časopis, 33 (4), pp 413-425 (1982) 5 figs, 11 refs

(In Slovak)

Key Words: Fatigue life, Random excitation

This paper is concerned with the method of fatigue life prediction under environmental loading, based on the energy criterion of fatigue strength. The principal of this method is transformation of the random loading process to the fictive harmonic equivalent loading. The criterion of such transformation can be postulated as the same fatigue damage during a certain time t, supposing that the fatigue damage is characterized by the accumulated hysteresis energy.

83-389

Variable Load Fatigue. Eighth Report: The Effects of Specimen Size and a Fillet Rolling Process

D.H. Wright

Motor Industry Res. Assn., Nuneaton, UK, Rept. No. 1981/3, 19 pp (1981)

MIRA-82/22

Key Words: Fatigue life, Variable amplitude excitation, Suspension systems (vehicles)

Plane-bending tests are described in which both small and large cantilever specimens are subjected to constant-amplitude loading and to a loading history recorded from a passenger-car front suspension component. Fillet rolling is also examined.

83-390

A Model for Fatigue Crack Propagation Based on the Cumulative Damage Concept

D.D. Cioclov

The Inst. of Welding and Metal Testing, Timisoara, Romania, Rev. Roumaine Sci. Tech., Mecanique Appl., 26 (6), pp 891-897 (Nov/Dec 1981) 6 figs, 18 refs

Key Words: Fatigue life, Crack propagation

A fatigue crack propagation model is derived based on the evaluation of the cumulative fatigue damage in the crack-tip plastic enclave. The evaluation of the cyclic plastic enclave extension at the crack tip and the associated crack-opening displacement variation within the enclave, coupled with a linear cumulative fatigue damage rule, are the essential features of the proposed model.

83-391

The Combined Effects of Mean Stress and Aggressive Environments on Fatigue Crack Growth

J.A. Kapp

Large Caliber Weapon Systems Lab., Army Armament Res. and Dev. Command, Watervliet, NY, Rept. No. ARLCB-TR-82012, 27 pp (May 1982) (Presented at 1982 Joint JSME-SESA Conf. on Exptl. Mech., Honolulu, HI, May 23-30, 1982)

AD-A116 562

Key Words: Crack propagation, Fatigue life

Experiments were performed to study the combined effects of aggressive environment and mean stress on fatigue crack growth. Since mean stress changes also change the stress ratio, experiments were performed to measure fatigue crack growth rates for various values of constant R. The experimental results were approximated mathematically using a modified superposition model.

83-392

The Effects of Friction-Induced Vibration on Friction and Wear

K. Kato, A. Iwabuchi, and T. Kayaba
Dept. of Mech. Engrg., Faculty of Engrg., Tohoku Univ., Sendai 980 Japan, Wear, 80 (3), pp 307-320 (Sept 1, 1982) 14 figs, 1 table, 6 refs

Key Words: Friction excitation, Wear

Friction tests were carried out with an elastic system where the specimen was supported by the elastic plate spring with strain gauges and with a rigid system where the vibration of the specimen was restricted. The coefficient of friction was obtained by two different methods: a deflection method with an assembly that consisted of a spring and strain gauges and an inertia method with a flywheel. The friction and wear properties of steel-steel, white metal-steel, phosphor bronze-steel and bronze-steel pairs were examined.

83-393

Dynamic Stress Intensity Factors Around a Rectangular Crack in a Half-Space under Impact Load

S. Itou
Dept. Mech. Engrg., Hachinohe Inst. of Tech., Hachinohe, Japan, Z. angew. Math. Mech., 62 (7), pp 301-311 (July 1982) 2 figs, 1 table, 29 refs

Key Words: Cracked media, Impact response, Fracture properties

The three-dimensional impact response of a rectangular crack in a semi-space is considered. Application of the Laplace and Fourier transforms reduces the problem to the solution of a pair of dual integral equations. To solve these equations, the crack surface displacement is expanded in a double series of functions which are zero outside of the crack. The unknown coefficients accompanied in this series are solved with the aid of the Schmidt method. Numerical results on the stress intensity factors are obtained.

83-394

The Study of Dynamic Fracture Problems Using Finite Element Method

K.-W. Chan
Ph.D. Thesis, Clarkson College of Tech., 184 pp (1982)
DA8220244

Key Words: Fracture properties, Finite element techniques, Numerical analysis

Numerical methods for determining stress intensity factors for elastodynamic crack problems in finite bodies of arbitrary shapes are presented, wherein linear-elastic material behavior and two-dimensional conditions prevail. Problems of plane stress and plane strain are solved by using singular quarter-point isoparametric elements.

ELASTICITY AND PLASTICITY

83-395

On the Solution of Elastic-Plastic Static and Dynamic Postbuckling Collapse of General Structure

J. Padovan and S. Tovichakchaikul
Dept. of Mech. Engrg., The Univ. of Akron, Akron, OH 44325, Computers Struc., 16 (1-4), pp 199-205 (1983) 5 figs, 3 tables, 11 refs

Key Words: Dynamic buckling

This paper develops a solution algorithm which enables the analysis of both static and dynamic large deformation elastic and elastic-plastic postbuckling problems of general structure. This is made possible through the use of a hyperellipsoidal constraint surface which self-adaptively controls the iteration process associated with the BFGS updated Newton Raphson scheme. Coupling this algorithm with implicit and explicit time integration operators, several numerical examples are presented which illustrate the efficiency and inherent stability of the scheme developed.

83-396

Wave Momentum and Scattering of Elastic Waves by Two-Dimensional Thin Objects

W. Möhring
Max-Planck-Institut f. Strömungsforschung, Göttingen, W. Germany, Wave Motion, 4 (4), pp 339-347 (Oct 1982) 1 fig, 8 refs

Key Words: Wave propagation, Elastic waves, Wave diffraction

The elastic wave momentum equation is applied to scattering of dilatational and shear waves by two-dimensional thin objects. It is shown that the sources of wave momentum are located at the edges of these objects. An application to inverse scattering problems is also given.

83-397
Some Exact Solutions for Wave Propagation in Viscoelastic, Viscoplastic and Electrical Transmission Lines
W.F. Ames and I. Suliciu
School of Mathematics, Georgia Inst. of Tech., Atlanta, GA 30332, Intl. J. Nonlin. Mech., 17 (4), pp 223-230 (1982) 1 fig, 7 refs

Key Words: Transmission lines, Viscoelastic media, Viscoplastic media, Wave propagation

For the subject media the constitutive laws remaining invariant under the dilatation and spiral groups are determined. Exact invariant solutions are constructed for a classical (linear) material, for a quadratic constitutive law and for a linear viscoelastic material. A viscoplastic material is studied in the light of group analysis and the machinery to determine the solution (numerically) for a variety of viscoplastic problems is established.

83-398
Comparison of the Unloading and Reversed Loading Behavior of Three Viscoplastic Constitutive Theories
E.P. Cernocky
Dept. of Mech. Engrg., Univ. of Colorado, Boulder, CO 80309, Intl. J. Nonlin. Mech., 17 (4), pp 255-266 (1982) 6 figs, 43 refs

Key Words: Viscoplastic properties, Constitutive equations, Cyclic loading

The predictions of three constitutive theories of viscoplasticity are compared in uniaxial homogeneous reversed loading. Both analytical and numerical methods are used to highlight similarities and differences in the predictions of the theories.

EXPERIMENTATION

MEASUREMENT AND ANALYSIS

(Also see No. 285)

83-399
Application of Pulse Code Modulation Technology to Aircraft Dynamics Data Acquisition
D. Brown
Flight Dynamics Lab., Wright-Patterson Air Force Base, OH, J. Aircraft, 19 (11), pp 934-939 (Nov 1982) 5 figs, 5 tables, 10 refs

Key Words: Pulse code modulation, Flight test data, Digital techniques

The application of pulse code modulation digital techniques to record dynamics data (20 kHz bandwidth) during flight tests is discussed. This approach is compared with current frequency modulation analog data recording technology and is found to provide a significant increase in both the dynamic range and number of data channels recorded simultaneously.

83-400
Determination of Sound Power Levels of External Noise Sources. Part 1: Measurement Methods. Part 2: Some Measurements
H.G. Jonasson and L. Eslon
Acoustics Lab., Statens Provningsanstalt, Boraes, Sweden, Rept. No. SP-RAPP-1981:45, 76 pp (1981) N82-25912

Key Words: Sound power levels, Measurement techniques, Standards and codes

A general frame standard for determining sound power levels of external noise sources by in situ measurements is proposed. Suitable ISO standards, a long distance method which permits directivity measurement and a short distance method are incorporated.

83-401
Automated Measuring System for Sound Power Measurement
T. Yanagisawa and W. Tsujita
Faculty of Engrg., Shinshu Univ., 500 Wakasato, Nagano 380, Japan, Appl. Acoust., 15 (6), pp 445-457 (Nov 1982) 9 figs, 2 tables, 5 refs

Key Words: Sound pressure levels, Measurement techniques, Computer-aided techniques

The development of an automatic measuring system for sound power is discussed and it is shown that the sound power obtained with the system devised agrees well with that obtained by more familiar means.

83-402

New Approaches to Finite Impulse Response Digital Filter Design

J.W. Adams

Ph.D. Thesis, Univ. of California, Los Angeles, CA, 97 pp (1982)

DA8219627

Key Words: Filters, Digital filters, Impulse response

A novel approach to the design of efficient finite impulse response digital filters is investigated. The essence of the proposed method is to decompose the design problem into two parts: the realization of an efficient prefilter and the design of the corresponding equalizer. It is shown that this method can provide benefits in three areas: reduced computational complexity, reduced sensitivity to coefficient quantization, and reduced roundoff noise. Various classes of prefilter structures are explored, and an extension to the Kaiser-Hamming filter sharpening method is presented.

83-403

Structural Dynamics Analyses Testing and Correlation

T.K. Caughey

Jet Propulsion Lab., Pasadena, CA, Rept. No. NASA-CR-168993, 59 pp (May 1, 1982)

N82-25532

Key Words: Vibration tests, Mathematical models

Some aspects of the lack of close correlation between the predictions of analytical modeling of dynamic structures and the results of vibration tests on such structures are examined. Ways in which the correlation may be improved are suggested.

83-404

New Presentations Aid Understanding of Vibration Data

J.M. Schachner

Nicolet Scientific Corp., S/V, Sound Vib., 16 (9), pp 6, 8, 10-11 (Sept 1982) 5 figs, 8 refs

Key Words: Spectrum analyzers

The capabilities of the 100A-10 spectrum analysis system are described. Examples of new data presentations are shown and applications to machinery vibration analysis are noted.

DYNAMIC TESTS

(Also see No. 428)

83-405

Methodology Investigation of Improvement of Shock and Vibration Testing Schedules for Transport of Loose, Restrained and Secured Cargo

E.L. Ehlers and H.T. Cline

Harry T. Cline and Associates, Churchville, MD, Rept. No. APG-MT-5521, 48 pp (Sept 1981)

AD-B060 211

Key Words: Cargo transportation, Ammunition, Vibration tests, Shock tests, Testing techniques

This investigation was developed to study and document the number of miles that cargo is transported as secured, restrained and/or loose cargo as a basis for future work in developing more realistic laboratory vibration and loosely stowed cargo test schedules.

DIAGNOSTICS

(Also see No. 409)

83-406

A Comprehensive Survey of Digital Transmultiplexing Methods

H. Scheuermann and H. Gockler

AEG-Telefunken Kommunikationstechnik, P.O.B. 1120, D-7150 Backnang, Germany, IEEE, Proc., 69 (11), pp 1419-1450 (Nov 1981) 29 figs, 2 tables, 92 refs

Key Words: Digital transmultiplexing methods, Signal processing techniques

An attempt is made to describe the great majority of all known methods of digital transmultiplexing (conversion) of time-division-multiplex to frequency-division-multiplex signals, and vice versa. To this end, the individual transmultiplexer approaches are classified into four categories according to the underlying algorithm: bandpass filter bank, low-pass filter bank, Weaver structure method, and multistage modulation method. The overall performance of the various transmultiplexer approaches are compared.

83-407

Ferrography: Machinery-Wear Analysis with a Predictable Future

P.S. Baur

Power, 126 (10), pp 114-117 (Oct 1982) 19 figs, 3 refs

Key Words: Diagnostic techniques

In ferrography, oil samples from rotating equipment provide quantitative and qualitative data to determine when abnormal wear begins, its causes, and the failing component before vibration monitors sense danger. The method, its advantages, disadvantages, and its costs, are described.

83-408
A Data Dependent Systems Strategy of On-Line Tool Wear Sensing
S.M. Pandit and S. Kashou
Michigan Technological Univ., Houghton, MI 49931, J. Engrg. Indus., Trans. ASME, 104 (3), pp 217-223 (Aug 1982) 10 figs, 6 tables, 24 refs

Key Words: Machine tools, Diagnostic techniques, Wear, Data Dependent Systems

An indirect method of tool wear sensing and critical wear detection is suggested. It is based on the Data Dependent Systems (DDS) modeling of vibrations from an accelerometer mounted on the tool holder at a safe distance away from the cutting process. The DDS provides an estimate of the tool acceleration component, sensitive to wear alone, at the natural frequency of the tool confirmed by impulse response testing.

MONITORING

83-409
Power Plant Monitoring and Diagnostics
B.L. Bannister
Westinghouse Electric Corp., Philadelphia, PA, S/V, Sound Vib., 16 (9), pp 16-19 (Sept 1982) 3 figs, 2 tables, 48 refs

Key Words: Power plants (facilities), Monitoring techniques, Diagnostic techniques

Improvement of power plant operating availability, a key issue with the U.S. utility industry, is based on generic problem identification and solution, and on minimizing the time to repair. One concept to improve power plant availability includes automated surveillance and diagnostics as reviewed in this article.

ANALYSIS AND DESIGN

ANALYTICAL METHODS
(Also see No. 280)

83-410
An Exact Solution to a Certain Non-Linear Random Vibration Problem
M.F. Dimentberg
Inst. for Problems of Mechanics, USSR Academy of Sciences, 101 Vernadskogo Prospect, Moscow, U.S.S.R. 117526, Intl. J. Nonlin. Mech., 17 (4), pp 231-236 (1982) 5 refs

Key Words: Exact methods, Random vibration, Nonlinear damping

A single-degree-of-freedom system with a special type of nonlinear damping and both external and parametric white-noise excitations is considered. For the special case, when the intensities of coordinates and velocity modulation satisfy a certain condition, an exact analytical solution is obtained to the corresponding stationary Fokker-Planck-Kolmogorov equation yielding an expression for joint probability density of coordinate and velocity.

83-411
Dynamic Behavior from Asymptotic Expansions
J.K. Hale and L.C. Pavlu
Lefschetz Ctr. for Dynamical Systems, Brown Univ., Providence, RI, Rept. No. LCDS-82-11, AFOSR-TR-82-0512, 22 pp (May 1982)
AD-A117 261

Key Words: Asymptotic approximation

Stability properties of solutions of periodic and almost periodic differential equations containing a small parameter are discussed.

83-412
The Application of Crossed Products to the Stability and Design of Time-Varying Systems
J.J. Murray

Dept. of Electrical Engrg., Texas Tech. Univ., Lubbock, TX, Rept. No. AFOSR-TR-82-0577, 8 pp (June 14, 1981)
AD-A116 998

Key Words: Stability, Time-dependent parameters

The research conducted for the past two years into linear time-varying systems is outlined. Crossed product algebras make precise the intuitive idea of a class of systems which can be synthesized from the usual delay elements and a fixed class of time-varying gains. It is shown that crossed products appear to be a most appropriate setting for input-output analysis of linear time-varying dynamical systems; they also always admit a bounded decomposition of a Hermitian operator into the sum of a causal operator and its adjoint.

83-413

Geometrically Non Linear 3-D Dynamic Analysis of Shells

C.R. Wouters

Dept. of Continuum Mechanics, Universite Libre de Bruxelles, Belgium, Computers Struc., 15 (6), pp 667-672 (1982) 8 figs, 9 refs

Key Words: Lagrange equations, Nonlinear theories, Three dimensional problems, Spherical shells, Shells, Plates, Arches

Applications of a new code for shells of arbitrary shape are presented. The geometrically nonlinear dynamic analysis is based on a total Lagrangian formulation and the direct time integration of the equations of motion. The cost effectiveness of a static condensation is shown and comparison of numerical results for classical examples of the literature (plates, arches and spherical shells) are presented using a full 3-D code.

83-414

Integral Equation Methods for the Direct and Inverse Boundary Value Problems in the Theory of Acoustic and Electromagnetic Vibrations (Integralgleichungsmethoden bei direkten und inversen Randwertproblemen aus der Theorie akustischer und elektromagnetischer Schwingungen)

R. Kress

Inst. Numer. u. Angewandte Math., Univ. Gottingen, Gottingen, Fed. Rep. Germany, Z. angew. Math. Mech., 62 (5), pp 241-250 (May 1982) 2 figs, 77 refs (In German)

Key Words: Integral equations

Several new integral equation methods for boundary value problems in the time harmonic wave equation and time harmonic Maxwell equations are described, particularly their application to numeric approximations. In addition, the application of integral equations for inverse boundary value problems is illustrated which enable to obtain boundaries and boundary values from radiation characteristics.

83-415

Acoustic Scattering and Radiation Problems, and the Null-Field Method

P.A. Martin

Dept. of Mathematics, Univ. of Manchester, Manchester M13 9PL, UK, Wave Motion, 4 (4), pp 391-408 (Oct 1982) 2 tables, 23 refs

Key Words: Wave diffraction, Wave propagation, Elastic waves, Sound waves, Boundary value problems

The best known methods for solving the scattering and radiation problems of acoustics are integral-equation methods. The simplest of these methods yield equations which are not uniquely solvable at certain discrete sets of frequencies (the irregular frequencies). In this paper an alternative method (the null-field method, or T-matrix method) is analyzed.

83-416

Investigation of the Equation of Single-Degree-of-Freedom Vibration with Spring Nonlinearity by the Method of Integral Inequalities

R. Gutowski

Inst. of Aviation Tech. and Appl. Mech., Dept. of Mechanics, Technical Univ., Warsaw, Poland, Bull. Acad. Polon. Sci., Ser. Sci. Tech., 29 (5-6), pp 81-88 (1981) 1 ref

Key Words: Single degree of freedom systems, Vibration analysis

The behavior of solutions of the equation of single-degree-of-freedom vibration with parametric-spring nonlinearity on the semi-infinite interval of time is examined. Taking a suitable distance between the non-zero and zero solution, the problem is reduced to the investigation of a certain nonlinear integral inequality. The essential results concerning this integral inequality are demonstrated and an estimation of the solutions of the examined nonlinear differential equation is obtained in a closed form.

83-417

On a Certain Simple Criterion of Stability in Lyapunov Sense of String Vibrations with Spring Nonlinearity

R. Gutowski
Inst. of Aviation Tech. and Appl. Mech., Dept. of Mech., Technical Univ., Warsaw, Poland, Bull. Acad. Polon. Sci., Ser. Sci. Tech., 29 (5-6), p 89 (1981) 4 refs

Key Words: Strings, Vibration analysis

The differential equation of string vibrations with spring nonlinearity is considered. The essential definitions and theorems concerning the stability in the Lyapunov-Movtchan sense are recalled. The Lyapunov function and the distance between solutions are constructed and with their aid a simple criterion of stability of motion is derived. This criterion has the form of a direct condition on the spring nonlinearity.

83-418

On the Influence of the Fourier Spectrum on the Vibration Amplitude of Time-Variable Systems

N. Eicher
Technische Universität, Berlin, Germany, Forsch. Ingenieurwesen., 48 (4), pp 117-125 (1982) 2 refs (In German)

Key Words: Fourier analysis, Spectrum analysis, Time-dependent excitation

For analytic examinations a linear system under periodic parametric and separate excitation is taken into consideration. The positions of all instability intervals of the purely parametrically excited system are characterized by a formula describing the interval limits at arbitrary approximation.

83-419

Time Domain Approximations in the Solution of Fields by Time Domain Diakoptics

P.B. Johns and K. Akhtarzad
Dept. of Electrical and Electronic Engrg., The Univ. of Nottingham, Nottingham, UK, Intl. J. Numer. Methods Engrg., 18 (9), pp 1361-1373 (Sept 1982) 9 figs, 2 tables, 5 figs

Key Words: Numerical analysis, Time domain method, Approximation methods

The numerical solution of field substructures in time domain diakoptics requires an iteration time consistent with the numerical accuracy required. When storing and reconnecting the substructures, the information required can be obtained from considerably fewer samples. This paper shows how time domain approximations can further reduce the storage and computing time in space approximated time domain diakoptics.

83-420

A Uniform Asymptotic Analysis of Dispersive Wave Motion Across a Space-Time Shadow Boundary

W.B. Gordon
Dept. of Mathematics, Baruch College, NY 10010, Wave Motion, 4 (4), pp 349-369 (Oct 1982) 1 fig, 8 refs

Key Words: Wave propagation

The one dimensional Klein-Gordon equation with spatially varying coefficients and with amplitude modulated high frequency signaling data is analyzed. A formal uniformly valid asymptotic expansion of the solution across a space-time shadow boundary is obtained with the help of two families of rays.

83-421

Frequency Domain Analysis of Time Integration Operators

A. Preumont
BELGONUCLEAIRE, Rue du Champ de Mars, 25, B-1050 Brussels, Belgium, Intl. J. Earthquake Engrg. Struc. Dynam., 10 (5), pp 691-697 (Sept/Oct 1982) 4 figs, 1 table, 4 refs

Key Words: Frequency domain method, Error analysis, Time integration method

This paper analyzes the error associated with the time integration operators in structural dynamics. It considers the time integration operators as digital recursive filters. The

transfer functions of the discretized equations are derived and compared with the transfer function of the differential equation. This leads to a new approach for the accuracy analysis of the time integration operators, which is not restricted to the homogeneous part of the discretized equation.

algorithm. Some properties of dynamic unilateral problems are outlined and the influence of several parameters on the solution is investigated by means of numerical examples.

83-422

Phase Properties of a Class of Random Processes

N.C. Nigam
Dept. of Aeronautical Engrg., Indian Inst. of Tech., Kanpur, India, Intl. J. Earthquake Engrg., Struc. Dynam., 10 (5), pp 711-717 (Sept/Oct 1982) 10 refs

Key Words: Probability theory, Random response, Phase data, Time domain, Frequency domain, Earthquakes

The probability structure of the phase derivative of a class of random processes is derived in the time- and frequency-domains. It is shown that in the time-domain the phase derivative reflects the spectral properties of a stationary random process; whereas in the frequency-domain the phase derivative reflects the non-stationary character of a modulated white-noise random process. The analysis provides a theoretical basis for the qualitative conclusions drawn in some recent investigations regarding the properties of the phase derivatives of earthquake ground accelerations.

83-423

A Linear Finite Element Approach to the Solution of the Variational Inequalities Arising in Contact Problems of Structural Dynamics

D. Talaslidis and P.D. Panagiotopoulos
Inst. of Struc. Engrg., Lehrstuhl IV, Ruhr Univ. Bochum, W. Germany, Intl. J. Numer. Methods Engrg., 18 (10), pp 1505-1520 (Oct 1982) 9 figs, 20 refs

Key Words: Finite element technique, Nonlinear vibration, Contact vibration

The theoretical and numerical treatment of dynamic unilateral problems are presented. The governing equations are formulated as an equivalent variational inequality expressing D'Alembert's principle in its inequality form. The discretization with respect to time and space leads to a static nonlinear programming problem which is solved by an appropriate

83-424

Errors in Natural Frequency Calculations Using Eigenvalue Economization

D.L. Thomas
CEGB South Western Region Scientific Services Dept., Bedminster Down, Bridgwater Rd., Bristol, UK, Intl. J. Numer. Methods Engrg., 18 (10), pp 1521-1527 (Oct 1982) 3 figs, 6 refs

Key Words: Eigenvalue problems, Natural frequencies, Error analysis

The eigenvalue economization process is an efficient way of reducing the size of eigenvalue problems to manageable proportions, at the expense of introducing approximations. The use of automatic criteria for selecting the slave variables to be eliminated has considerably eased the use of this technique recently. However, it is necessary to ensure that unacceptable errors are not introduced by the condensation process. In this paper the errors introduced in the condensation process are considered theoretically, using an algebraic approach. This enables an absolute error bound to be stated, together with an approximate bound which can be very easily evaluated. Examples are given of the use of the approximate bound.

83-425

Dynamic Analysis of Viscoelastic Structures Using Incremental Finite Element Method

W.-H. Chen and T.-C. Lin
Dept. of Power Mech. Engrg., Natl. Tsing-Hua Univ., Hsinchu, Taiwan 300, ROC, Engrg. Struc., 4 (4), pp 271-276 (Oct 1982) 10 figs, 23 refs

Key Words: Viscoelastic properties, Incremental methods, Finite element technique

This paper presents an efficient and accurate incremental finite element procedure, without involving any integral transformations, to deal with practical viscoelastic structures with complicated geometries subjected to dynamic loadings. The numerical error induced from the approximate inversion technique used is thus avoided. Based on the Hamilton's variational principle, an incremental functional is derived for each time increment and the inertia terms are retained in the analysis to estimate the transient viscoelastic behaviors.

NUMERICAL METHODS

83-426
An Averaged Lagrangian-Finite Element Technique for the Solution of Nonlinear Vibration Problems
M.A.E. Ghabrial and L.C. Wellford, Jr.
Dept. of Civil Engrg., Univ. of Southern California, Los Angeles, CA 90007, Computers Struc., 16 (1-4), pp 207-214 (1983) 18 figs, 11 refs

Key Words: Nonlinear vibration, Lagrange equations, Finite element technique, Shells, Plates, Circular plates, Caps (supports)

A technique for the dynamic analysis of geometrically nonlinear structures is developed. A Lagrangian function is employed to construct the structural Hamiltonian. The temporal variation of the response is then expressed in terms of the spatial variables through the use of the Hamiltonian function. To demonstrate the proposed technique, the nonlinear vibration of certain axisymmetric shells is analyzed.

GENERAL TOPICS

TUTORIALS AND REVIEWS

83-427
Noise Measurement, Noise Assessment (Annual Survey)
R. Martin
VDI Z., 124 (13), pp 507-514 (1982) 14 figs, 2 tables, 109 refs

Key Words: Standards and codes, Noise measurement, Measuring instruments

A review of standards, recommendations, noise measuring instruments, noise measurement procedures and noise assessment is presented.

BIBLIOGRAPHIES

83-428
Accelerometers. 1970 - August, 1982. (Citations from the Engineering Index Data Base)
NTIS, Springfield, VA, 231 pp (Aug 1982)
PB82-873001

Key Words: Bibliographies, Accelerometers, Measuring instruments, Vibration measurement, Shock response, Measurement techniques

This bibliography contains citations concerning research, design, construction, and applications of accelerometers for measurement of motion, vibration medicine, roughness, waves, shear stress, shock, and gravity.

USEFUL APPLICATIONS

83-429
Parametric Study of Vibratory Densification of Granular Soils
P.W. Chang
Ph.D. Thesis, Rutgers Univ., New Brunswick, NJ, 223 pp (1982)
DA8221649

Key Words: Compacting, Soil compacting, Vibratory techniques

The utilization of a vibratory method is an effective means of compacting sand. Although there have been many studies pertaining to the densification and liquefaction of sands, no comprehensive and systematic study has been conducted to isolate and evaluate the relative effects of the different parameters associated with vibratory densification of sand. The objectives of the research were to determine: the effect of each of the parameters associated wth the vibratory densification of sand, and variation of packing of particles induced by vibration.

AUTHOR INDEX

CALENDAR

MARCH 1983

21-23 NOISE-CON 83 [Institute of Noise Control Engineering] Cambridge, MA *(NOISE-CON 83, Massachusetts Inst. of Tech., Inst. Information Services, 77 Massachusetts Ave., Cambridge, MA 02139 - (617) 253-1703)*

28-31 Design Engineering Conference and Show [ASME] Chicago, IL *(ASME Hqs.)*

APRIL 1983

18-20 Materials Conference [ASME] Albany, NY *(ASME Hqs.)*

18-21 Institute of Environmental Sciences' 29th Annual Technical Meeting [IES] Los Angeles, CA *(IES, 940 E. Northwest Highway, Mount Prospect, IL 60056 - (312) 255-1561)*

19-21 Machinery Vibration Monitoring and Analysis Meeting [Vibration Institute] Houston, TX *(Ronald L. Eshleman, Director, Vibration Institute, 101 W. 55th St., Suite 206, Clarendon Hills, IL 60514 - (312) 654-2254)*

21-22 14th Annual Modeling and Simulation Conference [Univ. of Pittsburgh] Pittsburgh, PA *(William G. Vogt, Modeling and Simulation Conf., 348 Benedum Engineering Hall, Univ. of Pittsburgh, Pittsburgh, PA 15261)*

MAY 1983

9-13 Acoustical Society of America, Spring Meeting [ASA] Cincinnati, OH *(ASA Hqs.)*

9-13 Symposium on Interaction of Non-Nuclear Munitions with Structures [U.S. Air Force] Colorado Springs, CO *(Dr. C.A. Ross, P.O. Box 1918, Eglin AFB, FL 32542 - (904) 882-5614)*

17-19 Fifth Metal Matrix Composites Technology Conference [Office of the Undersecretary of Defense for Research and Engineering] Naval Surface Weapons Center, Silver Spring, MD *(MMCIAC - Kaman Tempo, P.O. Drawer QQ, Santa Barbara, CA 93102 - (805) 963-6455/6497)*

JUNE 1983

6-10 Passenger Car Meeting [SAE] Dearborn, MI *(SAE Hqs.)*

20-22 Applied Mechanics, Bioengineering & Fluids Engineering Conference [ASME] Houston, TX *(ASME Hqs.)*

JULY 1983

11-13 13th Intersociety Conference on Environmental Systems [SAE] San Francisco, CA *(SAE Hqs.)*

AUGUST 1983

8-11 Computer Engineering Conferences and Exhibit [ASME] Chicago, IL *(ASME Hqs.)*

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)*

26-29 Power Generation Conference [ASME] Indianapolis, IN *(ASME Hqs.)*

OCTOBER 1983

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)*

CALENDAR ACRONYM DEFINITIONS AND ADDRESSES OF SOCIETY HEADQUARTERS

AFIPS: American Federation of Information Processing Societies
210 Summit Ave., Montvale, NJ 07645

AGMA: American Gear Manufacturers Association
1330 Mass Ave., N.W.
Washington, D.C.

AHS: American Helicopter Society
1325 18 St. N.W.
Washington, D.C. 20036

AIAA: American Institute of Aeronautics and Astronautics, 1290 Sixth Ave.
New York, NY 10019

AIChE: American Institute of Chemical Engineers
345 E. 47th St.
New York, NY 10017

AREA: American Railway Engineering Association
59 E. Van Buren St.
Chicago, IL 60605

ARPA: Advanced Research Projects Agency

ASA: Acoustical Society of America
335 E. 45th St.
New York, NY 10017

ASCE: American Society of Civil Engineers
345 E. 45th St.
New York, NY 10017

ASME: American Society of Mechanical Engineers
345 E. 45th St.
New York, NY 10017

ASNT: American Society for Nondestructive Testing
914 Chicago Ave.
Evanston, IL 60202

ASQC: American Society for Quality Control
161 W. Wisconsin Ave.
Milwaukee, WI 53203

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

CCCAM: Chairman, c/o Dept. ME, Univ. Toronto,
Toronto 5, Ontario, Canada

ICF: International Congress on Fracture
Tohoku Univ.
Sendai, Japan

IEEE: Institute of Electrical and Electronics Engineers
345 E. 47th St.
New York, NY 10017

IES: Institute of Environmental Sciences
940 E. Northwest Highway
Mt. Prospect, IL 60056

IFToMM: International Federation for Theory of Machines and Mechanisms
U.S. Council for TMM
c/o Univ. Mass., Dept. ME
Amherst, MA 01002

INCE: Institute of Noise Control Engineering
P.O. Box 3206, Arlington Branch
Poughkeepsie, NY 12603

ISA: Instrument Society of America
400 Stanwix St.
Pittsburgh, PA 15222

ONR: Office of Naval Research
Code 40084, Dept. Navy
Arlington, VA 22217

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

SEE: Society of Environmental Engineers
6 Conduit St.
London W1R 9TG, UK

SESA: Society for Experimental Stress Analysis
21 Bridge Sq.
Westport, CT 06880

SNAME: Society of Naval Architects and Marine Engineers
74 Trinity Pl.
New York, NY 10006

SPE: Society of Petroleum Engineers
6200 N. Central Expressway
Dallas, TX 75206

SVIC: Shock and Vibration Information Center
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> 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 . . .

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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).
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5. Landahl, M., Unsteady Transonic Flow, Pergamon Press (1961).
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7. Lane, F., "Supersonic Flow Past an Oscillating Cascade with Supersonic Leading Edge Locus," J. Aeronaut. Sci., 24, (1), pp 65-66 (1957).

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