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SVIC NOTES

The Difference Between Knowledge and Information

Although SVIC is called the Shock and Vibration Information Center, it would be more correct to say that we provide the shock and vibration community with knowledge, not information. This is especially true of the Shock and Vibration Digest. I'll use the Digest as an example to explain what I mean in the following note.

I ask this question, "Does the Digest you are holding contain knowledge of information?" While it is true that a computer can process information at the speed of light, what is it that turns that information into knowledge? This question has two answers. First, you gain knowledge by throwing most of the information away. Second, knowledge is gained by grouping information into small chunks.

The secret is to prevent information overload, to save precious time by only reading what is important and relevant to you. Articles in over 160 periodicals are scanned to create the Shock and Vibration Digest, but only a small percentage of those articles are abstracted in the Digest. The abstracts that do appear are grouped (indexed) into small chunks (subjects). If you have a broad interest, scan all 200 or so abstracts; if you are interested in only a few specific subjects, review only a few abstracts.

The literature reviews represent another information-sorting knowledge-producing scheme. One expert in a specific subject area sorts through the world's literature, throws most of the information away and produces a literature review. Again, your time is saved by what you don't have to read.

The final lines of defense are the author and subject indexes in the Digest. To find a particular authors work, scan the yearly author index and find only the articles written by that individual. Likewise with the yearly subject index, for example, if you are interested in computer programs about shells, consult the subject index. The literature reviews, broad subject categories, and author and subject indexes are the end result of throwing most of the information away and grouping the rest into chunks.

If you now agree that what SVIC is giving you in the Digest is knowledge, not just information, then perhaps our title should in fact be Shock and Vibration Knowledge Center (SVKC)!

JGS

EDITORS RATTLE SPACE

SOME THOUGHTS ON THE INFORMATION EXPLOSION

A recent discussion in the **Journal of Tribology**[1] and a reprinted article in the **NFAIS Newsletter**[2], a publication of the National Federation of Abstracting and Information Services, have examined some aspects of the current information explosion. As a user, publisher, and secondary journal editor I have discussed the information explosion at length in this column. The discussion provided by Tischer in the **Journal of Tribology** notes that perhaps publishers and authors should refrain from publishing material that is not really new in an attempt to curb the information explosion. Further, Mr. Tischer suggests that secondary journals be furnished copies of primary publications free. The central issue focused on by Geiger and Heumann in their letter to CBE Views is the future financial relationship between primary and secondary publishers. The theme of their letter is that some compensation should be made to primary publishers from secondary publishers for the use of titles and abstracts of printed articles. Thus the two articles seem to be at odds on the financial relationship between primary and secondary publishers.

In this column I have written about the information explosion and its causes -- republication of similar material, articles with little relevant technical content, and the least publishable unit (LPU)[3]. Why is it that each year research budgets do not grow with the economy and yet the number of pages of published material goes up? New journals appear on the market each year. I believe the publishers have only themselves to blame for their present situation -- higher publishing costs and lower number of subscriptions. Geiger and Heumann make no mention of this problem in the publishing industry. Their point is that secondary publishers should pay for the material they use to make a profit and thus help the financial dilemma of the primary publisher. They reject the idea that the secondary journal is a source of advertisement and recognition for their product. I tend to agree that subscriptions are not sold directly from secondary journal listings. However, they do, in fact, identify the source of technology and provide recognition for the primary publication. I do not think the primary journal publisher can afford to forego this type publicity -- as a publisher I want as much exposure for my publications as possible. Certainly I do not expect those who list publications to pay me for that privilege. In my view, the secondary journal publisher is doing no more than providing an extended or annotated bibliography to the customer. With the number of publications and periodicals growing, secondary journals and information services are going to become a necessity if any researcher is going to retrieve technology in a meaningful way. In fact Tischer notes that it may be less costly to "reinvent the wheel" than to retrieve some technology from the literature.

In my opinion the solution to the financial problem of the publishers, the information explosion, and retrieval chaos is simple. Publishers must have the discipline and courage to be selective in what they print — eliminate republication, the LPU, and material not worth the paper it's printed on.

R.L.E.

[1]Tischer, H., **Journal of Tribology**, 107, July 1985, p 294.

[2]Geiger, S.R. and Heumann, K.F., "Future Financial Relations Between Primary and Secondary Publishers," (Letter to the Editor, CBE Views, 8 (1):46, Spring 1985), NFAIS Newsletter, 27 (3), June 1985.

[3]The LPU has been defined as the least publishable unit of technology that a referee will allow in a journal article.

COMPUTER-AUTOMATED FAILURE PREDICTION IN MECHANICAL SYSTEMS UNDER DYNAMIC LOADING

C.W. deSilva*

Abstract. **A computer-automated system for failure prediction in mechanical systems having many components that are functionally and physically interconnected is described in this article. This system consists of three subsystem modules: component failure models developed from available data and procedures; reliability model for the overall mechanical system, developed using functional interrelations and failure models of individual components; and failure diagnostic and model-parameter updating system. The general structures of these three modules and their role in obtaining accurate predictions for time and mode of next failure are discussed. Pertinent background information is provided.**

Any major industry that relies on machinery and equipment for production, processing, or services spends considerable time, effort, and money for maintenance. The significance of accurate failure prediction in complex systems, and maintenance management on that basis, has been recognized in relation to various applications. Reliable estimates show that in the Navy alone several billions of dollars are spent annually for maintenance of naval systems. Improved maintainability, or the ability to service or repair a faulty system in a specified time, is a key to minimizing maintenance costs. It is vital to have some means for early warning of impending failure in order to acquire and organize support resources and prepare for possible safety hazards. Economic advantages of avoiding unscheduled repairs can be considerable because premature component failures can cause secondary damage to a system that can be costly and hazardous. This article describes an early-warning system that would be useful in maintenance planning in complex multi-component systems.

METHOD

The approach to automated failure prediction described in this article is based on three activity modules that are to some extent interrelated (see Figure 1). Digital computer-aided automation is required for implementation of this method.

Module 1. This subsystem module consists of a collection of suitable failure models for critical components that are developed from available data and techniques. A lack of appropriate data is a major obstacle to developing accurate failure models for components. A common approach is to use a simplified failure distribution function (such as exponential or Wiebull) that is applicable to a general class of failures and then artificially assign parameters to satisfy the expected results. This procedure is unsatisfactory because it rarely incorporates engineering knowledge pertinent to failure of specific components. Component failure in relatively complex mechanical systems should be characterized with a high degree of precision so that a required level of accuracy in predicting system failure can be attained. The present method addresses the composition of Module 1 from two viewpoints: component failure data and component failure models.

Availability of reliable data in an appropriate form is the key to development of accurate failure models for components. Component data are available from various sources and can be divided into two categories:

- Data that correlate component aging, malfunction, or failure to dynamic environment

- Failure data under standard operating conditions. These include design life

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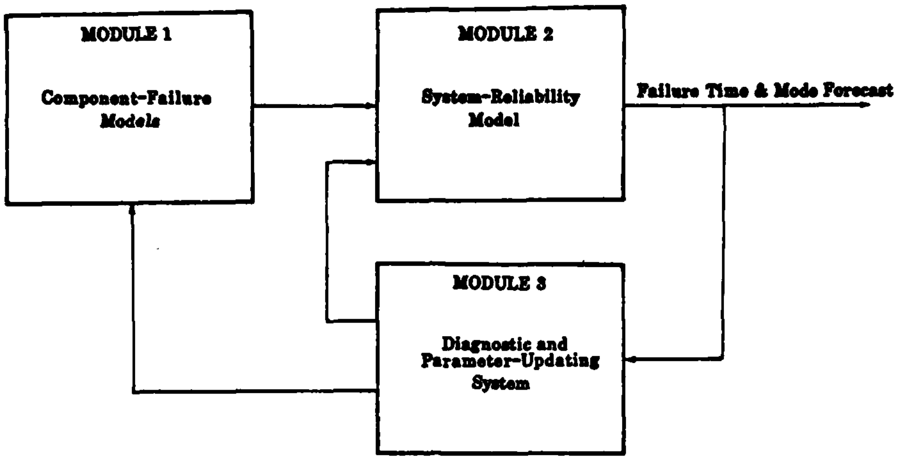

Figure 1. Schematic Diagram of the Modular Approach to Failure Prediction

data available from manufacturers and vendors and maintenance histories available from users of similar components

Data under the first category are available from dynamic qualification, design development, and quality control tests for components. Such data should be categorized according to component type and catalogued as functions of operating conditions (e.g., speed, force, torque, temperature, current, voltage) as well as characteristic parameters of the excitation environment. Non-dimensional forms of data are preferred. Features such as phase, intensity, decay rate, total power, and harmonic and nonharmonic power can be used to represent the excitation environment. Alternatively, representations such as Fourier spectra, response spectra, and power spectral densities (for example, in third-octave bands) can be used depending on the characteristics of a particular physical component and the nature of its dynamic environment. Time to failure is a significant parameter that should always be included in fragility test data. A computerized data bank that can store large volumes of data for basic components could serve as a library of such information.

Data retrieval could be accomplished by interfacing Module 1 with the data bank; computer-to-computer data transmission is widely available by subscription to a suitable communications network. Development of a public data bank of this nature is a national or international task that demands an extensive effort and an enormous amount of resources. Nevertheless, it is assumed that the required component data are available for implementation of the method. Module 1 requires data pertaining only to critical devices present in a particular mechanical system.

Component failure models can be developed on the basis of available data and techniques. This can be accomplished in two ways:

- By selecting a failure distribution model based on manufacturer and vendor data for standard operating conditions

- By using a cumulative damage function to represent the damage resulting from deviations in the dynamic environment

Initially, values can be assigned to model parameters on the basis of component data fed into Module 1. Periodic upgrading of component data would be necessary under the following circumstances:

- When new and more accurate data are available; e.g., from new and more refined tests
- When a failed component is replaced by a new component having different characteristics
- When failure predictions are unsatisfactory

Updating of model parameters based on continuous monitoring might be necessary if significant deviations are observed in the operating environment compared to design conditions.

Module 2. This module constitutes an appropriate reliability model for an overall system. Such a model is developed as follows:

- Determine functional interconnections, giving particular attention to the nature of component redundancies among critical components identified in Module 1
- Develop a fault-tree diagram to represent the reliability structure and failure modes of a particular mechanical system
- Include component-failure models from Module 1 in the reliability structure of the overall system

Functional interconnections between components are determined using available information on a system design. Computer programs are available for developing fault-tree diagrams for complex systems.

Module 3. This module consists of a failure diagnostic system and an algorithm to update the values assigned to parameters in the reliability model. Development of effective methods for failure diagnosis has received much attention, particularly with respect to on-condition maintenance, over the last decade. Renewal analysis based on a failure distribution function approach (e.g., Wiebull distribution), Markovian degradation approach, maximum likelihood method, and extreme value theory are analytical tools for estimating expected failure time and the most likely failure mode.

Sensitivity analysis can be used to determine guidelines for updating parameters of a reliability model. Guidelines can be developed as follows:

- Establish a suitable performance index for the failure prediction scheme
- Determine the sensitivity of the performance index to variations in failure model parameters
- Compare the actual failure mode with the predicted result and modify parameters based on sensitivity guidelines so that the corresponding prediction agrees with an actual result

In addition, continuous monitoring of the actual dynamic environment, which is usually an integral feature of many complex systems, can be used to update the cumulative damage functions in Module 1.

The operation of an overall failure prediction system is schematically shown in Figure 2, as applied to a flexible manufacturing cell. Dedicated microprocessors, or distributed processing, can be used to perform various computational tasks in the scheme. Large memory requirements for component data storage in Module 1 can be handled by expanding the memory of the associated processor or using on-line storage devices. Alternatively, a central minicomputer can be used to implement the entire system. Note that the scheme would not hinder normal operation of the mechanical system; such operation is interrupted only during repair. Because early warning would be available for planning, repair time would be reduced.

BACKGROUND KNOWLEDGE

Existing procedures of failure detection and maintenance scheduling of mechanical systems employ three basic policies:

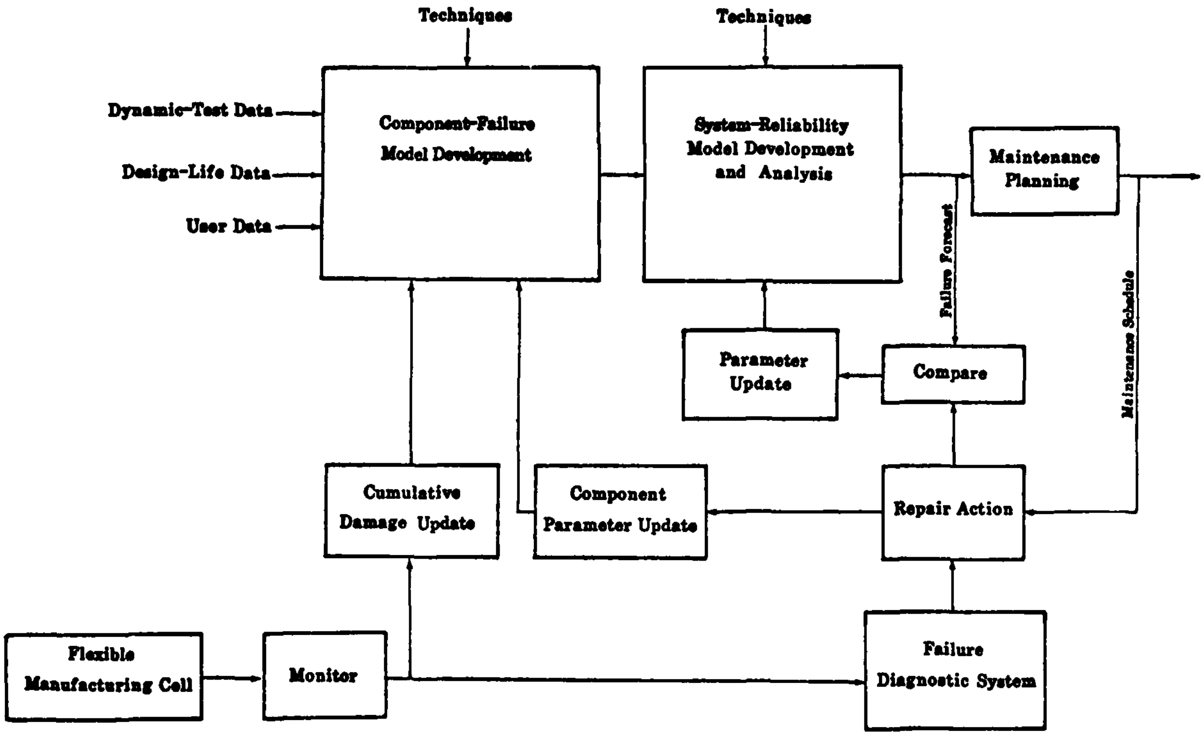

Figure 2. Schematic Description of the Failure-Prediction System

- Operate the system until it fails and then attempt diagnosis and repair
- Perform maintenance at predetermined regular intervals
- Perform condition-based maintenance, which uses continuous monitoring of various components of the system, and schedule maintenance on the basis of these data

The first approach can be expensive and undesirable for such reasons as lost output during repair, machine destruction beyond repair due to unnoticed secondary failures, and operational safety hazards. Furthermore, additional costs can be involved in terms of acquisition and organization of support resources required for unscheduled maintenance. The second approach to maintenance scheduling is preventive maintenance. This method might not be reliable for very new systems with little experience and insufficient information or failure data or for relatively old systems that have undergone several cycles of repair and would possess new components connected with old ones. Failure characteristics of a system can change significantly with age. The costs of unnecessary overhaul, mainly in the initial stages of operation, and possible catastrophes and unscheduled repairs in later stages can be high for complex systems. The third approach to maintenance scheduling requires costly system monitoring and analytic tools. The time interval between warning and actual failure, however, might not be adequate to plan maintenance, particularly in terms of organizing support resources.

Component-failure models. Dynamic-test data are valuable in developing failure models for components. Dynamic testing is an evaluation procedure that usually involves applying a specified excitation to a test object and monitoring its dynamic response, structural integrity, and performance of its intended function [1]. This technology has gradually evolved since World War II, at which time the method was used primarily in aircraft testing. Since then, dynamic testing has been successfully used to evaluate a wide spectrum of products that range from small printed circuit boards and microprocessor chips to large missiles, space vehicles, structures, and equipment and components in nuclear reactor facilities [2-8]. Fragility testing, or endurance testing [9], determines ultimate capability of a device, particularly with respect to its mechanical integrity and functional operation. Data from such tests are valuable in correlating component failure to characteristics of dynamic environment. Nevertheless, data from proof testing -- testing to a specific dynamic excitation -- can be useful in forecasting failure, particularly if the cause of failure (e.g., cyclic stress) can be isolated [10]. Note that actual service data, or field data, are often more significant than laboratory test data; hence service data should be incorporated with test data when available. Testing under actual conditions is the ideal way to study component failure. Such testing can be very expensive, however, and is often not feasible because the exact operating environment is stochastic in nature. For this reason, most tests employ simulated excitations that possess basic characteristics of the expected operating environment.

The bulk of test data available at present originates from dynamic qualification of nuclear power plant components. Two other sources of test data are design development tests and quality control tests [11]. An extensive failure-data bank for fundamental components can be amassed from these sources. Similarities in the characterization of simulated test excitations mean that it is feasible to take data from one source and modify or generalize them for a wide range of applications. Attention should be given to various representations of a dynamic environment [12]. Common representations include time history, response spectrum, Fourier spectrum, power spectral density function, and cepstrum. The choice of representation might depend on a particular application and failure phenomenon. For example, when failure is due to a peak stress phenomenon such as plastic deformation, response spectrum representation is appropriate. On the other hand, excitations causing fatigue failure can be adequately represented by a Fourier spectrum for deterministic environments or by a power spectral density function for random environments. Cepstrum is useful when spectral properties of an excitation source are separable from those of the system [13, 14]. Characteristics such as intensity, frequency content, decay rate, phasing, duration, and power of an excitation environment can be correlated with parameters in a failure model for a particular component.

Because accelerated tests are in common usage [10], an applicable accelerated model for a component should be used to reduce test data for that component to actual operating conditions. If a mechanical failure is predominantly a fatigue type, an accelerated fatigue model [15] could be used. Alternatively, equivalence techniques [1, 16] can be employed to correlate different excitation environments. The most common failure of components due to dynamic excitation is material fatigue. Nevertheless, failure or malfunction can result from other causes including a few excessive excitation amplitudes, shocks, or peak stresses (e.g., brittle fracture, plastic deformation, instability or buckling, contact failure in relays and switches, and collision or impact between two components that can cause fretting), certain excitation amplitudes or loads existing for an extended period of time (e.g., creep failure), or non-fatigue wear (e.g., due to friction and environmental effects). These causes could lead to conditions such as misalignment, unbalance, mechanical looseness, and rub. Furthermore, it is known that, in the case of random dynamic excitations, stress level interactions can significantly affect the life expectancy of a component. It is usually true, however, that mechanical failure is caused by a gradual accumulation of damage from more than one cause. It is appropriate, therefore, to define a suitable cumulative damage function [17, 18] that determines failure when certain bounds are exceeded. This is a satisfactory way to correlate component life expectancy with dynamic excitation.

Component life expectancy is usually represented by a failure model [17]. The basis of such models is the representation of statistical characteristics of failure by a suitable probability distribution function such as exponential, normal, gamma, Wiebull, and Poisson functions [19, 21]; other extensions include the Markovian degradation representation [14], the Bayesian approach, and likelihood ratio methods [22]. The most appropriate representation (model) for failure in each component is decided after critical examination of failure characteristics of that component and the accuracy required.

Numerical values for parameters in component models are assigned using available failure data. In addition to dynamic-test and field-operation data, valuable information is available from other sources such as manufacturers, vendors, users, maintenance documents, and reports. The usefulness of correlating component failure with functional parameters is obvious. Data from similar components, modified by engineering judgement and analysis based on dynamic characteristics of the components [16], can be used for new components for which no test data or field experience are available.

System-reliability model. Reliability analysis methods make possible the prediction of the expected time of failure and the most likely failure mode for a complex system. Analytical techniques for the study of reliability in systems have been developed primarily in the aircraft, aerospace, weapons, and electronics industries [21-24]. Other sectors, such as the manufacturing industry, process plant industry, and nuclear power industry, began to extensively employ reliability analysis as late as 1970. At present well-developed computer programs are available [21] to efficiently perform various tasks of reliability studies of complex multi-component systems.

Reliability analysis of a multi-component system requires development of a suitable reliability model. The first major step in this process is to isolate critical components and learn how they are interconnected with respect to functional operation. At this stage component redundancies [25, 26] should be identified. In particular, passive (or standby) redundancy and active (or parallel) redundancy are treated separately. This is important because failure in a redundant component need not immediately bring about system failure or malfunction; but such failure can overload a parallel (active) component that could result in its failure and subsequently cause system failure. System failure is unlikely in standby redundancies, however, but the reliability of a standby switching mechanism should be incorporated in the system reliability model. Redundant components need not be identical. For example, half-capacity or third-capacity subcomponents might be activated if the main component fails [27, 28]. Note that component redundancy invariably introduces new unreliability factors because the number of components, interconnections, and interfaces automatically increases. Possible failure modes in a multi-component assembly can be determined using modeling aids such as reliability block diagrams, reliability networks, signal-flow graphs, event-tree representations, or fault-tree models [14, 21, 25]. The state of the entire system can thus be described by the state of its components.

Failure distributions of individual components can be combined using the structure of the system-reliability model to obtain an overall failure distribution representation for an entire system. Renewal analysis [29] using a combined failure distribution function determines expected failure time and the most likely failure mode of an overall system. Confidence intervals for these predictions can be estimated using standard methods [21]. Monte Carlo methods [21, 22, 30] are often employed in reliability analysis of systems. These methods consist of building a probabilistic model for a system using a digital computer and carrying out several trial runs of the model by computer simulation. Such simulated data are useful in the absence of a complete description of system structure and quantification of failure parameters. A preferred method of analysis is to use computer codes based on kinetic tree theory [21, 31]. This method employs a suitable fault-tree model to compute reliability data for complex multi-component systems. Markovian deterioration approach [14, 28, 32] is also commonly used to determine maintenance schedules for multi-component systems. This method requires the development of a Markov model in terms of transition probability matrices that take into account the change of state (degradation or repair) in individual components with time.

Failure diagnosis and model-parameter updating. Failure diagnosis is essential in order to carry out necessary maintenance and repair. Updating of parameter values in a reliability model also depends on accurate failure diagnosis. For simple and well-understood systems, failure diagnosis can be accomplished by visual inspection or monitoring for structural and functional failures using simple instrumentation [33, 34]. For complex systems, however, extensive functional monitoring and analysis might be necessary for accurate diagnosis.

Vibration monitoring and analysis is the most extensively used method of failure diagnosis in systems; it is simple and usually does not interrupt the operation of the system being monitored. Fourier spectra, cepstra, or spectral density functions of monitored signals are examined to detect degradation and failure [1, 14]. The corresponding frequencies allow identification of the components that are deteriorating. This method has been employed in failure diagnosis in a wide range of components and assemblies including aircraft carriers [35], couplings [36], bearings [37], gear systems [38], turbogenerators [39], rotating machinery in continuously operating process plants [40], reciprocating machinery [41], piping systems [42], and nuclear fuel rotatory dissolvers [43]. The method is appl' .ble to failure diagnosis in mechanical components and components that perform non-mechanical functions but deterioration of whose functional characteristics can be correlated to mechanical failure.

More sophisticated methods of failure diagnosis sometimes require intricate systems for monitoring functional variables and extensive manipulation using dedicated data processors. Dynamic models can be used to represent possible failure modes of the system. Pattern recognition methods are usually incorporated in automated surveillance systems. Functional variables that are monitored include voltages, currents, optical signals, pressures, temperatures, flow rates, speeds, forces, torques, and displacements. Sophisticated sensors and transducers such as ultrasonic detectors, fiber-optic sensors, piezo-electric-polymer sensors, magnetic precipitators, ultraviolet detectors, infrared cameras, optical encoders, differential transformers, thermistors, resistance temperature detectors, semiconductor strain gages, and resolvers are sometimes needed for accurate monitoring. Diagnostic methods have been employed in such complex systems as the space shuttle [44], LANDSAT satellite [45], land vehicles [46], and large transformers [47]. These methods are generally complex and costly but have obvious advantages; for example, high prediction accuracy and no sensitivity to structural dynamic effects such as resonances in interacting subsystems.

Accurate diagnosis allows determination of whether a predicted failure time and mode are acceptable. Otherwise it is necessary to modify the numerical values assigned to reliability-model parameters. These parameters include failure-probability-distribution parameters of individual components and weighting parameters assigned to these components. Parameter updating can be accomplished by heuristic means based on a true failure mode or by analysis. A preferred analytical approach is to first define a suitable performance index [48] for the reliability model. Sensitivities [49] of the overall performance index to parameters that are suspected to be in error can be used to obtain guidelines for changes in reliability parameters that will improve prediction accuracy. Sensitivity analysis is also useful in determining the extent to which improvement of reliability in individual components would contribute to the reliability of the overall system [27]. Note that when serious discrepancies are consistently present in failure predictions, refinement of a reliability model would generally be necessary.

CONCLUSIONS

The primitive approach to system maintenance is to operate until the system fails and then attempt to diagnose and repair it. Such an approach can be costly and undesirable for various reasons: loss of output during repair, component degradation, system destruction beyond repair due to the absence of early detection of malfunctions that can result in unobserved secondary failures, and possible safety hazards due to catastrophic failure without early warning. Additional costs are involved in terms of acquisition and organization of support resources such as spare parts, maintenance personnel, equipment, back-up units, and facilities required for unscheduled maintenance.

A simplified approach to preventive maintenance is to schedule maintenance at predetermined regular intervals. This method is not always reliable because failure characteristics of a multi-component system can change significantly with age and after several cycles of repair. The costs of unnecessary overhaul, possible catastrophes, and unscheduled repairs often make this approach unsuitable for complex systems.

The modern approach to maintenance planning is to continuously monitor performance variables of critical components and schedule maintenance based on the condition of these components. Costly system monitoring and analysis tools are needed. In addition, the time interval between warning of an impending failure and the actual failure might not be adequate to plan maintenance.

This article has described an alternative computer-automated approach to failure prediction that consists of three modules; component failure models, a reliability model for the overall system, and a failure-diagnostic and parameter-updating module. The performance of this technique depends on the accuracy of these modules (models, data, and algorithms). The method does not require expensive on-line monitoring of system variables.

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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 reviews 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.

NOISE TRANSMISSION INTO PROPELLER AIRCRAFT

R. Vaicaitis*

Abstract. This paper is a survey of papers and reports, most of which were written since 1981, that are concerned with airborne and structure-borne noise transmission into a propeller-driven aircraft. Special attention is given to a new prop-fan aircraft.

This paper is a continuation of an earlier review [1]. With few exceptions the research discussed was published during the last three years. Recent review papers [2-5] present an in-depth overview of noise generation, transmission, and control for propeller-driven aircraft. The present paper elaborates the key elements of the earlier review and includes new material. The topics of airborne and structure-borne noise are considered. Airborne noise is generated by vibration of structures or structural components excited by acoustic or hydrodynamic pressures that arrive via an airborne path. Structure-borne noise involves mechanically-induced vibrations of structures or structural components that generate, transmit, and radiate audible sound.

AIRBORNE NOISE

Review of the literature indicates that there is active research on various aspects of airborne noise for propeller driven aircraft [1-4]. Research on airborne noise transmission is reviewed in this section. Noise from propellers and turbulent boundary layer is the major contributor to cabin noise in most aircraft. Progress since 1981 is reviewed below.

Significant effort has been devoted to aircraft with nearly flat sidewalls and rectangular cabin cross-sections [6-20]. Noise transmission predictions and measurements have been carried out for various laboratory models [10-13] and full-scale light aircraft [6-9, 14-20]. Theoretical predictions for noise transmission have been obtained by modal methods in which the structural modes of the sidewall and the acoustic modes of the cabin are accounted for. General agreement between predicted and measured results is good in view of the complexities involved. In addition to laboratory conditions, theoretical analyses [9] and tests [19, 20] of noise transmission into the cabin of a twin-engine light aircraft have been performed for flight conditions. An optimization study on cabin noise [8, 9] has been done for the aircraft used; some of the proposed acoustic treatments have been evaluated in the laboratory [13, 18, 19] for possible future testing in flight.

In recent years, much attention has been given to the class of propeller-driven aircraft having cylindrically shaped (or nearly cylindrical) fuselage structures [21-36]. Theoretical methods for noise transmission predictions have been developed and applied to cylindrical fuselages. Analytical procedures are based on acoustic power flow, statistical energy analysis (SEA), and modal methods [22-28]. A combination of classical noise transmission concepts and modal procedures [29-30] has been used to predict noise transmission into aircraft. Research has focused on advanced high-speed turboprop aircraft [26, 29-33, 36-39]. New propellers, called prop-fans, are used for these aircraft; they are significantly different from their predecessors. Prop-fans can deliver power to fly at altitudes and speeds comparable to commercial jets while reducing fuel consumption over that of conventional aircraft by 20 to 30 percent. One problem that presents an obstacle to utilization of prop-fans is the high noise levels transmitted into the cabin. Theoretical methods described above have been used to evaluate various add-on acoustic treatments for the control of noise in these aircraft [24-29, 31, 33, 36]. In addition to theo-

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retical studies, experimental programs have been carried out to validate analytical methods and to evaluate the effectiveness of acoustic treatments [32, 34, 35]. Results indicate that overall agreement between theoretical predictions and experimental measurements is satisfactory. However, the realism and degree of sophistication of modeling a noise source, fuselage structure, and interior acoustic conditions vary with the particular analytical method used [24-29, 39].

Although significant progress has been made in predicting interior noise levels in propeller-driven aircraft, modeling improvements of existing theories are needed in modeling structures, assessing the amount of noise transmitted through multiple layers of add-on treatments including double walls and sandwich constructions, and developing models of acoustic absorption to account for treatment nonuniformities and nonlocal reactions of porous layers.

STRUCTURE-BORNE NOISE

Structure-borne noise plays an important role in the vibration and sound environments of many ground and air transportation vehicles. Structure-borne noise can be produced by mechanically-induced vibrations or by wave propagation from neighboring structural components that are excited by either mechanical forces or airborne sound. The waves propagated are composed of flexural (perpendicular to the structural surface), longitudinal (tension-compression), shear, and torsional components. Flexural vibrations are of primary importance for sound generation and radiation. Fundamental properties of structure-borne sound provide basic engineering information on excitation, propagation, attenuation, radiation, and measurement [40]. The essential elements of structure-borne noise with respect to sound generation and transmission are similar for all types of transportation vehicles. However, in this paper only the technical areas of structure-borne noise for propeller driven aircraft are considered. An overview of structure-borne noise in rotorcraft, space vehicles, buildings, automotive vehicles, and ships is available [5].

Research efforts on noise generation, transmission, and control for propeller-driven aircraft have been mainly directed toward airborne noise [1-4]. However, other sources and transmission paths could be a potential cause of the high interior noise levels in these aircraft [5, 41-56]. This paper examines the structure-borne contribution to the cabin noise of single-engine light aircraft, commuter turboprop, and a new proposed high-speed prop-fan aircraft.

A research program centered on the structure-borne noise of a single-engine aircraft has shown that engine-induced vibration is a primary source of high noise levels in the cabin [45-49]. Sound levels in the aircraft were measured, and structural and acoustic modal surveys were carried out. These studies and other tests [51-52] indicate that cabin noise in these aircraft is dominated by low frequency components and that noise control measures applicable to the lower frequency region must be developed if the required noise reduction is to be achieved. Theoretical models of structure-borne noise transmission into a single-engine aircraft have utilized finite element methods [45, 46]. Coupled structural-acoustic equations of motion are derived by representing the fuselage and cabin with a discrete number of finite elements. Due to the limitations of available software and computer memory size, numerical results have been concerned mainly with somewhat simple cabin-only acoustic models [46]. Furthermore, the number of modal acoustic equations has been reduced by means of the acoustic subvolume technique. This technique has been shown to be an adequate tool for modeling complex geometries in structure-borne noise prediction. However, improvements are needed so that the effect of acoustic absorption can be included and better models of structural and acoustic radiation can be developed. The capability for analytically predicting noise transmission is desirable, but it is also important to develop measures for noise attenuation. Improved engine isolation seems to be one viable procedure for reducing structure-borne noise in these aircraft [47-49, 54]. Further work is needed to extend vibration isolation design studies to flight conditions.

Measurements obtained on turboprop aircraft show that structure-borne noise could be an important contribution to the noise environment in the cabin [51]. Vibrations of wing and tail surfaces due to propeller-induced slip-stream excitations and aerodynamic fluctuating pressures can be transmitted into the fuselage structure, which in turn, will radiate noise into the cabin. This type of loading has been observed in wind tunnel tests [41, 43]. A second source of cabin noise is the transmission of propeller and engine vibration through engine mounts into the wing and consequently to the fuselage. Few systematic studies on the contributions to cabin noise by these sources are available in the literature. However, some success has been achieved in research efforts at NASA Langley Research Center [50, 51]. Studies indicate that structure-borne noise could be a significant contributor to overall cabin noise in propeller-driven aircraft.

Recent investigations on noise transmission into prop-fan aircraft indicate that the unsteady pressures induced by propeller wake/vortex impingement on a wing surface could induce structural vibrations [41, 43]. These vibrations then propagate along the wing surface and the main wing structure into the fuselage, which radiates structure-borne noise. The levels and characteristics of wake/vortex-induced vibrations and noise are not yet known. A feasibility study, in which analytical models were developed to describe inputs and different noise transmission paths on the structure-borne problems of advanced prop-fan aircraft, was recently undertaken [55, 56]. Emphasis was placed on examining parameters that affect noise generation and noise transmission. Loading on the wing by the propeller wake is taken as a distribution of rotating vortices. Structural models of beams and plates are used to represent the response of the wing to this loading. The vibrations of the wing are coupled to a cylindrical fuselage to estimate noise transmission into the aircraft cabin.

COMPOSITE MATERIALS

The search for new lightweight and high-strength materials for aircraft structures and cabin noise control has generated research interest on the vibroacoustic behavior of composite materials [57-63]. A prototype light aircraft has been constructed [58], and the feasibility of using composites in propeller-driven and other types of aircraft is being studied. However, little information is available on the noise transmission characteristics of these materials. Preliminary studies indicate that some of the advantages of noise attenuation might be achieved at low frequencies [60, 61] but that at other frequencies these composites might transmit noise [57, 59, 62, 63]. To satisfy the required vibroacoustic environment in an aircraft, it might be necessary to modify designs utilizing composite materials by including double wall sandwich concepts [62, 63]. Additional theoretical and experimental studies are needed so that the noise transmitted by composite materials can be fully understood.

FUTURE RESEARCH TRENDS

Areas of future research on noise transmission into propeller-driven aircraft are:

- validation of analytical models by flight tests
- theoretical and experimental evaluation of structure-borne noise transmission for turboprop and prop-fan aircraft
- noise generation, propagation, and transmission for designs involving composite materials
- noise control by add-on treatments, isolation, and changes in design of the primary structure

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BOOK REVIEWS

INTRODUCTION TO PHYSICAL SYSTEM DYNAMICS

R.C. Rosenberg and D.C. Karnopp
McGraw-Hill Book Co., New York, NY
1983, 423 pages

Bond graphs were developed by Professor Henry Paynter more than 20 years ago. For several years the authors of this book have played a prominent role in spreading their use. The variables in bond graphs are energy variables; they can provide a unified approach to modeling physical systems even when several types of energy are involved. Bond graphs can be processed to obtain state equations, transfer functions, and block diagrams. They can be used as direct input to an ENPORT computer program.

Several textbooks are available on the dynamics of physical systems at the undergraduate level, but this book is different: it employs bond graphs throughout for modeling physical systems. Bond graph models of elementary mechanical systems are presented in Chapter 2; those of electrical circuits and networks are given in Chapter 3. The procedure for obtaining state equations from bond graphs is covered in Chapter 4. The dynamic response of low order linear constant coefficient systems given in Chapter 5 employs Laplace transformation and state equations; matrices are avoided. Block diagrams and transfer functions for linear systems are covered in Chapter 6, which also includes a technique for obtaining block diagrams from bond graphs. Chapter 7 is concerned with digital computer simulation of dynamic systems.

Chapters 8 to 13 cover detailed modeling of various physical systems including hydraulic, pneumatic, mechanical, electronic, and thermal systems; power converters; actuators; and instruments. The systems are modeled by bond graphs showing analogies on an energy basis. Pseudo-bond graphs are introduced for thermal systems for which energy variables are not used.

The dynamic response of lumped parameter systems is given in Chapters 14 to 16. The state equations in vector-matrix rotation are formulated from bond graphs. The time response of linear systems employs a state transition matrix with Laplace transformation. The frequency response is developed from transfer functions, and Bode diagrams are introduced. The numerical integration of state equations with some nonlinearities is also covered. The last three chapters consider applications, including the structure of multipart systems, and introductions to mechanical vibrations and feedback control.

The book is well written, but more problems should be included for some chapters. Bond graphs must be studied in detail to be useful. Thus far, the use of bond graphs has been restricted to a relatively small group of practitioners. If a decision were made to use bond graphs in introductory courses in system dynamics, this book would be a good text for a junior or senior level undergraduate course in Mechanical and Aerospace Engineering.

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ELECTROACOUSTIC SYSTEMS. FIELD, RADIATION AND TRANSDUCTION

D. Stanomir
Editura Tehnica, Bucharest, Romania
1984, 316 pages (In Romanian)

The book is concerned with the theory and application of sound transmitters, acoustical waveguides, electromechanical and electroacoustical transducers, and receivers. Even though the author has an electrical engineering background, the mechanical, acoustical and electrical portions of the book are given adequate emphasis. The book will be useful both as an introductory university textbook and as a reference book for research engineers and designers of electroacoustic instrumentation.

Although the theoretical material of the first three chapters is treated in standard treatises, the book contains more than 60 examples that range from simple calculations of resonance frequencies, radiation impedances, and directivity characteristics to a derivation of analog electrical circuits, and designs of Helmholtz resonators, acoustical filters, and electromechanical devices.

Chapter 1 contains a brief treatment of wave phenomena in solids. Wave equations, boundary conditions, and resonance frequencies are derived for bars, membranes, and thin plates. Applications are given for loudspeakers, capacitive microphones, and telephone receivers.

The second chapter is devoted to acoustical waves. Plane, spherical and cylindrical wave fields are treated; radiation impedance is calculated.

Chapter 3 contains an extensive treatment of sound transmitters and acoustical waveguides. Directivity functions and radiation impedances are derived for arrays of point sources, vibrating pistons, holes in screens and tubes, acoustical pipes, and horns.

The last chapter deals with electro-mechano-acoustical analogies and electromechanical transducers. Both lumped and distributed parameter systems are considered. Acoustic filters are separately treated.

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TURBULENCE-INDUCED VIBRATIONS AND NOISE OF STRUCTURES

M.M. Sevik, Ed.
ASME, New York, NY
1983, 135 pages

This paperback volume contains the proceedings of an international symposium in hydroacoustics held during the 1983 winter annual meeting of ASME. The eight papers communicate advances in vibrations and noise caused by turbulent flow adjacent to compliant boundaries and the coupling of flow to adjacent structures. The contents of the book are:

The purpose of the symposium was to communicate research on the effects of flow and structural discontinuities that are not yet fully understood. The symposium was restricted to research with low hydrodynamic Mach numbers. The information could be of significance to acousticians. Several of the papers question the assumption that boundary layer turbulence is not affected by the motion it induces on adjacent boundaries. This important observation should encourage investigators to look more closely into this phenomenon and should stimulate interest in turbulent flow adjacent to a structure.

This symposium was sponsored by the Noise Control and Acoustics Division of ASME. The important issues discussed justify future research and meetings to communicate advances in the state of the technology. Other than a few typographical errors, the book was well put together and will be an important source for future reference. One glaring omission was the absence of any recent case histories. Any future symposiums will surely benefit from the inclusion of experimental, real-world measurements that complement theoretical research. As the editor has stated in the foreward, "It is hoped that this will be the first of many such gatherings as much remains to be discussed." I couldn't agree more.

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AIRCRAFT NOISE HANDBOOK

Society of Automotive Engineers
Warrendale, PA
1984

The Society of Automotive Engineers (SAE) is recognized worldwide as an authoritative source for ground vehicle and aerospace standards. Technical committees work continuously to develop new and to revise existing standards for use in the aerospace and ground vehicle industries. A cooperative engineering program for standards development coordinates the efforts of government, industry, and academic personnel in research, design, development, and testing. SAE aerospace standards (AS), recommended practices (ARP), and information reports (AIR) are the tangible results of these cooperative efforts.

Standards, practices, and reports have been sold on an individual basis until the present. SAE now offers these individual documents conveniently packaged in durable vinyl binders called Handbooks. These new Handbooks pull together all the relevant standards information available through SAE on several subjects. The Aircraft Noise Handbook includes 25 documents associated with aircraft noise developed and revised by SAE. The contents of this handbook include:

Aircraft Exterior Noise Measurement (ARP 796)

A Technique for Narrow Band Analysis of a Transient (AIR 817)

Methods of Comparing Aircraft Takeoff and Approach Noises (AIR 852)

Definitions and Procedures for Computing the Perceived Noise Level of Aircraft Noise (ARP 865B)

Gas Turbine Jet Exhaust Noise Prediction (ARP 876B)

Determination of Minimum Distance from Ground Observer to Aircraft for Acoustic Tests (AIR 902)

Method for Calculating the Attenuation of Aircraft Ground to Ground Noise Propagation during Takeoff and Landing (AIR 923)

Definitions and Procedures for Computing the Effective Perceived Noise Level for Flyover Aircraft Noise (ARP 1071)

Aircraft Noise Research Needs (AIR 1079)

Frequency Weighting Network for Approximation of Perceived Noise Level for Aircraft Noise (ARP 1080)

House Noise-Reduction Measurements for Use in Studies of Aircraft Flyover Noise (AIR 1081)

Evaluation of Headphones for Demonstration of Aircraft Noise (AIR 1115)

Comparison of Ground-Runup and Flyover Noise Levels (AIR 1216)

Standard Indoor Method of Collection and Presentation of the Bare Turboshaft Engine Noise Data for Use in Helicopter Installations (ARP 1279)

Helicopter and V/STOL Aircraft Noise Measurement Problems (AIR 1286)

Measurement of Exterior Noise Produced by Aircraft Auxiliary Power Units (APUS) and Associated Equipment during Ground Operation (ARP 1307)

Type Measurements of Aircraft Interior Sound Pressure Levels in Cruise (ARP 1323)

Acoustic Effects Produced by a Reflecting Plane (AIR 1327)

Prediction Procedure for Near-Field and Far-Field Propeller Noise (AIR 1407)

Noise Control in Fluid Power Systems of Marine Vehicles (HIR 1622)

Practical Methods to Obtain Free-Field Sound Pressure Levels from Acoustical Measurements over Ground Surfaces (AIR 1672B)

Prediction Method for Lateral Attenuation of Airplane Noise during Takeoff and Landing (AIR 1751)

Measurement of Exterior Sound Level of Specialized Aircraft Ground Support Equipment (ARP 1801)

The Coanda/Refraction Concept for Gas Turbine Engine Test Cell Noise Suppression (AIR 1813)

Information transfer is an important tool in the development of any area of technology. This Handbook will be important to those working in aircraft noise where pretested processes and methods in the form of standards provide proven solutions to problems.

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

STANDARDS NEWS

Avril Brenig, Standards Manager

ASA Standards Secretariat, Acoustical Society of America
335 East 45 Street, New York, New York 10017

William A. Yost

Parmly Hearing Institute, Loyola University of Chicago, 6525 North Sheridan Road, Chicago, Illinois 60626

American National Standards (ANSI Standards) in the area of physical acoustics, bioacoustics, mechanical shock and vibration, and noise are published by the American Institute of Physics for the Acoustical Society of America (ASA). In addition to these standards, other Acoustical Society documents, a Catalog of Acoustical Standards—ASA Catalog 5-1984, and an Index to Noise Standards–ASA STDS Index 3-1985 (national and international) are available from the Standards Secretariat of the Acoustical Society. To obtain a current list of standards available from the Acoustical Society, write to Avril Brenig, at the above address. Telephone number: (212) 661-9404.

Calendar

The Fall meetings of the ASA standards committees are scheduled for Nashville, Tennessee 4–8 November 1985.

1985 November 4, ASA Committee on Standards, 7:30 p.m., the Hyatt Regency, Nashville, Tennessee. Meeting of the Committee that directs the ASA Standards Program.

1985 November 6, Accredited Standards Committee S2 on Mechanical Shock and Vibration (also Technical Advisory Group for ISO/TC/108 and IEC/SC50A), 2:00 p.m., the Hyatt Regency, Nashville, Tennessee. Review of international and S2 activities and planning for future meetings.

1985 November 7, Accredited Standards Committee S12 on Noise (also Technical Advisory Group for ISO/TC43/SC1), 9:30 a.m., the Hyatt Regency, Nashville, Tennessee. Review of international and S12 activities and planning for future meetings.

1985 November 7, Accredited Standards Committees S1 (Acoustics) and S3 (Bioacoustics) (also Technical Advisory Group for ISO/TC/43, IEC/TC/29, and ISO/TC108/SC4) at 1:30 p.m. at the Hyatt Regency, Nashville, Tennessee. The S1 meeting will be held first. Review of S1, S3, and international standards activities and planning for future meetings.

Standards News from the United States

The following news items have been received since the last issue of *Standards News:*

Annual directory of accredited laboratories includes new procedures for NVLAP program

The eighth annual directory from the National Voluntary Laboratory Accreditation program (NVLAP) lists approximately 120 laboratories nationwide that are accredited in one or more areas of testing by the Commerce Department's National Bureau of Standards (NBS). The directory includes information on the first major changes to the NVLAP program since it was established nine years ago.

Managed by the NBS Office of Product Standards Policy, NVLAP is a voluntary national program to accredit testing laboratories that are able to meet high standards in performing specific test methods on materials or products.

The annual directory includes a report on current program activities and a list of NVLAP accredited laboratories, as well as the new NVLAP program procedures that were adopted in late 1984.

The new procedures are designed to increase efficiency and reduce costs without affecting technical quality. Among the major revisions are a simplified method for requesting a new laboratory accreditation program, elimination of repetitious language in the procedures document, updated NVLAP criteria for compatibility with new national and international standards criteria, and a provision for reciprocal recognition of NVLAP-accredited laboratories by foreign accreditation systems.

ANSI publishes 1985 Catalog of American National Standards

The 1985 *Catalog of American National Standards* is now available from the American National Standards Institute (ANSI). Approximately 8000 ANSI-approved standards are listed in this year's edition.

The standards provide dimensions, ratings, terminology and symbols, test methods, and performance and safety requirements for materials, equipment, components, and products.

Catalog users have ready access to standards in a wide variety of fields, including: acoustics,...,construction,...,electrical and electronics,...,financial services,...,fuel gas,...,heating,...,air-conditioning and refrigeration, ...,information systems,...,measurement and automatic control,...,mechanical,...,medical devices,...,nuclear,...,petroleum,...,photography,...,physical distribution,...,safety and health,...,and textiles.

The *Catalog* is divided into two major sections—an alphabetical listing of standards by subject and a compilation of the designations of all standards listed.

Copies are being mailed to ANSI members, public libraries, and those who placed orders. Members and libraries that serve the general public receive the *Catalog* and its supplements free. Nonmembers may obtain a copy from ANSI's Sales Department for $10.00. Purchasers will receive, at no extra charge, copies of all supplements issued in 1985.

The American National Standards Institute is a private, nonprofit organization that coordinates the development of voluntary national standards, approves American National Standards, and represents U.S. interests in the International Organization for Standardization (ISO) and International Electrotechnical Commission (IEC).

ANSI encourages use of standards in schools

ANSI is taking steps to make trade and technical school administrators and educators more aware of American National Standards and to encourage them to use the standards in training students for careers.

An Institute exhibit at the May annual meeting of the National Association of Trade and Technical Schools highlighted the value of ANSI-approved standards as teaching tools in vocational training.

An article bylined by an ANSI staffer in a recent issue of the NATTS journal, *Career Training,* points out that American National Standards prepare students for on-the-job realities because they are created and used to solve specific problems of industry, business, and government. It suggests that administrators and educators consider using these nationally accepted technical resources in their programs.

Not all 8500 American National Standards are applicable, the article continues, but those that prescribe practices for accomplishing a job, whether it be welding or computer programming, are available to enrich curriculums.

A new ANSI minicatalog, entitled "American National Standards for Career Training," will be published in the near future for the information of educators. It provides a partial list of standards in 16 categories that can be used to help train students to prepare engineering drawings, inspect motor vehicles and boilers, install heating and air-conditioning systems, and for a host of other tasks. Copies are available without charge from the Institute's Communications Department.

A guide to noise standards

NBS has compiled and edited a new Index to National and International Standards for Noise, Sound Measurement, and Acoustics. The 168-page compilation, prepared by Marilyn Cadoff of the NBS Center for Manufacturing Engineering for the Acoustical Society of America, indexes international standards; American National Standards; U.S. professional organization trade association, and industry group standards; and non-U.S. national standards. Government regulations are not included, since most are summarized elsewhere.

Copies of the *Index to Noise Standards* are available for $20.00 prepaid from: Publications Sales, American Institute of Physics, 355 East 45th Street, New York, NY 10017. Request catalog number ASA STDS INDEX 3-1985.

Standards News from Abroad

The following news items have been received since the last issue of *Standards News:*

ISO certification group changes name and role

The name and functions of ISO's Certification Committee (CERTICO) have been changed to give it an active guidance role in testing, inspection, and certification to international standards.

This ISO Council Committee is now the Committee on Conformity Assessment (CASCO). Its responsibilites have been expanded to include the study of ways of assessing the conformity of products, processes, services, and quality systems to appropriate standards.

CASCO will also prepare two types of international guides. One will be for testing, inspection, and certification of products, processes, and services. The other type will cover operation and assessment of testing laboratories, inspection and certification bodies, and quality systems.

In addition, CASCO will promote mutual recognition and acceptance of national and regional conformity assessment systems and the use of International Standards for testing, inspection, certification, and quality systems.

CASCO's name and scope have been approved by Council, the governing body of the International Organization for Standardization.

Olle Sturen, ISO secretary general, announced that CASCO met in Geneva, 8–10 May. He also reports that R. H. Ford of South Africa remains chairman and that P and O members of CERTICO will continue to have the same status in CASCO.

ANSI is a P—participating—member. An international subcommittee of the Institute's Certification Committee will continue to prepare ANSI positions for CASCO activities.

Standards approved by ANSI and published by ASA

The following standards were approved by ANSI and published by ASA:

ANSI S1.6-1984	"Preferred Frequencies, Frequency Levels, and Band Numbers for Acoustical Measurement" (revision and redesignation of ANSI S1.6-1967)
ANSI S1.40-1984	"Specifications for Acoustical Calibrators"
ANSI S2.34-1984	"Experimental Determination of Rotational Mobility Properties and the Complete Mobility Matrix, Guide to"
ANSI S2.41-1985	"Mechanical Vibration of Large Rotating Machines with Speed Range from 10 to 200 rev/s—Measurement and Evaluation of Vibration Severity *in situ*"
ANSI S12.6-1984	"Real-Ear Attenuation of Hearing Protectors, Method for the Measurement of the" (revision and redesignation of ANSI S3.19-1974)

The above standards are available from the Standards Secretariat at the following address: AIP Publication Sales Department, Department STD: 335 East 45th Street, New York, NY 10017. (A 20% discount is available to individual and sustaining members of the Society.)

Standard approved by ANSI:

ANSI/ASME PTC 36-1985 Industrial Measurement of Sound

International documents on acoustics received in the United States

The documents listed below were received by the Standards Secretariat of the Society and announced to S1, S2, S3, or S12. The document number is listed to the left of each document and the Accredited Standards Committee to which the document was announced is listed in parentheses below the document number. Further information on each document can be obtained from the Standards Secretariat.

Report on *IEC/TC 29* Electroacoustics, *IEC/SC29C* Measuring Devices, and *IEC/SC29D* Ultrasonics—Documents processed by the Standards Secetariat from August 1984 through February 1985.

The following document was received for *comment* by the US Member Body:

IEC/TC29C (Central Office) (S3)	Audiometers, Part I: Pure-tone Audiometers (Revision of IEC 645). Announced to S3 (S3/219) on 4 January 1985 with R. L. Grason coordinating comments on this document. Comments were submitted to the USNC for IEC on 14 February 1985.

Report on ISO/TC 43 Acoustics, and ISO/TC 43/SC1 Noise—documents processed by the Standards Secretariat from September 1984 through March 1985.

The following documents were received for *vote* by the U.S. Member Body:

ISO/DIS 226 (S3)	Acoustics—Normal equal-loudness contours for pure tones under free-field listening conditions. Announced to S3 (S3/209) on 17 September 1984 with W. A. Yost coordinating the comments and recommendations for vote. The final recommendation was for approval with comments, transmitted to ISO on 27 December 1984.
ISO/DIS 7566 (S3)	Acoustics—Standard reference zero for the calibration of pure-tone bone-conduction audiometers. Announced to S3 (S3/211) on 1 October 1984 with D. Dirks coordinating comments and recommendations for vote. The final recommendation was for approval with comments, transmitted to ISO on 10 January 1985.
ISO/DIS 8253 (S3)	Acoustics—Pure-tone audiometric *test* methods. Announced to S3 (S3/210) on 1 October 1984 with L. A. Wilber coordinating comments and recommendations for vote. The final recommendation was for a negative vote on the basis of a printer's error in the proposed standard. Editorial comments were also submitted and the position transmitted to ANSI on 14 November 1984. (A correction to the text printed by ISO was received by the Standards Secretariat on 1 February 1985.)
ISO/DIS 7962 (S3)	Vibration and Shock—Mechanical transmissibility of the human body. Announced to S3 (S3/218) on 4 January 1985 with J. C. Guignard coordinating comments and recommendations for vote.

ISO/389 DAD2 (S3) — Acoustics—Standard reference zero for the calibration of pure-tone air conduction audiometer.
Announced to S3 (S3/217) on 4 January 1985 with L. Wilber coordinating comments and recommendations for vote. A recommendation for an affirmative U.S. vote was submitted to ANSI on 1 March 1985.

ISO/DP 8297 (S12) — Determination of Sound Power Levels of Multi-Source Industrial Plants for the Evaluation of the Sound Pressure Levels in the Environment—Engineering Method.
Announced to S2 (S12/89) on 1 March 1985 with P. D. Schomer coordinating comments and recommendations for vote.

The following documents were received for *comment* by the U.S.:

ISO/DP 8727-ISO/TC 108/SC4 N150 (S2 and S3) — First Draft Proposal on Standard Biodynamic Coordinate Systems.
Announced to S2 and S3 (S3/207) on 1 August 1984. J. C. Guignard coordinated comments on this document. A recommendation for a negative vote, with comments, was sent to ANSI on 15 October 1984.

ISO/DP 8798 (S3) — Acoustics—Reference Levels for Narrow-Band Masking.
Announced to S3 (S3/215) on 15 November 1984 with S. Buus coordinating comments. The U.S. comments, which were negative, were transmitted to ANSI on 30 January 1985.

Report on ISO/TC 108 Mechanical Vibration and Shock (and Subcommittees SC1, SC2, SC3, and SC4)—documents processed by the Standards Secretariat from October 1984 through April 1985.

The following documents were received for *vote* by the U.S. Member Body:

ISO/DIS 5349.2 (S2 and S3) — Guidelines for the measurement and the assessment of human exposure to hand-transmitted vibration.
Announced to S3 and S2 and (S3/203) on 8 June 1984 with J. C. Barton coordinating comments and recommendations for vote. The final recommendation was for an affirmative vote, with comments, submitted to ANSI on 19 November 1984.

ISO/DIS 8002 (S2) — Mechanical Vibration of Land Vehicles—Method for Reporting Measured Data.
Announced to S2 (S2/135) on 15 October 1984 with J. C. Barton coordinating comments and recommendations for vote. A recommendation for an affirmative vote, with comments, was submitted to ANSI on 15 February 1985.

ISO/DIS 7962 (S3) — Vibration and Shock—Mechanical Transmissibility of the Human Body.
Announced to S3 (S3/218) on 4 January 1985 with J. C. Guignard coordinating comments and recommendations for vote.

ISO/DIS 5348.2 (S2) — Mechanical Vibration and Shock—Mechanical Mounting of Accelerometers.
Announced to S2 (S2/137) on 14 January 1985 with B. Douglas coordinating comments and recommendations for vote. A recommendation for a negative vote, with comments, was submitted to ANSI on 14 February 1985.

ISO/DIS 7626/1 (S2) — Vibration and Shock—Experimental Determination of Mechanical Mobility—Part 1: Basic Definitions and Transducers.
Announced to S2 (S2/139) on 22 January 1985 with P. K. Baade coordinating comments and recommendations for vote. A recommendation for an affirmative vote, with comments, was submitted to ANSI on 20 March 1985.

ISO/DIS 2631/1 (S3 and S2) — Evaluation of human exposure to whole-body vibration—Part 2: Evaluation of human exposure to vibration and shock in buildings (1 to 80 Hz).
Announced to S3 and S2 (S3/222) on 16 April 1985 with J. C. Barton coordinating comments and recommendations for vote.

The following documents were received for *comment* by the U.S. Member Body:

ISO/DP 8727—ISO/TC 108/SC 4 N 150 (S2 and S3) — First Draft Proposal on Standard Biodynamic Coordinate Systems.
Announced to S3 and S2 (S3/207) on 1 August 1984. J. C. Guignard coordinated comments on this document. A recommendation for a negative vote, with comments, was submitted to ANSI on 15 October 1984.

ISO/DP 8821 (S2) — Rotor Shaft Key Convention for Balancing.
Announced to S2 (S2/136) on 31 October 1984 with D. G. Stadelbauer coordinating comments. A recommendation for a positive U.S. position was forwarded to ANSI on 1 March 1985.

International Standards Activities

Activities of International Electrotechnical Commission Subcommittee 50A—Shock and Vibration

This IEC subcommittee covers the development, improvement, and periodic review of the test methods in IEC Publication 68 on Shock, Vibration, Bump, Acoustical, and Seismic testing.

Since many of the shock and vibration test methods have been in use for many years the committee work now consists primarily of improvement of these tests methods and their associated procedures as well as the development of the more exotic test methods involving very high-frequency, sound or seismic testing.

The last meeting of the committee was held in Milan, Italy on 4 and 5 June 1984. Attendance at the meeting consisted of 32 delegates from 13 countries. Representing the U.S. was Glenn W. Carter, Technical Advisor for SC 50A from the United States National Committee, and Eric Heberlein, Chairman of Working Group 8 on Seismic Testing Procedures.

Committee activity consists of the following:

(1) Improvement and addition of new requirements, including mounting requirements, to the shock and vibration tests which are now in IEC Pub. 68.

(2) Random vibration confirmation methods will be developed and a new working group is being activated to do this.

(3) Working Group 8 on seismic testing developed test procedures and are continuing that effort. Eric Heberlein of the U.S. is in charge of that work.

(4) A new acoustical vibration working group has been set up and will prepare an initial draft of a testing procedure. It will then be issued as a Secretariat Document to all National Committees. The U.S. representative on this Working Group is Gordon Getline.

Working Groups which are now active are as follows:

Working Group 12—Random Vibration/Confirmation Methods and Revisions of Test Procedures. *TASK*—To produce a proposal for an IEC document giving nonmandatory information dealing with confirmation methods for the random vibration tests, Test Fd of IEC Publication 68. The document will cover possible instrumentation errors, statistical errors, and analyzing errors. Also to up date and revise the test method.

Working Group 11—Acoustic Vibration Test. *TASK*—To produce an Environment Acoustic Vibration Test suitable for components and equipment. This should be based on the preliminary proposals 50A (Secretariat) 199 and 50A. Milan/France/8.

Working Group 8—Seismic Test Guidance. *TASK*—To prepare procedures and guidance for sine-beat and time-history tests for seismic applications.

(5) The most recent document circulated for review: 50A (U.S.S.R.) 143 September 1984—Proposal to Amend Test Tolerance for Steady Accelerations.

The next meeting of the inernational committee is scheduled for March 1986.

ISO TC 43 and ISO/TC 43/SC1 Working Groups

The following working groups are currently part of ISO/TC 43, Acoustics, and ISO/TC 43/SC1, Noise. Most of the working groups met during the ISO TC 43 meetings held 22–26 April 1985 in Budapest, Hungary.

Working Group No.	Title of Working Group	Chair	Secretariat
ISO/TC 43	Acoustics [Secretariat: Denmark (DS)]		
WG 1	Threshold of Hearing	K. Brinkman Germany, FR	Denmark
WG 3	Techniques for Audiometry	Vacant	Netherlands
WG 4	Alarm Signal for Emergency Purposes	M. Whitcomb, USA	USA
ISO/TC 43/SC1	Noise [Secretariat: Denmark (DS)]		W. Germany
WG 3	Noise from Heating, Ventilating, and Air Conditioning Equipment	U. S. Bolleter, Switzerland	W. Germany
WG 8	Noise Emitted by Road Vehicles	J. Martin, France	France
WG 9	Noise from Compressors, Pneumatic Tools, and Pneumatic Machinery	J. Wenstrom, Sweden	Sweden
WG 13	Noise Emitted by Electrical Rotating Machines	G. Hubner, Germany, FR	W. Germany
WG 14	Noise from Gas Turbines	G. Pleeck, Belgium	
WG 17	Sound Attenuation of Ear Protectors	B. Johansson, Sweden	Denmark
WG 18	Assessment of Noise with Respect to Community Response—Revision of ISO/R 1996	O. Pedersen, Denmark	Denmark
WG 19	Assessment of Occupational Noise Hazard—Revision of ISO/R 1999	H. E. von Gierke, USA	Denmark
WG 20	Noise from Large Sound Sources	Vacant	Vacant
WG 21	Statistical Methods for Verifying Stated Noise Levels	K. Petrick, W. Germany	West Germany
WG 22	Measurement and Characterization of Noise Radiated by Structural Components of Machines	G. Hubner, W. Germany	West Germany
WG 23	Measurement of Airborne Noise Emitted by Computer and Business Equipment	W. W. Lang, USA	USA
WG 24	Sound Propagation Outdoors	J. E. Piercy, Canada	Denmark
WG 25	Acoustics—Determination of the Sound Power of Noise Sources Using Intensity Measurement	F. Fahy, U. K.	Denmark
Study Group	Infrasound and Ultrasound	O. J. Pedersen, Denmark H. E. von Gierke, USA	Vacant
WG XX	Acoustics—Methods for the Measurement of Isolated Bursts of Sound Energy Emitted by Machinery and Equipment		

SHORT COURSES

SEPTEMBER

MACHINERY INSTRUMENTATION AND DIAGNOSTICS

Dates: September 10-13, 1985
Place: New Orleans, Louisiana
Dates: September 24-27, 1985
Place: Anaheim, California
Dates: October 8-11, 1985
Place: Philadelphia, Pennsylvania
Dates: October 21-25, 1985
Place: Carson City, Nevada
Dates: November 5-8, 1985
Place: Boston, Massachusetts
Dates: December 3-6, 1985
Place: Houston, Texas

Objective: This course is designed for industry personnel who are involved in machinery analysis programs. Seminar topics include a review of transducers and monitoring systems, machinery malfunction diagnosis, data acquisition and reduction instruments, and the application of relative and seismic transducers to various types of rotating machinery.

Contact: Customer Information Center, Bently Nevada Corporation, P.O. Box 157, Minden, NV 89423 - (702) 782-3611, Ext. 9242.

OCTOBER

UNDERWATER ACOUSTICS AND SIGNAL PROCESSING

Dates: October 21-25, 1985
Place: University Park, Pennsylvania

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

Contact: Alan D. Stuart, Course Chairman, Applied Research Laboratory, Pennsylvania State University, P.O. Box 30, State College, PA 16804 - (814) 865-7505.

MACHINERY VIBRATION ANALYSIS

Dates: Oct. 29 - Nov. 1, 1985
Place: Oak Brook, Illinois

Objective: This course emphasizes the role of vibrations in mechanical equipment instrumentation for vibration measurement, techniques for vibration analysis and control, and vibration correction and criteria. Examples and case histories from actual vibration problems in the petroleum, process, chemical, power, paper, and pharmaceutical industries are used to illustrate techniques. Participants have the opportunity to become familiar with these techniques during the workshops. Lecture topics include: spectrum, time domain, modal, and orbital analysis; determination of natural frequency, resonance, and critical speed; vibration analysis of specific mechanical components, equipment, and equipment trains; identification of machine forces and frequencies; basic rotor dynamics including fluid-film bearing characteristics, instabilities, and response to mass unbalance; vibration correction including balancing; vibration control including isolation and damping of installed equipment; selection and use of instrumentation; equipment evaluation techniques; shop testing; and plant predictive and preventive maintenance. This course will be of interest to plant engineers and technicians who must identify and correct faults in machinery.

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

VIBRATIONS OF RECIPROCATING MACHINERY

Dates: Oct. 29 - Nov. 1, 1985
Place: Oak Brook, Illinois
Dates: August 19-22, 1986
Place: New Orleans, Louisiana
Objective: This course on vibrations of reciprocating machinery includes piping and foundations. Equipment that will be addressed includes reciprocating compressors and pumps as well as engines of all types. Engineering problems will be discussed from the point of view of computation and measurement. Basic pulsation theory --including pulsations in reciprocating compressors and piping systems -- will be described. Acoustic resonance phenomena and digital acoustic simulation in piping will be reviewed. Calculations of piping vibration and stress will be illustrated with examples and case histories. Torsional vibrations of systems containing engines and pumps, compressors, and generators, including gearboxes and fluid drives, will be covered. Factors that should be considered during the design and analysis of foundations for engines and compressors will be discussed. Practical aspects of the vibrations of reciprocating machinery will be emphasized. Case histories and examples will be presented to illustrate techniques.

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

NOVEMBER

MACHINERY INSTRUMENTATION

Dates: November 12-14, 1985
Place: Calgary, Alberta, Canada
Objective: This seminar provides an in-depth examination of vibration measurement and machinery information systems as well as an introduction to diagnostic instrumentation. The three-day seminar is designed for mechanical, instrumentation, and operations personnel who require a general knowledge of machinery informa-tion systems. The seminar is a recommended prerequisite for the Machinery Instrumentation and Diagnostics Seminar and the Mechanical Engineering Seminar.

Contact: Customer Information Center, Bently Nevada Corporation, P.O. Box 157, Minden, NV 89423 - (702) 782-3611, Ext. 9243.

DECEMBER

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

Dates: December 2-6, 1985
Place: Santa Barbara, California
Dates: February 3-7, 1986
Place: Santa Barbara, California
Dates: March 10-14, 1986
Place: Washington, DC
Dates: May 12-16, 1986
Place: Detroit, Michigan
Dates: June 2-6, 1986
Place: Santa Barbara, California
Dates: August 18-22, 1986
Place: Santa Barbara, California
Objective: Topics to be covered are resonance and fragility phenomena, and environmental vibration and shock measurement and analysis; also vibration and shock environmental testing to prove survivability. This course will concentrate upon equipments and techniques, rather than upon mathematics and theory.

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

MARCH

MEASUREMENT SYSTEMS ENGINEERING
Dates: March 10-14, 1986
Place: Phoenix, Arizona
MEASUREMENT SYSTEMS DYNAMICS
Dates: March 17-21, 1986
Place: Phoenix, Arizona
Objective: Electrical measurements of mechanical and thermal quantities are presented through the new and unique "Unified Approach to the Engineering of Measurement Systems." Test requestors, designers, theoretical analysts, managers and experimental groups are the audience for which these programs have been designed. Cost-effective, valid data in the field and in the laboratory, are emphasized. Not only how to do that job, but how to tell when it's been done right.

Contact: Peter K. Stein, Director, 5602 East Monte Rosa, Phoenix, AZ 85018 - (602) 945-4603; (602) 947-6333.

JULY

ROTOR DYNAMICS
Dates: July 14-18, 1986
Place: Rindge, New Hampshire
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, Director, The Vibration Institute, 101 West 55th Street, Suite 206, Clarendon Hills, IL 60514 - (312) 654-2254.

SEPTEMBER

MODAL TESTING OF MACHINES AND STRUCTURES
Dates: September 8-11, 1986
Place: Chicago, Illinois
Objective: Vibration testing and analysis associated with machines and structures will be discussed in detail. Practical examples will be given to illustrate important concepts. Theory and test philosophy of modal techniques, methods for mobility measurements, methods for analyzing mobility data, mathematical modeling from mobility data, and applications of modal test results will be presented.

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

ADVANCE PROGRAM

56th SHOCK and VIBRATION

SYMPOSIUM

October 22-24, 1985

Monterey, California

Host
U.S. Naval Postgraduate School
Monterey, California

THE SHOCK AND VIBRATION
INFORMATION CENTER

GENERAL INFORMATION

CONFERENCE LOCATION: Registration, information and unclassified technical sessions are at the Monterey Holiday Inn, Monterey, California. Classified sessions will be held at the U.S. Naval Postgraduate School, and the Defense Language Institute, Monterey, California. There is a separate program for the classified sessions.

REGISTRATION: Registration fee covers the cost of the proceedings of the 56th Shock and Vibration Symposium. There is no fee for SVIC Annual Subscribers* or for participants. Since the registration fee covers only the cost of the proceedings, there will be no reduced fee for part time attendance. The schedule of fees is as follows:

Subscriber Registration (for employees of SVIC Annual Subscribers*) -- No Fee

Participant Registration (authors, speakers, chairmen, cochairmen) -- No Fee

General Registration (all others) (payable to Disbursing Officer, NRL) -- $200.00

On-Site Registration: Pre-registrants may obtain their badges or last minute registration may be accomplished at the following times:

Monterey Holiday Inn

Monday, October 21 -- 7 p.m. to 9 p.m.
Tuesday, October 22 -- 7:30 a.m. to 4 p.m.
Wednesday, October 23 -- 8 a.m. to 4 p.m.
Thursday, October 24 -- 8 a.m. to 2 p.m.

INFORMATION: The information and message center will be located in the registration area. The phone number of the hotel is (408) 394-3321. Telephone messages and special notices will be posted near the registration desk. All participants should check regularly for messages or timely announcements. Participants will not be paged in the sessions.

COMMITTEE MEETINGS: Space is available to schedule meetings for special committees and working groups at the Symposium. To reserve space, contact SVIC. A schedule of special meetings will be posted on the Bulletin Board.

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SUMMARIES OF PRESENTED PAPERS: These will be available to all attendees at the time of registration. These summaries are longer than the usual abstract and contain enough detail to evaluate their usefulness to you as an individual. By reading these in advance of the sessions, you may more effectively choose the papers you wish to hear.

SHOCK AND VIBRATION BULLETIN No. 56: Papers presented at the 56th Symposium will, at the author's request, be reviewed and published in the Bulletin after approval by two reviewers. The discussion following these papers will be edited and published with the respective papers. Registrants who have paid the registration fee or have satisfied the registration requirements will receive a copy of the Bulletin. Additional sets of the 56th Bulletin will be sent to Annual Subscribers. Others may purchase the Bulletin from the Shock and Vibration Information Center. The price is $200.00 for each set delivered in the United States.

OTHER PUBLICATIONS: Sample copies of current publications of the Shock and Vibration Information Center may be examined at the registration area. Order blanks are available for those wishing to use them.

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TUESDAY, OCTOBER 22

8:30 a.m.
Point Cabrillo - Alones - Pinos

Opening Session

This session is still being planned. Details will appear in the final program.

2:00 p.m.
La Grande

Session 1A
Pyrotechnic Shock/Shipboard Shock

1. The Pre-Pulse in Pyroshock Measurement and Analysis -- A.E. GALEF, TRW, Redondo Beach, CA

2. Super*Zip (Linear Separation) Shock Characteristics -- K.Y. CHANG and D.L. KERN, Jet Propulsion Laboratory, Pasadena, CA

3. Zero Shift of Piezoelectric Accelerometers in Pyroshock Measurement --A. CHU and A. GILBERT, ENDEVCO, San Juan Capistrano, CA

4. Numerical Simulation of Atlas Centaur Stage Separation Shaped Charge Firing and Structural Response -- D. DAVISON, J. GORDON, AND P. CHAO, Physics International Co., San Leandro, CA; N. VISTE and J. WEBER, General Dynamics, Convair Division, San Diego, CA; and S. HANCOCK, Consultant

5. Computation of Excitation Forces Using Structural Response Data -- B.J. DOBSON, Royal Naval Engineering College, Devon, UK, and D. DUBROWSKI, Canadian Armed Forces

6. Underwater Shock Trials on a Plain Unreinforced Cylinder -- R.J. RANDALL, Admiralty Research Establishment, Portland, Dorset, UK

7. Structural Design of Deck Edge Aircraft Elevator for Minimum Weight -- E. SCHULZ, G. ELMER, and R. FAIRFIELD, NKF Engineering, Inc., Vienna, VA

2:00 p.m.
Point Cabrillo - Alones

Session 1B
Blast and Ground Shock

1. Dynamic Response of Armor Plate to Non-Penetrating Projectile Impact -- W.S. WALTON, U.S. Army Combat Systems Test Activity, Aberdeen Proving Ground, MD

2. Evaluation of Shock Response in Combat Vehicles: Scale Model Results -- J.F. UNRUH and D.J. POMERENING, Southwest Research Institute, San Antonio, TX

3. Yield Effects on the Response of a Buried Blast Shelter -- T.R. SLAWSON and S.A. KIGER, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS

4. Shelter Response in a Simulated 1 MT Nuclear Event -- S.C. WOODSON, S.A. KIGER, and T.R. SLAWSON, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS

5. A "Numerical Gauge" for Structural Assessment -- T. KRAUTHAMMER, University of Minnesota, Minneapolis, MN

6. Dependence of Free-Field Impulse on the Decay Time of Energy Efflux for a Jet Flow -- K.S. FANSLER, U.S. Army Ballistic Research Laboratory, Aberdeen Proving Ground, MD

7. Computer Implementation of a Muzzle Blast Prediction Technique -- C.W. HEAPS, K.S. FANSLER, and E.M. SCHMIDT, U.S. Army Ballistic Research Laboratory, Aberdeen Proving Ground, MD

8. Design Criteria and Certification Test Specifications for Blast Resistant Windows -- G. MEYERS, Naval Civil Engineering Laboratory, Port Hueneme, CA

WEDNESDAY, OCTOBER 23

8:30 a.m.
Point Cabrillo - Alones

Plenary A
Subject: Pyrotechnic Shock

9:40 a.m.
La Grande

Session 2A
Modal Test and Analysis

1. Multiple Tests Concept for Improved Validation of Large Space Structure Mathematic Models -- B.K. WADA, C.P. KUO, and R. GLASER, Jet Propulsion Laboratory, Pasadena, CA

2. Automating the Modal Analysis Process Using the Multivariate Mode Indicator Function -- D.L. HUNT, SDRC, Inc., San Diego, CA

3. The Algorithm and Application of a New Multi-Input Multi-Output Modal Parameter Identification Method -- L. ZHANG and H. KANDA, University of Cincinnati, Cincinnati, OH

4. Identification Techniques and Non Structured Masses -- S. HANAGUD, M. MEYYAPPA, and J.I. CRAIG, Georgia Institute of Technology, Atlanta, GA

5. Modal Parameter Identification Using Adaptive Digital Filters -- B.H. WENDLER, TRW, Redondo Beach, CA

6. SAFE/DAE: Modal Test in Space -- T.E. NESMAN and D.K. REED, NASA Marshall Space Flight Center, Huntsville, AL

9:40 a.m.
Point Cabrillo - Alones

Session 2B
Testing Techniques

1. Random Variation of Modal Frequencies -- Experiments and Analysis -- T.L. PAEZ, L.J. BRANSTETTER, and D.L. GREGORY, Sandia National Laboratories, Albuquerque, NM

2. Vibration Frequency and Damping Coefficient as Nondestructive Evaluations for Graphite-Epoxy Laminates -- C.T. SUN, D. LIU, and L.E. MALVERN, University of Florida, Gainesville, FL

3. An Alternative to Static Loads or Centrifuge Tests -- A.J. CURTIS, Hughes Aircraft Co., El Segundo, CA

4. A Digital, Realtime Control and Data Acquisition System for Railroad Vehicle Vibration Testing and Analysis -- G.A. HAMMA and P.A. WELIK, Synergistic Technology Inc., Cupertino, CA

5. A Three Dimensional Motion System and Digital Realtime Control System -- G.A. HAMMA, Synergistic Technology Inc., Cupertino, CA and K.L. CAPPEL, Wyle Laboratories, Huntsville, AL

9:40 a.m.
Point Pinos

Session 2W
Pyroshock Workshop I

Chairman: Charles Moening, The Aerospace Corporation, Los Angeles, CA

Topic 1: Pyroshock Instrumentation and Data Acquisition

Topic 2: Pyroshock Data Interpretation, Design and Test Requirements

2:00 p.m.
La Grande

Session 3A
Machinery Dynamics

1. Statistical Energy Analysis Applied to Marine Structures -- W.B. ROCKWOOD, L.K.H. LU, and P.C. WARNER, Westinghouse Electric Corp., Sunnyvale, CA; S.S. SATTINGER, Westinghouse R&D Center, Pittsburgh, PA; and R.G. DeJONG, Cambridge Collaborative, Inc., Cambridge, MA

2. Modeling of Multi-Rotor Torsional Vibrations in Rotating Machinery Using Substructuring -- F.R. SOARES, Rockwell International Corp., Downey, CA

3. Prediction of Natural Frequencies of Flexible Shaft-Disk System -- M. LALANNE, P. BREMAND, and G. FERRARIS, Institut National des Sciences Appliquees de Lyon, Villeurbanne, Cedex, France

4. Parameter Identification of a Non-Linear Dynamic System -- T. TSAI, C.F. GAU, H.M. HUANG, and J.C.S. YANG, University of Maryland, College Park, MD

5. Implementation of Active Force Control for Robots Subject to Dynamic Loading -- R. HOLLOWELL, R. GUILE, P. FITZPATRICK, and S. FOLEY, United Technologies Research Center, East Hartford, CT

6. Force Magnitude and Angular Velocity Reduction in a Spring-Restrained, Flexibly-Supported, Four-Bar Mechanical Linkage -- R.A. McLAUCHLAN and S.H. HONG, Texas A&I University, Kingsville, TX

2:00 p.m.
Point Cabrillo - Alones

Session 3B
Isolation and Damping

1. Analytically Determined Response of Elastically Isolated Equipment to Random Vibration Base Motion -- P.M. WIENER and P.J. WENDER, C.S. Draper Laboratory, Inc., Cambridge, MA

2. The Application of Impedance Models to the Design of Machinery Foundations -- R.G. DEJONG, J.E. MANNING, and A.C. AUBERT, Cambridge Collaborative, Cambridge, MA

3. Analytical Study of the Effect of Early Warning on Optimal Shock Isolation -- Y. NARKIS and W. PILKEY, University of Virginia, Charlottesville, VA

4. The Cascaded Two Degree of Freedom System -- G.M. HIEBER, Hieber Engineering, Watchung, NJ

5. Temperature Shift Considerations for Damping Materials -- L.C. ROGERS, Air Force Wright Aeronautical Laboratories, Wright Patterson Air Force Base, OH

6. Nonsynchronous Motion of Squeeze Film Damper Systems -- X. LI, General Motors Research Laboratories, Warren, MI and D.L. TAYLOR, Cornell University, Ithaca, NY

7. Effectiveness of On-Off Damper in Isolating Dynamical Systems -- S. RAKHEJA and S. SANKAR, Concordia University, Montreal, Canada

8. Active Vibration Control by Forecasting Control Method and Phase Adjusting Method -- J. ZHANG and L. CHOU, Xi'an Jiaotong University, Xi'an, The People's Republic of China

2:00 p.m.
Point Pinos

Session 3W
Pyroshock Workshop II

Chairman: Charles Moening, The Aerospace Corporation, Los Angeles, CA

Topic 3: Pyroshock Prediction, Protection, and Attenuation

Topic 4: Pyroshock Simulation and Testing

THURSDAY, OCTOBER 24

8:30 a.m.
Point Cabrillo - Alones

Plenary B

Speaker: Dr. David J. Ewins, Imperial College of Science and Technology, London, England

Subject: State-of-the-Art Assessment of Structural Dynamic Response Analysis (DYNAS)

9:40 a.m.
La Grande

Session 4A
Structural Dynamics

1. Dynamic Stress at Critical Locations of a Structure as a Criterion for Mathematical Model Modification -- C. IP and C.A. VICKERY, TRW, San Bernardino, CA and D.L.G. JONES, Air Force Wright Aeronautical Laboratories, Wright Patterson Air Force Base, OH

2. Buckling of Ring Stiffened Cylindrical Shells with Dynamic Loads -- T.A. BUTLER and J.C. BENNETT, Los Alamos National Laboratory, Los Alamos, NM; W.E. BAKER, University of New Mexico, Albuquerque, NM; and C.D. BABCOCK, California Institute of Technology, Pasadena, CA

3. On the Use of Simplified Models in the Supercomputer Era -- S. GINSBURG, University of Kansas, Lawrence, KS

4. Can the Practicing Engineer Afford to be Ignorant of Nonlinear Resonances -- D.T. MOOK and A.H. NAYFEH, Virginia Polytechnic Institute and State University, Blacksburg, VA

5. Forced Vibrations of Stringer Stiffened Damped Sandwich Panels -- N. KAVI, R.E. College, Rourkella, India and N.T. ASNANI, I.I.T., New Delhi, India

6. Helicopter Six-Force-Factor Identification -- J. ZHANG and Y. QIU, Xi'an Jiaotong University, Xi'an, The People's Republic of China and W. LI, China Aeronautical Establishment, Flight Test Research Institute, Xi'an, The People's Republic of China

9:40 a.m.
Point Cabrillo - Alones

Session 4B
Fatigue Acoustics and Fluid Flow

1. Prediction of Metal Fatigue Using Miner's Rule -- H.H.E. LEIPHOLZ, University of Waterloo, Waterloo, Ontario, Canada

2. Optimization of Satellite Antenna Structures Subjected to Random Vibration and Fatigue Constraints -- V.K. JHA, SPAR Aerospace Ltd., Ste. Anne de Bellevue, Quebec, Canada and T.S. SANKAR and R.B. BHAT, Concordia University, Montreal, Quebec, Canada

3. Evaluation of Vibration Specifications for Static and Dynamic Material Allowables -- S.P. BHATIA and J.H. SCHMIDT, Northrop Corporation, Hawthorne, CA

4. Pipe Wall Excitation Due to Internally Fully Developed Turbulent Flow -- J.M. CUSCHIERI, Florida Atlantic University, Boca Raton, FL

5. Supersonic Flow Induced Cavity Acoustics -- L.L. SHAW, Air Force Wright Aeronautical Laboratories, Wright Patterson Air Force Base, OH

6. Response of Geometrically Nonlinear Elastic Structures to Acoustic Excitation -- An Engineering Oriented Computational Procedure -- G. MAYMON, Israel Ministry of Defense, Haifa, Israel

2:00 p.m.
La Grande

Session 5A
Shock Testing and Analysis

1. Shock Reconstruction from the Shock Spectrum -- C.T. MORROW, Consultant, Encinitas, CA

2. The Shock Response Spectrum at Low Frequencies -- D.O. SMALLWOOD, Sandia National Laboratories, Albuquerque, NM

3. Relative Conservatism of Drop Table and Shaker Shock Tests -- T.J. BACA and T.D. BLACKER, Sandia National Laboratories, Albuquerque, NM

4. Investigation into the Effects of Using Detonating Cord to Remove a Conventional Propeller from a Waterborne Surface Ship --Y.S. SHIN and J.H. STRANDQUIST, Naval Postgraduate School, Monterey, CA

5. Shock and Vibration of Tube Banks in Inertial Fusion Reactors -- R.L. ENGELSTAD and E.G. LOVELL, University of Wisconsin, Madison, WI

6. Random Imperfections for Dynamic Pulse Buckling -- H.E. LINDBERG, APTEK, Inc., Mountain View, CA

7. Active One-Dimensional Protective Layers -- S. GINSBURG, University of Kansas, Lawrence, KS

8. Vibration Characteristics of Large-Scale Buried Structure -- F.D. DALLRIVA and S.A. Kiger, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS

2:00 p.m.
Point Cabrillo - Alones

Session 5B
Short Discussion Topics

This session is still being planned. Details will appear in the final program.

ABSTRACTS FROM THE CURRENT LITERATURE

ABSTRACT CONTENTS

AVAILABILITY OF PUBLICATIONS ABSTRACTED

None of the publications are available at SVIC or at the Vibration Institute, except those generated by either organization.

Periodical articles, society papers, and papers presented at conferences may be obtained at the Engineering Societies Library, 345 East 47th Street, New York, NY 10017; or Library of Congress, Washington, D.C., when not available in local or company libraries.

Government reports may be purchased from National Technical Information Service, Springfield, VA 22161. They are identified at the end of bibliographic citation by an NTIS order number with prefixes such as AD, N, NTIS, PB, DE, NUREG, DOE, and ERATL.

Ph.D. dissertations are identified by a DA order number and are available from University Microfilms International, Dissertation Copies, P.O. Box 1764, Ann Arbor, MI 48108.

U.S. patents and patent applications may be ordered by patent or patent application number from Commissioner of Patents, Washington, D.C. 20231.

Chinese publications, identified by a CSTA order number, are available in Chinese or English translation from International Information Service, Ltd., P.O. Box 24683, ABD Post Office, Hong Kong.

Institution of Mechanical Engineers publications are available in U.S.: SAE Customer Service, Dept. 676, 400 Commonwealth Drive, Warrendale, PA 15096, by quoting the SAE-MEP number.

When ordering, the pertinent order number should always be included, not the **DIGEST** abstract number.

A List of Periodicals Scanned is published in issues, 1, 6, and 12.

MECHANICAL SYSTEMS

ROTATING MACHINES

85-1497
Modal Parameters of Disc Brake Rotor by Data Dependent Systems
S.M. Pandit, E.N. Jacobson, W.R. Shapton
Michigan Technological Univ., Houghton, MI 49931
Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, FL, Vol. II, pp 850-856, 2 figs, 3 tables, 10 refs

KEY WORDS: Rotors, Brakes (motion arresters), Data dependent systems, Experimental modal analysis

A recently developed methodology called Data Dependent Systems (DDS) was used to obtain a comprehensive quantitative description of the dynamic characteristics of disc brakes. This was done by means of high order stochastic difference equation. Each rotor was modeled with data collected at sixty points on three equally spaced diameters. The modal parameters were obtained from the recursively fitted time series difference equations. These DDS models contain all the dynamic characteristics of the rotor excited in the testing. The DDS results are compared with those obtained by the FFT.

85-1498
A Blade Loss Response Spectrum for Flexible Rotor Systems
M. Alam, H.D. Nelson
Arizona State Univ., Tempe, AZ 85287
J. Engrg. Gas Turbines Power, 107 (1), pp 197-204 (Jan 1985), 15 figs, 4 tables, 13 refs

KEY WORDS: Flexible rotors, Blade loss dynamics

A shock spectrum procedure is developed to estimate the peak displacement response of linear flexible rotor-bearing systems subjected to a step change in unbalance (i.e., a blade loss). A progressive and a retrograde response spectrum are established. These blade loss response spectra are expressed in a unique non-dimensional form and are functions of the modal damping ratio and the ratio of rotor spin speed to modal damped whirl speed. The procedure is applied to three example systems using several modal superposition stategies. The results of each are compared to true peak displacements obtained by a separate transient response program.

85-1499
Self-Excited Vibration of Multi-Disc Rotor Supported on Several Flexible Bearings
E.M. Badawy, H.M. Metwally, F.K. Salman
Alexandria Univ., Alexandria, Egypt
Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, FL, Vol. II, pp 1115-1120, 8 figs, 12 refs

KEY WORDS: Rotors, Flexible bearings, Transfer matrix method, Stability, Internal damping

A calculation method incorporating the transfer matrix method and the characteristic-vector locus method has been developed for stability analysis of self-excited vibration of a rotating shaft system with many bearings and discs. A two-rotor model is presented to show the influence of rotor and its gyroscopic action, support stiffness characteristics, internal and external damping on stability. A computer solution of the transfer matrix method shows the rotor stability is improved by damped support. A computer solution of the governing equations of motion is presented showing the shaft stability region for various speed ranges and effect of bearing stiffness ratio on the stability region.

85-1500
Shaft Cracking Supervision of Heavy Turbine Rotors by FMM Method
A. Rauch
The Technical Univ. of Denmark, Lundtoftevej 100 DK-2800 Lyngby, Denmark

Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, Florida, Vol. II, pp 714-722, 7 figs, 24 refs

KEY WORDS: Shafts, Turbine components, Crack detection, Failure detection, Modal analysis

Shaft cracking supervision of heavy turbine rotors is becoming a crucial problem for electricity board authorities, power plants, and turbine manufacturers because of an increased tendency to use in-line mounted large power units. A method of on-load crack supervision called the Figures of Merit for Maintenance (FMM) method is suggested based on crack pattern correlated evaluation of rotor response to impact bearing excitation in situ. This method has been developed by computer simulation and seems to be very promising. A review of investigation methods and aspects of shaft crack detecting is also presented.

85-1501

Transfer Matrix Eigensolutions for Damped Torsional Systems

S. Doughty, G. Vafaee

Univ. of Wisconsin - Platteville, Platteville, WI 53818

J. Vib., Acoust. Stress, Rel. Des., Trans. ASME, 107 (1), pp 128-131 (Jan 1985), 5 figs, 3 tables, 4 refs

KEY WORDS: Shafts, Damped structures, Torsional vibration, Transfer matrix method, Eigenvalue problems

A transfer matrix method is presented for determination of complex eigensolutions associated with damped torsional vibrations of single shaft machine trains. The system is described and the natures of the eigenvalues are discussed. The general solution method is developed, and the method is applied to two example problems.

85-1502

Proposed Solution Methodology for the Dynamically Coupled, Nonlinear Geared Rotor Mechanics Equations

L.D. Mitchell, J.W. David

Virginia Polytechnic Inst. and State Univ., Blacksburg, VA 24061

J. Vib., Acoust. Stress, Rel. Des., Trans. ASME, 107 (1), pp 112-116 (Jan 1895), 4 figs, 9 refs

KEY WORDS: Shafts, Disks, Unbalanced mass response, Torsional vibration, Lateral vibration

The equations which describe three-dimensional motion of an unbalanced rigid disk in a shaft system are nonlinear and contain dynamic-coupling terms. Traditionally, investigators have used an order analysis to justify ignoring the nonlinear terms in the equations of motion, producing a set of linear equations. This paper will show that, when gears are included in such a rotor system, the nonlinear dynamic-coupling terms are potentially as large as the linear terms. Because of this, one must attempt to solve the nonlinear rotor mechanics equations. A solution methodology is investigated to obtain approximate steady-state solutions to these equations.

85-1503

A Theoretical Study of Stability of a Rigid Rotor Under the Influence of Dilute Viscoelastic Lubricants

A. Mukherjee, R. Bhattacharyya, A.M. Rao Dasary

I.I.T., Kharagpur-721302, India

J. Tribology, Trans. ASME, 107 (1), pp 75-81 (Jan 1985), 11 figs, 21 refs

KEY WORDS: Rigid rotors, Stability

An attempt is made to study theoretically stability of a symmetrical, horizontal, rigid rotor mounted on two identical short bearings. Dilute viscoelastic solutions are used as lubricants. Experimental studies reveal that at high shear rates, which occur in the journal bearing clearance space, the Weissenberg effect is degraded while the relaxation time remains unaltered. Harnoy proposed a constitutive equation which decouples the Weissenberg effect and relaxation time may be used to depict the constitutive relations for lubricants under above-mentioned conditions. The study reveals that an apparent inertia tensor, arising out of linearized elasto-viscous acceleration dependent forces, has a predominant effect on the stability of such a rotor.

85-1504

Eigenvalues of Rotating Machinery

B.T. Murphy

Ph.D. Thesis, Texas A&M Univ., 230 pp (1984), DA8419858

KEY WORDS: Rotating machinery, Eigenvalue problems

The current industry standard for linear eigenanalysis for vibration of rotating machinery is the transfer matrix method. This is true for both lateral and torsional vibration. Lateral vibration computer codes based on this method are subject to a variety of convergence problems. A method of calculation is presented which overcomes these problems. A technique is derived by which transfer matrices are used to compute the coefficients of the system's characteristic polynomial. The eigenvalues are the roots of this polynomial.

85-1505

Vibration Characteristics of the HPOTP (High-Pressure Oxygen Turbopump) of the SSME (Space Shuttle Main Engine)

D.W. Childs, D.S. Moyer
Texas A&M Univ., College Station, TX 77843

J. Engrg. Gas Turbines Power, 107 (1), pp 152-159 (Jan 1985), 15 figs, 16 refs

KEY WORDS: Pumps, Space shuttles

A review is presented of various rotordynamic problems which have been encountered and eliminated in developing current flight engines and of continuing subsynchronous problems; these are being encountered in developing a 109 percent power level engine. The basic model for the HPOTP, including the structural dynamic model for the rotor and housing and component models for the liquid and gas seals, turbine-clearance excitation forces, and impeller-diffuser forces, are discussed. Results from a linear model are used to examine the synchronous response and stability characteristics of the HPOTP, examining bearing load and stability problems associated with the second critical speed.

85-1506

Steady-State Torsional Response with Viscous Damping

S. Doughty
Univ. of Wisconsin-Platteville, Platteville, WI 53818

J. Vib., Acoust. Stress, Rel. Des., Trans. ASME, 107 (1), pp 123-127 (Jan 1985), 3 figs, 4 tables, 8 refs

KEY WORDS: Torsional vibration, Viscous damping, Periodic excitation

The purpose of this paper is to develop the complete steady-state torsional response to periodic excitation in a form directly suited to machine computation. This will be a solution for the actual rotation of each station, not the relative rotation. This is also the motion required for comparison with measurements made using single station, FFT measuring techniques. The relative motion is readily available from these results simply by computing station-to-station differences. There follows below a description of the system leading to formulation of the equation of motion, the determination of the complete particular solution, and two example problems illustrating the methods and results obtained.

85-1507

Identification of Subsynchronous Whirl-Case History of a 158 MW Steam Turbine

J.A. Kubiak, E. Murphy A.
Instituto de Investigaciones Electricas, Cuernavada, Mexico

Machinery Vibration Monitoring and Analysis Meeting, Proc., June 26-28, 1984, New Orleans, LA. Spons. by Vibration Institute, Clarendon Hills, IL, pp 41-49, 9 figs, 2 tables, 10 refs

KEY WORDS: Steam turbines, Whirling, Subsynchronous vibrations, Case histories

During start-up of a 158 MW steam turbine which took place after a main overhaul, severe vibrations were recorded. Synchronous vibrations were identified at 2700 RPM on Bearing No. 3. The magnitude of the amplitude reached 8.5 mils. Above 3300 RPM the turbine was strongly excited by a vibration whose amplitude reached 21 mils with a frequency equal to 1/3 of operating speed. The case has been analyzed and remedies have been recommended and applied.

RECIPROCATING MACHINES

85-1508
The Vibrational Behaviour of I.C. Engine: Computer Simulation and Experimental Verification
A.E. Yousif, J.F. Hassan
Univ. of Baghdad, Baghdad, Iraq
Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, Florida, Vol. II, pp 1322-1330, 14 figs, 3 refs

KEY WORDS: Internal combustion engines, Computer programs, Experimental modal analysis, Diagnostic techniques

Vibration of an I.C. engine running at a constant speed was analyzed theoretically and measured experimentally in an attempt to study the different contributory effects (moving parts and combustion process) on the engine vibration. A computer program was developed in which three dimensional shaking forces and moments acting on the engine frame as well as the motion of any point on the frame were analyzed and calculated by means of Fourier technique. The accuracy of the program was experimentally verified using a four-cylinder petrol engine.

METAL WORKING AND FORMING

85-1509
Identification of the Joint Structural Parameters of Machine Tool by DDS and FEM
J.X. Yuan, X.M. Wu
Univ. of Wisconsin-Madison, Madison, WI 53706
J. Engrg. Indus., Trans. ASME, 107 (1), pp 64-69 (Feb 1985), 5 figs, 7 tables, 8 refs

KEY WORDS: Machine tools, Parameter identification technique, Dynamic data system technique, Finite element technique

A unique methodology is proposed to identify the joint structural parameters of the machine tool by combining the Dynamic Data System (DDS) methodology with the Finite Element Method (FEM). The structural parameter identification of a simple system with complete modal matrix is introduced together with the modal analysis by the DDS method. The simulation study of a two degree-of-freedom system shows the high accuracy of the identification procedure.

85-1510
A Modified Model of Machining Chatter
C.Y. Hu, C.I. Weng, C.K. Chen
National Cheng Kung Univ., Tainan, Taiwan, Rep. of China
Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, Florida, Vol. II, pp 1178-1184, 9 figs, 15 refs

KEY WORDS: Machine tools, Chatter, Modal analysis

A modified dynamic model of cutting force considering the geometry of orthogonal cutting, the relationships of cutting angles, the effects of tool cutting on a wavy surface of workpiece, and the variations of cutting angles in cutting process, is derived. The cutting system is simulated by a two-degree dynamic model. By the concept of energy, therefore, the stability will be predicted from the damping term in the equation of motion.

85-1511
Modal Synthesis Technique of Machine Tool Structure
Wang Guanfu, Peng Zemin

Tianjin Univ., Tianjin, Peoples Rep. of China
Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, Florida, Vol. II, pp 1185-1193, 5 figs, 2 tables, 8 refs

KEY WORDS: Modal synthesis, Machine tools, Damping effects

Based on the Rubin free-interface modal synthesis technique, a new method is presented taking into consideration the complex damping effect which is a particular feature of machine tool structure. This new technique is based upon static and dynamic experiments of various machine tool components, and then put through assembly step by step for modal synthesis.

85-1512
Modal Analysis of Twist Drills
M. Kohring, C. Johnson, W. Shapton
Cincinnati Milacron, Cincinnati, OH
Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, Florida, Vol. II, pp 1171-1177, 14 figs, 3 refs

KEY WORDS: Modal analysis, Drills, Natural frequencies, Mode shapes, Damping coefficients

Modal analysis of a twist drill with three representative boundary conditions was performed. The boundary conditions approximated fixed-free, fixed-pinned and fixed-fixed constraints. These boundary conditions are representative of conditions occurring during the actual drilling process. The natural frequencies, mode shapes and damping factors were determined.

85-1513
Machine Tool Vibrations — A Review
V. Ramamurti, D. Ganapathi Rao
Indian Inst. of Technology, Madras-600036, India
Shock Vib. Dig., 16 (12), pp 9-13 (Dec 1984), 64 refs

KEY WORDS: Machine tools, Reviews

The material reported here is work done on machine tool vibrations and noise since 1981.

MATERIALS HANDLING EQUIPMENT

85-1514
Field Modal Testing and Evaluation of Modifications for Bridge Crane Structures Designed for Sensitive Equipment
W.D. Strunk, B.W. Van Hoy
Martin Marietta Energy Systems, Inc., Oak Ridge, TN
Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, Florida, Vol. I, pp 1-6, 8 figs, 3 refs

KEY WORDS: Overhead cranes, Experimental modal analysis, Structural modification techniques, Case histories

The large span and unique payload grapple/rotation mechanisms of overhead bridge cranes present complex challenges in the analysis and solution of excessive payload vibration levels. The problems characterized and solved include: testing of heavily damped structural components and massive in-situ structures with high modal density carrying dynamically sensitive payloads; work in poorly accessible locations on in-use equipment within a limited time frame; assessing test results and proposing structural modifications; and qualifications of modifications.

85-1515
Active Damping in a Three-Axis Robotic Manipulator
P. Meckl, W. Seering
Massachusetts Inst. of Tech., Cambridge, MA 02139
J. Vib., Acoust. Stress, Rel. Des., Trans. ASME, 107 (1), pp 38-46 (Jan 1985), 15 figs, 22 refs

KEY WORDS: Robots, Active vibration control, Active damping

This paper explores several methods to eliminate residual vibration of a robot arm at the end of a move, using open-loop control. The robot structure is modeled as lumped masses and springs with negligible damping, representative of a three-axis Cartesian manipulator. Vibration control is achieved using two different types of forcing functions. These functions are then compared in their ability to attenuate residual vibration in practice.

85-1516
Reduction of Residual Vibrations in Positioning Control Mechanism
I. Yamada, M. Nakagawa
Yokosuka Electrical Communication Lab., Nippon Telegraph and Telephone Public Corp., Yokosuka, Kanagawa, Japan
J. Vib., Acoust. Stress, Rel. Des., Trans. ASME, 107 (1), pp 47-52 (Jan 1985), 10 figs, 2 tables, 6 refs

KEY WORDS: Positioning devices (machinery), Vibration control, Printing

This paper clarifies numerically and experimentally the characteristics of residual vibrations caused by the natural frequency variation for a positioning mechanism, such that a load modeled as a one-degree-of freedom vibratory system is driven by a servomotor. A multi-design-point method is proposed which can reduce residual vibrations over a comparatively wide range of parameter variations.

STRUCTURAL SYSTEMS

BRIDGES

85-1517
Impact in Truss Bridge Due to Freight Trains
Kuang-Han Chu, V.K. Garg, M.H. Bhatti
Illinois Inst. of Tech., Chicago, IL 60616
ASCE J. Engrg. Mech., 111 (2), pp 159-174 (Feb 1985), 13 figs, 3 tables, 15 refs

KEY WORDS: Bridges, Railroad trains, Moving loads

The dynamic responses of railway bridge members due to vehicle-track-bridge interaction were investigated for the effects of vertical and lateral track irregularities, approach track quality, and bridge damping. In each case, a train consisting of three vehicles moving at constant speed was simulated traveling on the bridge.

85-1518
Impact Studies on Small Composite Girder Bridge
C. O'Connor, R.W. Pritchard
Univ. of Queensland, St. Lucia, Queensland, Australia
ASCE J. Struc. Engrg., 111 (3), pp 641-653 (Mar 1985), 10 figs, 32 refs

KEY WORDS: Bridges, Girders, Impact response

Two impact studies on a small span, composite girder highway bridge have given widely scattered impact fractions. Field strains were used to measure maximum midspan bending moments for trucks in normal traffic, and these were compared with equivalent static values computed from axle weights measured by a weighbridge. The scatter of the results suggests that impact is vehicle dependent, and that it may vary with suspension geometry. Possible causes of high impact are examined.

BUILDINGS

85-1519
Influence of Windows and Doorways on the Fatigue Strength of Walls Under Vibratory Stress (Der Einfluss von Maueröffnungen auf die Schwingungsfestigkeit von Hauswanden)
A. Koller
München Siemens AG, Zentrale Aufgaben Informationstechnik
Siemens Res. Dev. Repts., 13 (6), pp 253-259 (1984), 12 figs, 14 refs

KEY WORDS: Buildings, Natural frequencies, Seismic excitation, Wind-induced excitation

Earthquakes and hurricanes excite natural vibrations in buildings that cause structural damage. A simple method of calculating the fundamental vibrations of walls with or without windows and doorways is described. The declarative power of the calculations is demonstrated.

85-1520
Mathematical Model to Predict 3-D Wind Loading on Buildings
G. Solari
Istituto di Scienza delle Costruzioni, Univ. of Genova, Genova, Italy
ASCE J. Engrg. Mech., 111 (2), pp 254-276 (Feb 1985), 12 figs, 6 tables, 31 refs

KEY WORDS: Buildings, Wind-induced excitation, Frequency domain method, Mathematical models

A mathematical model to predict 3-D wind loading on buildings with rectangular geometry and wind acting normally to a face is formulated. This methodology allows the evaluation of force distribution in the frequency domain including mean wind loads and fluctuating loads due to alongwind and acrosswind atmospheric turbulence and wake excitation. The reliability of the proposed technique is verified by comparing predicted results with experimental data available in the literature.

85-1521
Effects of Repeated Blasting on a Wood Frame House
M.S. Stagg, D.E. Siskind, M.G. Stevens, C.H. Dowding
Bureau of Mines, Minneapolis, MN
Bureau of Mines Rept. Investigations RI 8896, pp 1-82 (1984), 40 figs, 14 tables, 64 refs

KEY WORDS: Buildings, Wood, Fatigue tests

A wood frame test house, built in the path of an advancing surface coal mine, was investigated for the effects of repeated blasting. Structural fatigue and damage were assessed over a two-year period. Failure strain characteristics of construction materials were evaluated as a basis for comparing strains induced by blasting and shaker loading to those induced by weather and household activities.

85-1522
Modal Analysis of a Base Isolated Building
G.C. Pardoen, G.C. Hart
Univ. of California, Irvine, CA
Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, Florida, Vol. II, pp 1082-1086, 5 figs, 3 refs

KEY WORDS: Buildings, Base isolation, Seismic isolation, Experimental modal analysis

The first building in the United States to be located in a seismic zone that is on a base isolation system is described. The design objective involves the isolation of the building from the ground with a shock isolation type system which filters out the majority of the earthquake input to the structure. The modal testing consists of acquiring ambient and forced vibration velocity data using Ranger seismometers and processing this data using standard techniques to obtain the modal parameters.

TOWERS

85-1523
Using Vibrational Responses to Wind for Modal Analysis of Huge Structures Such as Natural Convection Cooling Towers
P. Kopff
Electricite de France
Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, Florida, Vol. II, pp 1331-1337, 5 figs, 6 refs

KEY WORDS: Experimental modal analysis, Cooling towers, Wind-induced excitation

A method of performing periodic and inexpensive modal identification of lower resonances of natural convection cooling towers is presented. Forced excitation of such huge structures was impractical; therefore, wind excitation was relied upon. The method developed calls for synchronous accumulation of numerically filtered time samples of the responses, triggered by null-increasing condition on one pick-up: this is shown to converge toward the direct and cross impulse responses of the structure.

85-1524

Experimental Determination of the Effective Mass of Stored Granular Materials in Silos Subject to Horizontal Oscillations

J.D. Von Nad

Ph.D. Thesis, Univ. of Colorado at Boulder, 106 pp (1984), DA8422663

KEY WORDS: Grain silos, Harmonic excitation, Seismic response

Results of experimental work for the determination of the effective mass of granular materials stored in silos subject to horizontal, harmonic oscillations are presented. Within the range of sizes of silo models, the type of materials tested, and the frequencies of oscillations applied, this effective mass resulted to be between 58 and 90 percent of the actual mass of stored materials.

FOUNDATIONS

85-1525

Dynamic Stiffness of Nonuniformly Embedded Foundations

Huei-Tsyr Jeremy Chen

Ph.D. Thesis, The Univ. of Texas at Austin, 253 pp (1984), DA8421677

KEY WORDS: Foundations, Stiffness coefficients, Finite element technique, Boundary element technique, Winkler foundations

The dynamic stiffnesses of uniformly and nonuniformly embedded foundations are computed using three different approaches: a finite element discretization, a boundary element formulation and a simplified procedure assuming a Winkler foundation (replacing the soil along the sidewalls by dynamic springs, complex functions of frequency). The results are presented in terms both of real and imaginary stiffness and of dynamic stiffness coefficients.

85-1526

Analysis of In-Plane and Out-of-Plane Ground Motions Using the Boundary Element Method

M.H. Sadd, J.M. Rice

Univ. of Rhode Island, Kingston, RI

Rept. No. ARO-18477, 87 pp (July 1984), AD-A146 229

KEY WORDS: Ground motion, Boundary element technique

A completed research program is presented which has developed new computational methods to study geomechanics ground motions excited by subsurface sources. Both in-plane (plane strain) and out-of-plane anti-plane strain) motions are investigated by employing a direct boundary element within the framework of linear dynamic elasticity theory.

UNDERGROUND STRUCTURES

85-1527

Dynamic Stresses and Displacements in a Buried Tunnel

K.C. Wong, A.H. Shah, S.K. Datta

Univ. of Manitoba, Winnipeg, Canada R3T 2N2

ASCE J. Engrg. Mech., 111 (2), pp 218-234 (Feb 1985), 15 figs, 8 refs

KEY WORDS: Tunnels, Underground structures, Numerical methods, Finite element technique, Modal superposition method

The dynamic response of a cylindrical tunnel embedded in a semi-infinite elastic medium is analyzed. The problem considered is one of plane strain, in which it is assumed that the waves are propagating perpendicular to the axis of the tunnel. Since this problem cannot be solved exactly except when the tunnel is circular, a numerical technique that combines the finite element method with the eigenfunction expansions is used. Numerical results are presented.

85-1528

Vibration Characteristics of Full- and One-Half Scale Structural Models

S.A. Kiger
USAE Waterways Experiment Station, Vicksburg, MS

Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, Florida, Vol. I, pp 15-20, 5 figs, 4 tables, 2 refs

KEY WORDS: Experimental modal analysis, Underground structures, Ammunition, Damping coefficients, Case histories

Prototype and 1/2-scale structural models of an earth-covered ammunition assembly facility were constructed and, as part of the pretest analysis, a series of vibration tests was conducted. Objectives of the vibration tests were to verify the fidelity of the 1/2-scale model and to investigate the effects of soil backfill on damping and frequency characteristics. Tests were conducted before and after backfilling.

HARBORS AND DAMS

85-1529

Reservoir Bottom Absorption Effects in Earthquake Response of Concrete Gravity Dams

G. Fenves, A.K. Chopra
Univ. of California, Berkeley, CA

ASCE J. Struc. Engrg., 111 (3), pp 545-562 (Mar 1985), 12 figs, 3 tables, 10 refs

KEY WORDS: Dams, Concrete, Seismic response

Linear responses of the tallest non-overflow monolith of a dam to taft ground motion are presented for a range of properties for the reservoir bottom materials and various assumptions for the impounded water and foundation rock. The alluvium and sediments at the reservoir bottom, upstream of the dam, are modeled by a reservoir bottom that partially absorbs incident hydrodynamic pressure waves. Based on these response results, it is demonstrated that the earthquake response of dams is increased by dam-water interaction and decreased by reservoir bottom absorption. The magnitude of these effects depends on the flexibility of the foundation rock and on the component of ground motion.

85-1530

Linear Finite Element Comparison with Experimental Modal Analysis for a Concrete Gravity Dam

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U.S. Army Engineer Waterways Experiment Station, P.O. Box 631, Vicksburg, MS 39180

Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, Florida, Vol. I, pp 59-65, 6 figs, 1 table, 5 refs

KEY WORDS: Dams, Concrete, Experimental modal analysis, Finite element techniques

Three-dimensional finite element (FE) analyses of a concrete gravity dam were conducted to determine the dam's natural frequencies and mode shapes. The results of the linear elastic FE analyses were compared to the dynamic properties computed from experimental results. Two models for the foundation were used.

POWER PLANTS

85-1531

Candu 600 Fuelling Machine Non-Linear Finite Element Modelling and Modal Testing

A.S. Banwatt, H.A. Wu, H. Murakami, M. Nagata

Atomic Energy of Canada Limited, CANDU-Operations, Mississauga, Ontario, Canada
Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, Florida, Vol. II, pp 1023-1030, 22 figs, 1 ref

KEY WORDS: Finite element technique, Modal analysis, Nuclear reactors, Test facilities

This paper describes the development of the nonlinear finite element model and explains the significant nonlinearities in the Canadian Deuterium and Uranium 600 fuelling machine system. Features and functions of a special purpose nonlinear finite element code and full scale modal testing of the fuelling machine test rig in the laboratory environment are also discussed. The results for frequency response analysis, free vibration and forced vibration cases are briefly described for a simple test model using the nonlinear code.

85-1532

Seismic Response Evaluation of a Reactor Core Using Modal Synthesis

R.G. Hill, K.R. Merckx
Exxon Nuclear Co., Inc., Richland, WA
Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, Florida, Vol. II, pp 996-1000, 6 figs, 3 refs

KEY WORDS: Modal synthesis, Nuclear reactor safety, Nuclear fuel elements, Seismic response

The dynamic response of the core in a pressurized water reactor (PWR) subjected to combined seismic and loss of coolant accident (LOCA) excitation must be evaluated as one of the required safety analyses. The modeling of this event assumes that a row of fuel assemblies is excited by the lateral motion of the core support plates. If these excitations are severe, then the spacer grids on the fuel assemblies can impact one another or the core barrel. This paper describes how the dynamic response of the fuel assemblies are modeled using a modal synthesis simulation.

85-1533

Problems of Modal-Analytical Experiments Performed Under Hostile Environmental Conditions

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Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, Florida, Vol, II, pp 723-729, 5 figs, 9 refs

KEY WORDS: Experimental modal analysis, Nuclear fuel elements, Nuclear reactor components

The paper deals with one particular procedure of experimental modal analysis developed to determine the natural frequencies, mode shapes and critical damping ratios of mechanical structures exposed to hostile environmental conditions. The application of this procedure to a typical structure (reactor core barrel) located in a hostile reactor environment yielded a consistent set of eigenfrequencies, mode shapes and critical damping ratios required to verify fluid-structure interaction codes in nuclear technology.

85-1534

Seismic Excitation Modal Participation Factor Estimates from Base Fixed Modal Analyses Parameters

J.F. Unruh
Southwest Res. Inst., San Antonio, TX
Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, Florida, Vol. II, pp 1001-1006, 4 figs, 4 tables, 6 refs

KEY WORDS: Modal analysis, Nuclear reactor components, Seismic response

The generation of seismic excitation modal participation factor estimates from base fixed modal analyses parameters requires the solution of the inverse problem of determining the structure's nodal mass distribution from modal measurements. The solution is cast in terms of a minimization problem with an objective function constructed from the mass orthogonality property of the eigenvectors and a weighted

condition of nodal mass variance. Several example problems are used to demonstrate the utility of the solution technique via comparison to finite element generated modal participation factors.

OFF-SHORE STRUCTURES

85-1535
Detection of Damages in Structures by the Cross Random Decrement Method
T. Tsai, J.C.S. Yang, R.Z. Chen
Univ. of Maryland
Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, Florida, Vol. II, pp 691-700, 12 figs, 3 tables, 4 refs

KEY WORDS: Off-shore structures, Drilling platforms, Modal analysis, Failure detection, Random decrement technique

The purpose of this paper is to develop a better understanding of the mechanism of failure of structures and to develop and test the new cross random decrement method for the early detection, identification and *location of damages.* An experimental study has been conducted on a scale model offshore platform structure. The dynamic responses of the platform under single impact and random excitation were measured for three damage scenarios.

VEHICLE SYSTEMS

GROUND VEHICLES

85-1536
Automotive Body Structure Dynamic Sensitivity Investigations Using Body Structural Joint Databank and Modal Analysis Techniques
M.K. Rao, R.J. Olsen, H.C. Crabb
Ford Motor Co., Allen Park, MI 48101
Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, Florida, Vol. II, pp 869-875, 8 figs, 6 refs

KEY WORDS: Automobiles, Joints, Finite element technique, Experimental modal analysis, Structural modification techniques

A comprehensive analysis system combining laboratory static testing, finite element analysis, and experimental modal testing for quantifying the effects of body joint stiffness characteristics on the body-in-white dynamic response is described.

85-1537
Structural-Acoustic System Analysis Using the Modal Synthesis Technique
D.J. Nefske, S.H. Sung
General Motors Res. Labs., Warren, MI 48090
Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, Florida, Vol. II, pp 864-868, 4 figs, 12 refs

KEY WORDS: Modal synthesis, Finite element technique, Automobiles, Interior noise, Structure borne noise

This paper describes the application of the modal synthesis technique to develop a structural-acoustic system model of the automotive vehicle. Finite element models of a representative vehicle structural system and the associated passenger compartment acoustic cavity are considered. A mathematical method for combining these models via the component mode synthesis technique is described.

85-1538
Driving Simulation with Translational Movement (Fahrsimulation mit translatorischer Beschleunigungsdarstellung)
W. Tomaske
Automobiltech. Z., 87 (1), pp 23-29 (Jan 1985), 16 figs, 9 refs (In German)

KEY WORDS: Automobiles, Test facilities

A report on a new driving system which simulates lateral movement by translation is presented. It consists of a computer program simulating the rolling behavior of the controlled element "car" and portraying the driver's corresponding perceptual stimuli in a cab.

85-1539
Traffic Noise Survey and Analysis in Singapore
H.K. Sy, P.P. Ong, S.H. Tang, K.L. Tan
National Univ. of Singapore, Kent Ridge, Singapore 0511
Appl. Acoust., 18 (2), pp 115-125 (1985), 8 figs, 3 tables, 5 refs

KEY WORDS: Traffic noise, Statistical analysis

A comprehensive survey and statistical analysis of daytime traffic noise in Singapore was carried out. The results are presented in terms of average L_{10}, L_{50} and L_{90} for four different classes of sites. By clearly distinguishing between temporal and spatial noise fluctuations, it is possible, on the basis of the Gaussian noise distributions obtained, to verify that the overall noise fluctuation can also be derivable from the respective temporal and spatial noise fluctuations.

85-1540
Vibrations Generated by Traffic and Building Construction Activities
R. Holmberg
Swedish Council for Building Research, Stockholm, Sweden
Rept. No. ISBN-91-540-4159-7, 117 pp (Oct 1983), PB85-103885

KEY WORDS: Traffic-induced vibrations, Construction industry

The scope of this publication is to report elementary facts about sources of vibrations in connection with traffic and construction activities. The publication describes different sources of vibrations, transmission media, human responses, damage criteria, and methods to decrease levels of vibrations and their associated costs. Information from the fields of blasting, traffic, piling, sheet piling, vibratory compaction, compaction by means of a drop weight and excavation is reported in order to facilitate community planning and construction activities.

SHIPS

85-1541
Modal Analysis of a Cylindrical Structure Immersed in Water
R. Randall
Royal Naval Engrg. College, Plymouth, Devon, UK
Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, Florida, Vol. II, pp 738-744, 3 figs, 1 table, 4 refs

KEY WORDS: Experimental modal analysis, Submerged structures, Cylinders, Ships

The paper describes a series of dynamic studies conducted upon a cylindrical structure tested in air and totally immersed in water. Modal analysis techniques have been used to identify the natural frequencies and mode shapes under both conditions. Good correlation has been obtained between experimental results and an analytical model.

AIRCRAFT

85-1542
Time Series Analysis of Closed-Loop Pilot Vehicle Dynamics
D.J. Biezad
Ph.D. Thesis, Purdue Univ., 275 pp (1984), DA8423330

KEY WORDS: Time series analysis method, Aircraft

The off-line development of linear discrete autoregressive models for man-machine closed-loop flight performance is presented. The development includes single input, sin-

gle output (single-channel) and multiple input, multiple output (multi-channel) closed-loop systems. Previous research is consolidated by extensive surveys of both single and multi-channel closed-loop modeling and is extended into a comprehensive joint auto-regressive man-machine identification process.

85-1543
Rotary-Wing Aircraft Noise Measurements: Analysis of Variations and Proposed Measurement Standard
P.D. Schomer
Construction Engrg. Res. Lab. (Army), Champaign, IL
Rept. No. CERL-TR-N-184, 24 pp (Sept 1984), AD-A146 207

KEY WORDS: Helicopter noise, Aircraft noise, Noise measurement

Helicopter noise is assessed using a computerized model developed and modified for rotary-wing aircraft use. Helicopter source emissions data are required as input to this model. This report explores the statistical variations in helicopter source emissions characterization and recommends a draft measurement standard designed to minimize the effects of these variations.

85-1544
Experimental Study of Noise Transmission into a General Aviation Aircraft
R. Vaicaitis, D.A. Bofilios, R. Eisler
Columbia Univ., New York, NY
Rept. No. NASA-CR-172357, 153 pp (June 1984), N84-30888

KEY WORDS: Aircraft noise, Interior noise, Honeycomb structures, Noise reduction

The effect of add-on treatments on noise transmission into a cabin of a light aircraft was studied under laboratory conditions for diffuse and localized noise inputs.

85-1545
Detection, Classification, and Extraction of Helicopter-Radiated Noise
R.F. Dwyer
Naval Underwater Systems Ctr., New London, CT
Rept. No. NUSC-TM-841134, 14 pp (July 25, 1984), AD-A145 993

KEY WORDS: Helicopter noise

Surface ships operating in conjunction with supporting helicopters may experience sonar performance degradation due to the accompanying interference from helicopter-radiated noise. The paper discusses detection and classification of helicopter-radiated noise from cumulative distribution function estimates, autocorrelation estimate, spectrum estimates, and from higher-order moment estimates. A method to extract the interference by implementing a nonlinearity in the frequency domain is presented.

85-1546
Prediction and Modeling of Helicopter Noise
R. Raspet, M. Kief, R. Daniels
Construction Engrg. Lab. (Army), Champaign, IL
Rept. No. CERL-TR-N-186, 54 pp (Aug 1984), AD-A145 764

KEY WORDS: Helicopter noise, Noise prediction

Sound exposure level data from three Army helicopters were used to test a proposed method for calculating sideline decay developed for fixed-wing aircraft. The Federal Aviation Administration and the U.S. Air Force have adopted this method for use with fixed-wing aircraft, and it was desired to know if the same method could predict rotary-wing aircraft sideline decay with distance or if a more complex computer model is necessary. The procedure was found accurate for limited altitudes and slant distances.

85-1547
Helicopter Design Problem
S.F. Girgis

Al-Fateh Univ., Tripoli, Libya
Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, Florida, Vol. II, pp 1316-1321, 6 figs, 3 refs

KEY WORDS: Helicopters, Rotors, Whirling, Flutter, Design techniques

A new term called 'whirl-flutter' is used to explain the coupling between the engine and propeller disc with rigid blades that are firmly secured to shaft. Rotor whirl flutter, in which the degrees of freedom of the individual blade of the rotor had to be taken into consideration to explain the flight phenomena. Analytical treatment to explain the mechanism leading to the self-induced oscillation is presented. Experiments to clarify the phenomena were made. The influence of individual parameters were discussed.

85-1548

Nonlinear System Identification Methodology Development Based on F-4S Flight Test Data Analysis

J.H. Vincent, S.N. Franklin, U.H. Rabin, T.L. Trankle
Systems Control Technology, Inc., Palo Alto, CA
179 pp (Dec 1983), AD-A146 289

KEY WORDS: Aircraft, Aerodynamic characteristic, System identification technique

An advanced flight test data processing technique that supports an integrated flight testing procedure (i.e., extraction of test data for multiple test requirements from common flight conditions) has been developed. This data processing technique is commonly referred to as system (or parameter) identification. Realization of this goal for an integrated flight testing procedure is dependent on the ability to identify nonlinear aerodynamic characteristics and propulsion system performance from flight test data. The identified models can be used to define performance, stability and control, and unaugmented airframe dynamic characteristics of the aircraft being evaluated.

85-1549

Dynamic and Flutter Analysis Using F.E.M. of the GP-180

A. Mazzoni, M. Pizzamiglio, R. Piaggio
Finale Ligure, Italia
Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, Florida, Vol. II, 1162-1170, 23 figs

KEY WORDS: Aircraft, Flutter, Finite element technique

A dynamic and flutter analysis of the GP-180, a business airplane, was performed. After a preliminary investigation of its characteristics, using a simple beam finite element model, a detailed analysis, was performed using the static model. Final verification of the results were done in a wind tunnel using an aeroelastic model.

85-1550

Design of a Candidate Flutter Suppression Control Law for DAST ARW-2

W.M. Adams, Jr., S.H. Tiffany
NASA Langley Res. Ctr., Hampton, VA
Rept. No. NASA-TM-86257, 28 pp (July 1984), N84-29833

KEY WORDS: Aircraft, Active flutter control

A control law is developed to suppress symmetric flutter for a mathematical model of an aeroelastic research vehicle. An implementable control law is attained by including modified LQC (Linear Quadratic Gaussian) design techniques, controller order reduction, and gain scheduling. An alternate (complementary)design approach is illustrated for one flight condition wherein nongradient-based constrained optimization techniques are applied to maximize controller robustness.

85-1551

Optimization of Airplane Wing Structures Under Landing Loads

S.S. Rao
San Diego State Univ., San Diego, CA 92182

Computers Struc., 19 (5/6), pp 849-863 (1984), 12 figs, 5 tables, 9 refs

KEY WORDS: Aircraft wings, Optimum design, Landing, Impact shock

A methodology is presented for the optimum design of aircraft wing structures subjected to landing loads. The stresses developed in the wing during landing are computed by considering the interaction between the landing gear and the flexible airplane structure.

MISSILES AND SPACECRAFT

85-1552
Comparison of Sine and Random Test Results from a Satellite Modal Test
C.R. Voorhees, G.A. Clark
RCA Astro-Electronics, Princeton, NJ 08540
Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, Florida, Vol. II, pp 814-823, 4 figs, 8 tables, 3 refs

KEY WORDS: Experimental modal analysis, Spacecraft, Multiple sine dwell method, Single point excitation technique, Multi-point excitation technique

Several modal test techniques were employed in a recently completed modal test on a meteorological spacecraft. The primary technique was the classical multiple-shaker sine-dwell method. The results are presented of this test and comparison is made with the results of both single-point random and multiple-point random tests. The paper concludes with a short discussion of the relative merits of each technique.

85-1553
Interactive Computer Graphics and Its Role in Control System Design of Large Space Structures
A.S.S.R. Reddy
Howard Univ., Washington, D.C. 20059
Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, Florida, Vol. II, pp 782-788, 2 figs, 2 tables, 15 refs

KEY WORDS: Space shuttles, Graphic methods, Computer aided techniques, Modal analysis, Structural members

This paper attempts to show the relevance of the interactive computer graphics in the design of the control systems to maintain attitude and shape of large space structures to accomplish the required mission objectives. Typical phases of control system design are reviewed and the need of the interactive computer graphics is demonstrated.

85-1554
Truncated Elastic Modes Coupling Effects Minimization Method by Using Special Attitude Control Scheme
D.C. Ceballos, A.R. Neto
Instituto de Pesquisas Espaciais - INPE, C.P. 515 - São José dos Campos -12.200 -Sao Paulo, Brazil
Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, Florida, Vol. II, pp 1227-1233, 3 figs, 3 tables, 13 refs

KEY WORDS: Modal analysis, Spacecraft, Attitude control equipment, Truncation

An adaptive control scheme is applied to minimize the truncated modes coupling effects for the attitude controlled spacecraft. The basic idea for the scheme is to nullify the accumulated effect of the truncated modes by using a correction in the control, such as to induce the physical system to have a behavior close to the model of work used in the syntheses and implementation of the control.

85-1555
A Study on Truncation Error in Substructure Testing
S. Sekimoto
Toshiba Corp., Kawasaki, Japan
Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, Florida, Vol. II, pp 1220-1226, 8 figs, 5 refs

KEY WORDS: Modal analysis, Spacecraft, Substructuring methods, Truncation, Error analysis

On vibration testing of a large structure, it is difficult to handle the whole structure as an entire system. An alternate approach, substructure testing, is considered. One of the problems with this method, however, is truncation error, which is the subject of this investigation.

BIOLOGICAL SYSTEMS

HUMAN

85-1556

Aircraft Noise Annoyance at Three Joint Air Carrier and General Aviation Airports

S. Fidell, R. Hononjeff, J. Mills, E. Baldwin
Bolt Beranek and Newman, Inc., P.O. Box 633, Canoga Park, CA 91305

J. Acoust. Soc. Amer., 77 (3), pp 1054-1068 (Mar 1985), 15 figs, 13 refs

KEY WORDS: Aircraft noise, Airports, Human response

The results of social surveys conducted near three airports that support both general aviation and scheduled air carrier operations are presented and discussed.

85-1557

A Path Model of Aircraft Noise Annoyance

S.M. Taylor
McMaster Univ., Hamilton, Ontario, Canada L8S 4K1

J. Sound Vib., 96 (2), pp 243-260 (Sept 22, 1984), 2 figs, 9 tables, 20 refs

KEY WORDS: Aircraft noise, Human response

This paper describes the development and testing of a path model of aircraft noise annoyance by using noise and social survey data collected in the vicinity of Toronto International Airport. Path analysis is used to estimate the direct and indirect effects of seventeen independent variables on individual annoyance. Results show that the strongest direct effects are for speech interference, attitudes toward aircraft operations, sleep interruption and personal sensitivity to noise.

85-1558

Surveying the Noise Exposure of Classrooms

A.L. Brown, R. Chan, H.F. Chan
Environmental Protection Agency, Empire Ctr., Tsim Sha Tsui, Kowloon, Hong Kong

Appl. Acoust., 18 (1), pp 55-67 (1985), 3 figs, 1 table, 11 refs

KEY WORDS: Traffic noise, Human response

The results of a survey of schools exposed to road traffic and aircraft noise are reported. The purpose of the survey was to produce noise exposure data on all the schools in the city. The results of the study are presented as a tool with which the existence and severity of the problem can be assessed and with which decision-makers can examine the ramifications of setting different noise level standards.

85-1559

Some Applications of Numerical Methods to the Analysis of the Compression of Articular Cartilage

P.A. Rombult, C.M. McC. Ettles
Rensselaer Polytechnic Inst., Troy, NY

Intl. J. Numer. Methods Engrg., 20 (12), pp 2197-2211 (Dec 1984), 12 figs, 1 table, 14 refs

KEY WORDS: Joints (anatomy), Numerical methods

Three different numerical formulations of the confined compression creep of cartilage have been developed to study the feasibility of applying numerical methods to dynamically loaded joints in biomechanics. The accuracy, convergence and stability of these numerical methods are assessed. Extensions of the analysis to include joint lubrication and non-uniform properties are discussed.

MECHANICAL COMPONENTS

ABSORBERS AND ISOLATORS

85-1560
The Active Control of Forced Vibration Produced by Arbitrary Disturbances
J.S. Burdess, A.V. Metcalfe
The Univ. of Newcastle upon Tyne, Newcastle upon Tyne, UK
J. Vib., Acoust. Stress, Rel. Des., Trans. ASME, 107 (1), pp 33-37 (Jan 1985), 11 figs, 14 refs

KEY WORDS: Active vibration control

This paper considers the vibration control of a single degree of freedom mass-spring-damper system when subjected to an arbitrary, unmeasurable disturbance. The idea of a disturbance observer is introduced and it is shown how an estimate of the excitation can be derived and used to generate a control, which reduces the vibration. Experimental results are presented which show the efficacy of the method when the system is excited by periodic, random, and impact forces.

85-1561
Refinement and Evaluation of Helicopter Real-Time Self-Adaptive Active Vibration Controller Algorithms
M.W. Davis
United Technologies Res. Ctr., East Hartford, CT
Rept. No. R83-956149-16, NASA-CR-3821, 285 pp (Aug 1984), N84-33378

KEY WORDS: Active vibration control, Helicopter vibration

A real-time self-adaptive (RTSA) active vibration controller was used as the framework in developing a computer program for a generic controller that can be used to alleviate helicopter vibration. Based upon on-line identification of system parameters, the generic controller minimizes vibration in the fuselage by closed-loop implementation of higher harmonic control in the main rotor system.

85-1562
Analysis of Three-Wheeled All-Terrain Vehicle/Rider System Dynamics
Teong Eng Tan
Ph.D. Thesis, Iowa State Univ., 324 pp (1984), DA8423746

KEY WORDS: Suspension systems (vehicles), Off-highway vehicles, Spring, Dampers

The primary objective of this research was to theoretically investigate what effects the spring-damper suspensions have on pitch, vertical and roll motions of three-wheeled all-terrain vehicles.

85-1563
Computer Aided Dynamic Analysis and Optimal Design of Suspension Systems for Off-Road Tractors
S. Rakheja
Ph.D. Thesis, Concordia Univ., (1984)

KEY WORDS: Suspension systems (vehicles), Off-highway vehicles

Rice improvement of agricultural tractors is investigated through optimal suspension systems at the seat and at the cab. The investigation has been carried out in four phases: passive seat suspension incorporating bounce, longitudinal, lateral, roll, and pitch modes of vibration of a rigidly mounted cab; cab suspension with a rigidly mounted seat; seat suspension with a suspended cab; bounce seat suspension employing semi-active "on-off" damping.

85-1564
Absorber Stops Elusive Multi-Stage-Pump Vibration
R.E. Mondy
Virginia Power Co.
Power, 129 (3), pp 51-52 (Mar 1985), 3 figs

KEY WORDS: Vibration absorbers, Pumps, Case histories

A vibration absorber treats the symptoms, not the causes, of vibration. But after multiple modifications had been made to a vertical, multi-stage/ash-sluice pump, this turned out to be the only possible way to solve the problem of excessive vibration at the motor top.

fler, there is no need to solve any unknown variables except for those of the inlet boundary and the outlet boundary.

85-1565

Design of Dynamic Vibration Absorber of Machine-Floor System

K.S. Wang, R.T. Wang

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Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, Florida, Vol. II, pp 1207-1213, 4 figs, 8 refs

KEY WORDS: Dynamic vibration absorption (equipment), Machine foundations, Design techniques, Modal analysis

The governing equations for the motion of machine, floor and dynamic vibration absorber are derived based on the assumption that the floor is considered as a thick plate. In the physical model the isolator is inserted between the machine and floor. The solutions are built up by Galerkin's method.

85-1566

A Method for the Analytical Prediction of Insertion Loss of a Two-Dimensional Muffler Model Based on the Transfer Matrix Derived from the Boundary Element Method

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J. Vib., Acoust. Stress, Rel. Des., Trans. ASME, 107 (1), pp 86-91 (Jan 1985), 17 figs, 8 refs

KEY WORDS: Mufflers, Sound insertion loss, Boundary element technique

The purpose of this paper is to introduce a new highly efficient method for predicting insertion loss, based on the transfer matrix equations derived from the boundary element method (BEM). The BEM solves all the unknown variables on the total boundary, but in calculating the insertion loss of an acoustic system which includes a muf-

85-1567

Use of Modal Parameters and an Interferometer Control System to Provide an Ultra Stable, Optical Base

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Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, Florida, Vol. II, pp 1007-1013, 11 figs, 7 refs

KEY WORDS: Base isolation, Laser structures, Rings, Modal analysis

A large ring laser gyro of 100 foot perimeter is supported by a reinforced concrete, isolation test platform with dimensional instabilities and vibration amplitudes in excess of that allowable for the central Fabry-Perot interferometer ring. The problems of providing an ultra stable 100 foot ring optical bench by minimizing the vibration coupling and incorporation of an interferometer sensor control system are addressed.

TIRES AND WHEELS

85-1568

Modal Analysis of Tires Relevant to Vehicle System Dynamics

T.R. Richards, J.E. Brown

The Goodyear Tire & Rubber Co., Akron, OH

Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, Florida, Vol. II, pp 857-863, 10 figs, 2 tables, 4 refs

KEY WORDS: Tires, Tire-vehicle systems, Finite element technique, Experimental modal analysis

This paper presents procedures for calculating the vibration modes of a tire using a detailed finite element model and for reducing these results to a much smaller modal model. Modal data from a specialized tire test rig is presented and the effects of tire modes on the dynamics of a tire/vehicle system model are discussed. These results show good agreement between calculated and measured tire modes and a strong dependence of system behavior on the interaction between tire and vehicle modes.

BLADES

85-1569

The Dynamic Behavior of Center Crack Tension Specimens During High Frequency Material Fatigue Tests

D.J. Koester, T.J. Lagnese, J.O. Barnett
Univ. of Dayton, Dayton, OH
Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, Florida, Vol. II, pp 794-801, 13 figs, 2 tables

KEY WORDS: Blades, Disks, Fatigue tests, Turbine engines, Experimental modal analysis

Material high frequency tests, simulating turbine engine blade and disk stress fields, can encounter many load and crack-tip stress field control problems arising from high frequency resonances in the specimens and load frame. To identify and avoid these resonant responses a thorough examination of the dynamic characteristics is required. These characteristics were examined by identifying the modal response of the specimen using a Fast Fourier digital spectrum analyzer. Several modal tests were completed for various loads and crack lengths representing limiting loading conditions of the specimen and load frame. The receptance data from these modal tests were then correlate to strain data to determine those modes which caused enough specimen bending to invalidate the material test.

85-1570

Basic Study of Bladed Disk Structural Response

A.V. Srinivasan, D.G. Cutts
United Technologies Res. Ctr., East Hartford, CT
Rept. No. R83-914806-48, AFWAL-TR-83-2075, 250 pp (Nov 1983), AD-A146 226

KEY WORDS: Propeller blades, Bladed disks, Fatigue life

Vibration induced fatigue failure of rotor blades is of continuing concern to the designer of aircraft engines. The dynamic response of a shrouded fan was characterized over a range of speeds by subjecting the assembly to forced vibration in vacuum in a spin rig and to distortion induced vibration in an aerodynamic rig. The characterization was established by analysis of blade strain response data obtained when the assembly was driven by predetermined standing or traveling wave forcing through piezoelectric crystal drive elements attached to the blades, by means of an aerodynamic distortion screen and by exit guide vanes.

85-1571

Improved Methods of Vibration Analysis of Pretwisted, Airfoil Blades

K.B. Subrahmanyam, K.R.V. Kaza
NASA Lewis Res. Ctr., Cleveland, OH
Rept. No. E-2175, NASA-TM-83735, 37 pp (1984), N84-30329

KEY WORDS: Blades, Airfoils, Finite difference technique, Geometric effects

Vibration analysis of pretwisted blades of asymmetric airfoil cross section is performed by using two mixed variational approaches. Numerical results obtained from these two methods are compared to those obtained from an improved finite difference method and also to those given by the ordinary finite difference method.

85-1572

Active Attenuation of Propeller Blade Passage Noise

J.M. Zalas, J. Tichy
Lord Corp., Erie, PA
Rept. No. NASA-CR-172386, 86 pp (July 1984), N84-30886

KEY WORDS: Propeller blades, Noise reduction, Active attenuation

Acoustic measurements are presented to show that active cancellation can be used to achieve significant reduction of blade passage noise in a turboprop cabin. Simultaneous suppression of all blade passage frequencies was attained.

85-1573

Stochastic Motor Blade Dynamics

Y.K. Lin, J.E. Prussing
Univ. of Illinois, Urbana-Champaign, IL

Rept. No. AAE-84-3, UILU-ENG-84-503, ARO-17830-5-EG, 11 pp (July 1984), AD-A146 312

KEY WORDS: Propeller blades, Helicopters, Turbulence, Stochastic processes

The results of a theoretical investigation into the effects of atmospheric turbulence on the dynamical behavior of helicopter rotor blades are reported.

85-1574

Propeller FOD Qualification Using Modal Analysis, Artificial Birds, and a Static Impact Facility

M.L. Drake, R.S. Bertke
Univ. of Dayton, Dayton, OH 45469

Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, Florida, Vol. II, pp 1072-1081, 14 figs, 4 tables, 19 refs

KEY WORDS: Propeller blades, Bird impact, Modal analysis

This paper describes the results of a program to investigate the impact response of a composite propeller blade to bird impacts. The objective of the program was to demonstrate that the particular propeller designed for the M10877 Beech Aircraft Model 1900 would pass FAA certification requirements. The program philosophy, four major program tasks, and program results are discussed.

BEARINGS

85-1575

Analysis of Starved Journal Bearings Including Temperature and Cavitation Effects

A. Artiles, H. Heshmat
Mechanical Technology, Inc., Latham, NY 12110

J. Tribology, Trans. ASME, 107 (1), pp 1-13 (Jan 1985), 18 figs, 5 tables, 16 refs

KEY WORDS: Journal bearings, Fluid-film bearings, Lubrication, Temperature effects, Cavitation

A method of analysis is described treating starvation in finite journal bearing pads. A variable-size finite difference mesh is used to represent the two-dimensional temperature and pressure fields. A combination of Newton-Raphson iteration, direct iteration, and column matrix methods are used to solve for the start-of-film and journal positions as well as the coupled two-dimensional energy and Reynolds equations.

85-1576

Stability, Load Capacity, Stiffness, and Damping Advantages of the Double Pocket Journal Bearing

J.C. Nicholas
McGraw-Edison Co., Wellsville, NY 14895

J. Tribology, Trans. ASME, 107 (1), pp 53-58 (Jan 1985), 12 figs, 2 tables, 12 refs

KEY WORDS: Journal bearings, Stability, Stiffness coefficients, Damping coefficients

The double pocket bearing design is discussed and compared to the plain three axial groove bearing. Rigid rotor stability, load capacity, and stiffness and damping curves are shown for the two bearing designs illustrating the stability and load capacity advantages of the double pocket bearing.

85-1577

A Fluid Film Squeezed Between Two Rotating Parallel Plane Surfaces

E.A. Hamza
Univ. of Khartoum, Khartoum, Sudan
J. Tribology, Trans. ASME, 107 (1), pp 97-103, (Jan 1985), 8 figs, 13 refs

KEY WORDS: Fluid-film bearings, Fluid inertia forces, Centrifugal forces

The motion of a fluid film squeezed between two rotating parallel plane surfaces is studied. Attention is given to the case of impulsive squeezing and impulsive rotation. Approximation analytic solutions are obtained and a numerical solution to the full nonlinear equations of motion is presented.

85-1578

Stability of Multirecess Hybrid-Operating Oil Journal Bearings

Y.S. Chen, H.Y. Su, P.L. Xie
Beijing Inst. of Aeronautics and Astronautics, Beijing, Peoples Republic of China
J. Tribology, Trans. ASME, 107 (1), pp 116-121 (Jan 1985), 8 figs, 1 table, 10 refs

KEY WORDS: Journal bearings, Fluid-film bearings, Stiffness coefficients, Damping coefficients, Finite difference technique

An analysis and a numerical solution using the finite difference method to predict the dynamic performance of multirecess hybrid-operating oil journal bearings are presented. The linearized stiffness and damping coefficients of a typical capillary-compensated bearing with four recesses are computed for various design parameters. The corresponding stiffness and the stability threshold of the bearing are then obtained,and the opposite influences of the hydrodynamic action on them are demonstrated.

85-1579

Dynamics of Rolling Element — Bearings Experimental Validation of the DREB and RAPIDREB Computer Programs

P.K. Gupta, J.F. Dill, H.E. Bandow
Air Force Wright Aeronautical Labs., Wright Patterson Air Force Base, OH 45433
J. Tribology, Trans. ASME, 107 (1), pp 132-137 (Jan 1985), 13 figs, 6 refs

KEY WORDS: Rolling contact bearings, Whirling, Computer programs

The general motion of the cage predicted by computer models in an angular with contact ball bearing operating up to two million DN is compared with experimental data. Both the computer predictions and experimental data indicate a certain critical shaft speed at which the cage mass center beings to whirl. The predicted and measured whirl velocities and orbit shapes are in good agreement.

85-1580

Parametric Evaluation of a Solid-Lubricated Ball Bearing

P.K. Gupta, J.F. Dill, H.E. Bandow
Air Force Wright Aeronautical Labs., Wright-Patterson Air Force Base, Oh 45433
ASLE, Trans., 28 (1), pp 31-39 (Jan 1985), 8 figs, 2 tables, 8 refs

KEY WORDS: Ball bearings, Clearance effects

Parametric evaluations, based on analytical simulations of the dynamic performance of a solid-lubricated ball bearing, indicate that, for prescribed operating conditions and lubricant traction behavior at the ball/race contact, a reduction in the ball/cage pocket and cage/race guiding land clearances results in an increased frequency of collision both at the ball/cage and cage/race interfaces.

85-1581

The Combined Effect of Surface Roughness and Elastic Deformation in the Hydrodynamic Slider Bearing Problem

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Institut fur Maschinenelemente und Maschinengestaltung, D-5100 Aachen, West Germany
ASLE, Trans., 28 (1), pp 69-74 (Jan 1985), 4 figs, 1 table, 10 refs

KEY WORDS: Slider bearings, Surface roughness, Elastic properties

Results of a numerical study concerning the combined effect of two-sided roughness and elasticity in a one-dimensional slider bearing are presented. Based upon the assumption that Reynolds' equation holds in the presence of roughness, and using Christensen's stochastic models for two-sided roughness, it is established that there is a strong interaction between the roughness and elasticity.

85-1582

Evaluation of Various Approximate Solutions for Fluid Inertia Effects on the Dynamic Performance of a Stepped Thrust Bearing

Y. Haruyama, T. Kazamaki, A. Mori, H. Mori
Toyama Univ., Toyama, 930 Japan

J. Tribology, Trans. ASME, 107 (1), pp 39-45 (Jan 1985), 9 figs, 13 refs

KEY WORDS: Thrust bearings, Fluid-inertia forces, Approximation methods

Based on the Navier-Stokes equations in which the pressure is assumed to be constant across the film thickness, various approximate solutions and the exact one for the dynamic performance of an infinitely wide, stepped thrust bearing in a laminar flow regime are presented under the assumption of a small harmonic vibration.

BELTS

85-1583

Modal Testing and Analysis in Continuous Band Systems

W.Z. Wu
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Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, Florida, Vol. II, pp 908-914, 10 figs, 10 refs

KEY WORDS: Experimental modal analysis, Bands, Belts, Finite element technique

The dynamics of an entire band system were studied. Observations of band vibration during testing of a full-scale industrial band mill showed dynamic coupling between the principal and secondary spans of the band blade.

GEARS

85-1584

Formulation and Programming of Equations of Motion of Driving Systems (Zur Formulierung und Programmierung der Bewegungsgleichungen von Antriebsstrangen)

F. Kücükay

VDI-Z, 126 (20), pp 769-774 (Oct 1984) 9 figs, 2 tables, 4 refs (In German)

KEY WORDS: Mechanical drives, Gears, Equations of motion

Regarding the investigation of vibrations which affect driving trains, complicated mechanical substitution models with many degrees of freedom require correspondingly high expenditures to draw up the associated equations of motion. A procedure is proposed in this contribution that allows to keep this expenditure to a minimum.

85-1585

Determination of the Rational Parameters of Noise-Reducing Damping Rings for Gears by Experimental Methods

Liang Zhong, Zhang Ce
Zhejiang Univ., People's Rep. of China

Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, Florida, Vol. II, pp 1214-1219, 5 figs, 2 tables, 1 ref

KEY WORDS: Gear noise, Noise reduction

Several resonance domains exist within the range of gear meshing speed generally used in industry. The function of dynamic behavior of gears due to the effect of noise-reducing damping rings is analyzed, and an experimental method to determine the rational parameters of noise-reducing damping rings for gears is developed.

STRUCTURAL COMPONENTS

85-1586
Control Valve Noise
J.G. Seebold
Chevron Corp., 555 Market St., San Francisco, CA 94105
Noise Control Engrg. J., 24 (1), pp 6-12 (Jan/Feb 1985), 6 figs, 20 refs

KEY WORDS: Valves, Noise reduction

The options for reducing the noise of pressure control valves are limited to the use of quiet valves, inline silencers, or acoustical lagging; the latter of these is not a particularly desirable technique as a design-stage option. In this paper the author explains why the options are so few and examines the practical means for reducing control valve noise.

SEALS

85-1587
Eccentricity and Misalignment Effects on the Performance of High-Pressure Annular Seals
W.C. Chen, E.D. Jackson
Rocketdyne Div., Rockwell International, Canoga Park, CA 91304
ASLE, Trans., 28 (1), pp 104-110 (Jan 1985), 16 figs, 8 refs

KEY WORDS: Seals, Eccentricity, Alignment

Annular pressure seals act as powerful hydrostatic bearings and influence the dynamic characteristics of rotating machinery. This work, using the existing concentric seal theories, provides a simple approximate method for calculation of both seal leakage and the dynamic coefficients for short seals with large eccentricity and/or misalignment of the shaft. Rotation and surface roughness effects are included for leakage and dynamic force calculation.

STRINGS AND ROPES

85-1588
Motion of a String Vibrating Against a Straight Fixed Obstacle (Mouvement d'une corde vibrante en presence d'un obstacle rectiligne)
H. Cabannes
Laboratoire de Mécanique théorique, associé au C.N.R.S., Universite Pierre-et-Marie-Curie, 4, place Jussieu, 75005 Paris, France
J. de Mecanique Theor. Appl., 3 (3), pp 397-414 (1984), 6 figs, 8 refs (In French)

KEY WORDS: Strings

A vibrating string fixed at both ends, moving in a plane in the presence of a straight fixed obstacle situated on the line joining the two ends of the string is studied.

85-1589
Transverse Impact of a Hyperelastic Stretched String
M.F. Beatty, J.B. Haddow
Univ. of Kentucky, Lexington, KY 40506
J. Appl. Mech., Trans. ASME, 52 (1), pp 137-143 (Mar 1985), 12 figs, 14 refs

KEY WORDS: Strings, Impact response

Governing equations are derived for the plane motion of a stretched hyperelastic string subjected to a suddenly applied force at one end. These equations can be put in the form of a quasilinear system of first-order partial differential equations, which is totally hyperbolic for an admissible strain energy function. The results are applicable to the neo-Hookean or Mooney-Rivlin material, and the nature of the solution for another special hyperelastic material is discussed.

CABLES

85-1590

NATFREQ Users Manual - a FORTRAN IV Program for Computing Natural Frequencies, Mode Shapes, and Drag Coefficients for Taut Strumming Cables with Attached Masses and Spring-Mass Combinations

W.D. Iwan, N.P. Jones
California Inst. of Tech., Pasadena, CA
Rept. No. NCEL-CR-84.026, 203 pp (June 1984), AD-A146 058

KEY WORDS: Cables, Natural frequencies, Mode shapes, Drag coefficients, Computer programs

This manual describes a computer program that has been developed to calculate natural frequencies and mode shapes of taut cables with attached masses and spring-mass combinations. The equations of motion are solved by an iterative technique allowing accurate calculation even for extremely high mode numbers. The approach has the advantages that is is fast, accurate, and can easily accommodate a variety of system configurations including bodies attached to the cable.

BARS AND RODS

85-1591

Dynamic Stability of Bars Considering Shear Deformation and Rotatory Inertia

B.P. Shastry, G. Venkateswara Rao
Vikram Sarabhai Space Centre, Trivandrum-695 022, India
Computers Struc., 19 (5/6), pp 823-827 (1984), 1 fig, 7 tables, 6 refs

KEY WORDS: Bars, Dynamic stability, Rotatory inertia effects, Transverse shear deformation effects, Finite element technique

Dynamic stability of bars including shear deformation and rotatory inertia are investigated using finite element formulation for various slenderness ratios. Stability and frequency parameters and instability regions for these bars for various end conditions and slenderness ratios are presented. A master dynamic stability curve covering all end conditions and slenderness ratios of the bar is presented in the non-dimensionalized form.

BEAMS

85-1592

Thermal Vibrations of Beams with Temperature-Dependent Properties

A.H. Wahyono, E.G. Lovell
Surabaya Inst. of Technology, Surabaya, Indonesia
Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, Florida, Vol. II, pp 1087-1092, 13 figs, 3 refs

KEY WORDS: Beams, Temperature effects, Modal analysis

Rapidly applied intense thermal loadings may produce mechanical vibrations of thin structural components. An analysis is made of beams in which temperature-dependent elasticity is included. Specific loadings consist of periodic pulsed and suddenly applied heat flux. A comparison is made of stresses and deflections for different materials in which the modulus may exhibit a positive or negative change with increasing temperature.

85-1593

A Method of Damping Overhung Bars Using a Secondary Bar

L. Turno, B.J. Stone
Univ. of Western Australia, Nedlands, Western Australia 6009
Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, Florida, Vol. II, pp 1194-1199, 11 figs, 4 refs

KEY WORDS: Cantilever beams, Bars, Vibration damping

Overhung cantilever bars are known to be sources of vibration problems. The method often employed to introduce damping is that of adding a vibration absorber consisting of an auxiliary spring/mass with damping. This is not always convenient in practice and an alternative is presented. This involves the use of a second cantilever bar and is shown to be effective both theoretically and experimentally. In particular a boring bar for a machine tool is described for which the secondary bar is contained within the main bar.

85-1594

Nonlinear Forced Vibrations of Beams

M. Countryman, R. Kannan
Louisiana Tech Univ., Ruston, LA 71272
J. Appl. Mech., Trans. ASME, 52 (1), pp 163-166 (Mar 1985), 3 tables, 9 refs

KEY WORDS: Beams, Forced vibration, Iteration

An iterative procedure for computing periodic solutions of nonlinear vibrating beams is presented. The nonlinear partial differential equation is replaced by a coupled system of equations. The contraction mapping principle is then applied to generate a method of successive approximations. The coupled equations are approximated by discrete equations that are solved by matrix-theoretic techniques and numerical quadrature procedures.

85-1595

Verification of Large Space Structures Using Scale Modelling Laws

Jay-Chung Chen, J.A. Garba, L.A. Demsetz
California Inst. of Technology, Pasadena, CA
Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, Florida, Vol. I, pp 31-36, 6 figs, 11 refs

KEY WORDS: Modal analysis, Spacecraft, Scaling, Structural members, Beams

The feasibility of testing large space structures in 1-g environment for the purpose of verifying its performance requirement is considered. Because of the difference in test objectives as compared to the conventional structural systems, the scale modelling laws are examined. The investigation is performed on a generic structural element, a space beam.

85-1596

The Mechanical Analysis of a Mass-Spring Load Supported on a Beam System

Y.Z. Wang, K.S. Wang, R.T. Wang
National Tsing Hua Univ., Hsinchu, Taiwan, Rep. of China
Intl. J. Mech. Sci., 26 (9/10), pp 503-514 (1984), 8 figs, 4 tables, 11 refs

KEY WORDS: Beams, Mass-spring systems, Natural frequencies, Machine foundations

The static deflection and dynamic characteristics of a mass-spring system supported on beam systems are investigated. It is shown that maximum deflection is reduced considerably when a clamped-free beam is replaced by a beam system which consists of a primary beam, one end of which is clamped and the other end supported by a subsidiary beam. The addition of a subsidiary beam leads to axial forces in both beams, the primary one in tension and the subsidiary in compression.

85-1597

Limitation of Simplified Hypotheses for the Prediction of Torsional Oscillations for Thin-Walled Beams

A. Potiron, D. Gay, C. Czekajski, S. Laroze
I.N.S.A., 31062 Toulouse (Cedex), France
J. Vib., Acoust. Stress, Rel. Des., Trans. ASME, 107 (1), pp 117-122 (Jan 1985), 5 figs, 3 tables, 10 refs

KEY WORDS: Beams, Torsional vibration

The study of uniform torsion of thin walled beams is done fairly easily in the thin wall beam case, the effects of thickness being neglected. The classical Saint-Venant warping function simplifies to the double sectorial area. The dynamical case requires the use of a more refined theory involving nonuniform warping, and characterized by supplementary dynamic torsion constants. The computed values obtained from BIEM for those constants are compared with those deduced from thin walled beam theory, and from the measurements of experimental natural frequencies.

85-1598

Forced Vibration of Timoshenko Beams Made of Multimodular Materials

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J. Vib., Acoust. Stress, Rel. Des., Trans. ASME, 107 (1), pp 98-105 (Jan 1985), 10 figs, 10 refs

KEY WORDS: Beams, Timoshenko theory, Transfer matrix method, Periodic response

A transfer-matrix analysis for determining sinusoidal vibration response of thick, rectangular cross-section beams made of multimodular materials (materials which have different elastic behavior in tension and compression) is presented. An experimentally determined stress-strain curve for aramid-cord rubber is approximated by four straight-line segments (two segments in tension and two segments in compression). To validate the transfer-matrix results, a closed-form solution is also presented for the special case in which the neutral-surface location is uniform along the length of the beam.

85-1599

The Radiation of Sound from Mass-Loaded and Stiffened Beams

A.F. Seybert, P.J. Bowles
Univ. of Kentucky, Lexington, KY 40506-46

J. Vib., Acoust. Stress, Rel. Des., Trans. ASME, 107 (1), pp 67-73 (Jan 1985), 10 figs, 19 refs

KEY WORDS: Stiffened beams, Sound waves, Wave radiation, Finite element technique

The sound radiation efficiency of uniform, mass-loaded, and stiffened beams is examined. The radiation efficiency of vibrating beams is determined using a finite element vibration model of the beam and a numerical approach to determine the radiated sound field.

85-1600

A Comparison of Transient and Steady State Finite Element Analyses of the Forced Response of a Frictionally Damped Beam

Chia-Hsiang Menq, J.H. Griffin
Carnegie-Mellon Univ., Pittsburgh, PA 15213

J. Vib., Acoust., Stress, Rel. Des., Trans. ASME, 107 (1), pp 19-25 (Jan 1985), 11 figs, 13 refs

KEY WORDS: Beams, Coulomb friction, Finite element technique, Forced vibration

An efficient method for approximately calculating the forced response of frictionally damped structures utilizing finite element models is presented. An example is given of the method's application to the analysis of a frictionally damped beam and results are compared with independently calculated long-time solutions obtained from a traditional transient finite element analysis.

85-1601

Transverse and Torsional Vibrations of an Axially-Loaded Beam with Elastically Constrained Ends

M. Chi, B.G. Dennis, Jr., J. Vossoughi
The Catholic Univ. of America, Washington, DC 20064

J. Sound Vib., 96 (2), pp 235-241 (Sept 22, 1984) 12 figs, 18 refs

KEY WORDS: Beams, Elastic restraints, Flexural vibration, Torsional vibration, Wind-induced excitation

A general case of an axially-loaded beam with ends elastically restrained against rotation is analyzed for either flexural or torsional vibration. The general frequency equation is numerically evaluated for various end fixities. Results are graphically presented for the first three modes and are of interest in bridge and machine designs.

85-1602

The Response of Metallic Structures to Dynamic Loading

J.M. Mosquera

Ph.D. Thesis, Brown Univ., 159 pp (1984), DA8422465

KEY WORDS: Beams, Fiber composites, Elastic properties, Plastic properties, Experimental data

Experimental results on the dynamic mechanical response of beams of fiber reinforced materials when subjected to transverse loading are described. Behavior of isotropic structures when loaded dynamically by force pulses of arbitrary shape and long duration is also described.

85-1603

Deflection of Partially Prestressed Concrete Beams Under Sustained and Cyclic Fatigue Loadings

S. Watcharaumnuay

Ph.D. Thesis, Univ. of Illinois, Chicago, IL, 353 pp (1984), DA8420408

KEY WORDS: Beams, Prestressed concrete, Cyclic loading, Fatigue life

After an exclusive review of literature on the time dependent deflection of concrete members, this study describes the formulation of an analytical model leading to a general method to predict deflection at any time, t and/or any cycle, N in fully reinforced, partially prestressed and fully prestressed concrete beams. Compared to the time step method where the deflection is obtained from the summation of increments over several time intervals, the proposed method leads to the deflection at any time, t and/or any cycle, N directly.

COLUMNS

85-1604

Dynamic Lateral-Load Tests of R/C Column-Slabs

D.G. Morrison

Geustyn, Forsyth & Joubert Inc., P.O. Box 413, Stellenbosch, 7600, Republic of South Africa

ASCE J. Struc. Engrg., 111 (3), pp 685-698 (Mar 1985), 9 figs, 1 table, 8 refs

KEY WORDS: Columns, Reinforced concrete, Experimental data, Seismic response

The response of interior reinforced concrete plate-column connections in a laterally loaded structure is investigated. Nine specimens were tested, five statically and four dynamically. This paper describes results from dynamically tested specimens.

85-1605

Refined Modelling of Reinforced Concrete Columns for Seismic Analysis

S.A. Kaba, S.A. Mahin

Univ. of California, Richmond, CA

Rept. No. UCB/EERC-84/03, NSF/CEE-84018, 112 pp (Apr 1984), PB84-234384

KEY WORDS: Columns, Reinforced concrete, Seismic analysis

The report extends the fiber representation of a section to make possible the analysis of reinforced concrete or steel members independently or as part of two-dimensional frames. Slice locations are specified along the length of the element. Each slice is further discretized into steel and/or concrete fibers. By monitoring the various fibers and slices, it is possible to obtain the local response at critical sections including moment-curvature and shear histories.

FRAMES AND ARCHES

85-1606

Dynamic Finite Element Method of a Frame

Yin Xuegang

Chongqing Univ., Chongqing, Sichuan, People's Rep. of China

Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, Florida, Vol. II, pp 1245-1250, 2 figs, 3 tables, 6 refs

KEY WORDS: Frames, Modal synthesis, Substructuring methods, Finite element technique

Based on the theory of substsructure mode synthesis,two normal mode functions of element are added to the current FEM of a plane frame as part of the shape frame as part of the shape functions of an element. The elemental characteristic matrixes of dynamic finite element of a frame are developed.

85-1607

The Control of Frame Vibration by Friction Damping in Joints

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Imperial College, London SW7, UK

J. Vib., Acoust., Stress, Rel. Des., Trans. ASME, 107 (1), pp 26-32 (Jan 1985), 15 figs, 15 refs

KEY WORDS: Frames, Joints, Coulomb friction

Some effects of friction damping occurring in joints on the frequency response of a portal frame are presented and discussed. The frame was designed so that the joint clamping forces could be varied, allowing some control of the friction damping caused by interfacial slip in the joints.

85-1608

Experimental Modelling and Analysis of Three One-Tenth-Scale Reinforced Concrete Frame-Wall Structures

C.E. Wolfgram

Ph.D. Thesis, Univ. of Illinois at Urbana-Champaign, 350 pp (1984), DA8422176

KEY WORDS: Framed structures, Seismic response, Test models

Three one-tenth-scale frame-wall models were tested on an earthquake simulator. The prototype was a full-scale structure tested at the Building Research Institute (BRI) in Japan. The models were composed of individual planar system representing the primary lateral load resisting elements of the BRI structure.

85-1609

Adaptive Nonlinear Dynamic Analysis of Three-Dimensional Steel Framed Structures with Interactive Computer Graphics

S.I. Hilmy

Ph.D. Thesis, Cornell Univ., 308 pp (1984), DA8415399

KEY WORDS: Framed structures, Cyclic loading, Interactive computing, Computer graphics

Efficient and practical nonlinear dynamic computational procedures are established for steel framed structures subjected to complex cyclic loading. The beam-column elements are modeled by a novel concentrated plasticity formulation. This model describes effectively the hysteretic behavior of members subjected to relatively stable cyclic loads such as developed by an earthquake.

MEMBRANES, FILMS, AND WEBS

85-1610

Mode Shapes of Thin Membranes Via Conformal Mapping Techniques

H.J. Weaver
Univ. of California, Livermore, CA 94550

Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, Florida, Vol. II, pp 745-750, 5 figs

KEY WORDS: Membranes, Mode shapes, Conformal mapping, Modal analysis

A simple technique by which the mode shapes of membranes of various geometries can be obtained is presented. The method is based upon using conformal mapping to transform a rectangular region in the z-plane to another geometric region in the w-plane. The mode shapes of a membrane possessing this new geometry are then obtained by multiplying the the simple formula describing the rectangular case by a two-dimensional scaling function. This scaling function is obtained by differentiation of the conformal mapping formulas.

PANELS

85-1611

Acoustic Transmission from a Rigid and Semi Rigid Panel in Air (Transmission Acoustique d'une Paroi Perforee Associee a une Lame d'Air et a une Paroi Pleine Semi-rigide)

Y. Goibert, M. le Torrivellec, C. Charles
Laboratoire d'Acoustique, Conservatoire National des Arts et Métiers, 292 Rue Saint-Martin, 75141--Paris, Cedex 03 France
Appl. Acoust., 18 (1), pp 1-20 (1985), 5 figs, 1 table, 11 refs (In French)

KEY WORDS: Panels, Noise transmission

The transmission loss of a combination of a perforated and a rigid panel separated by an air space is studied. The experimental results are in good agreement with calculations. The perforated panel increases the transmission loss of a simple panel provided that the air space is sufficiently deep.

PLATES

85-1612

Vibration of Rectangular Plates Using Beam Characteristic Orthogonal Polynomials in Rayleigh-Ritz Method

R.B. Bhat
Concordia Univ., Montreal, Quebec, H3G 1M8
Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, Florida, Vol. II, pp 1046-1052, 6 figs, 4 tables, 10 refs

KEY WORDS: Modal analysis, Rectangular plates, Rayleigh-Ritz method, Natural frequencies, Mode shapes

A class of beam characteristic orthogonal polynomials, constructed using Gram-Schmidt process, are employed as deflection functions for rectangular plates in Rayleigh-Ritz method to obtain their natural frequencies and mode shapes. The orthogonal nature of the polynomials makes the analysis simple, and the natural frequencies obtained are superior compared to those obtained using beam mode shapes, particularly for plates with some of the edges free.

85-1613

The Acoustic Response of a Periodically Rough Elastic Plate (Ice) in Contact with Water

A. Lakhtakia, V.K. Varadan, V.V. Varadan
The Pennsylvania State Univ., University Park, PA 16802
J. Appl. Mech., Trans. ASME, 52 (1), pp 144-148 (Mar 1985), 3 figs, 14 refs

KEY WORDS: Plates, Sound waves, Wave scattering, Floating ice

The plane wave scattering matrix theory is applied to formulate a T-matrix which characterizes the acoustic response of an infinite solid plate bounded by semi-infinite vacuum and fluid half spaces on either side. Individual T-matrices for the periodically rough vacuum/solid and solid/fluid interfaces are used in this derivation. Using the computed results, the anomalies in the scattering response of the rough solid plate are explained in terms of the Rayleigh, the Scholte, and the Lamb waves.

85-1614

Free Vibrations of Multi-Layer Thick Bimodulous Composite PLates

Lien-Wen Chen, C.J. Lin
National Cheng Kung Univ., Tainan, Taiwan, People's Rep. of China
Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, Florida, Vol. II, pp 895-900, 5 figs, 2 tables, 12 refs

KEY WORDS: Plates, Composite structures, Bimodular properties, Modal analysis

The governing differential equations of thick composite plates are used to study the free vibrations of multi-layer bimodulus composite plates. The effects of initial stresses and transverse shear deformations are included. An iteration technique is used to solve the free vibration problems and to determine the neutral surface positions.

85-1615
Nonlinear Static and Dynamic Analysis of Plates
Ren-Jye Yang, M.A. Bhatti
Univ. of Iowa, Iowa City, IA
ASCE J. Engrg. Mech., 111 (2), pp 175-187 (Feb 1985), 14 figs, 21 refs

KEY WORDS: Plates, Finite element technique, Geometric effects

An efficient element for static and dynamic analysis of plates including geometric effects is presented. A formulation of the heterosis element presented by Hughes and Cohen for linear static analysis of Mindlin plates is given. This formulation is then extended to include large displacement effects using Von-Karman assumptions and updated Lagrangian formulation. Several numerical examples for both static and dynamic loads are presented.

85-1616
Impulse Response of Plates Using Modal Superposition
J.R. Hutchinson
Univ. of California, Davis, CA 95616
Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, Florida, Vol. II, pp 882-887, 2 figs, 7 refs

KEY WORDS: Circular plates, Impulse response, Acoustic emission, Modal superposition method, Modal analysis

The axisymmetric transient response due to a point source at the center of a circular plate is solved using modal superposition of modes generated by the Pickett plate theory. The purpose of this paper is to show the application of this plate theory to the solution of wave propagation problems with a view to its application in the field of acoustic emissions.

85-1617
Effects of Geometric Imperfections on Frequency-Load Interaction of Biaxially Compressed Antisymmetric Angle Ply Rectangular Plates
D. Hui
Ohio State Univ., Columbus, OH 43210
J. Appl. Mech., Trans. ASME, 52 (1), pp 155-162 (Mar 1985) 3 figs, 20 refs

KEY WORDS: Rectangular plates, Geometric imperfection effects, Vibration frequencies

This paper deals with the influence of small geometric imperfections on the vibration frequencies of rectangular, simply supported, angle ply, thin composite plates subjected to inplane uniaxial or biaxial compressive preload. Interaction curves between frequency and applied preload are plotted for various fiber angles and imperfection amplitudes for both the uniaxial and equal biaxial loading cases.

85-1618
Dynamic Response of Plate Systems by Combining Finite Differences, Finite Elements and LaPlace Transform
D.E. Beskos, K.L. Leung
Univ. of Patras, Patras, Greece
Computers Struc., 19 (5/6), pp 763-775 (1984) 13 figs, 28 refs

KEY WORDS: Rectangular plates, Finite difference technique, Finite element technique, Laplace transformation

A numerical method for determination of the dynamic response of large rectangular plates or plate systems to lateral loads is proposed. The method is a combination of the finite difference method, the finite element method and the Laplace transform with respect to time. The method is illustrated and its merits demonstrated by means of numerical examples.

85-1619
Vibration of a Bimodulus Thick Plate
Ji-Liang Doong, Lien-Wen Chen
National Cheng Kung Univ., Tainan, Taiwan, Rep. of China
J. Vib., Acoust., Stress, Rel. Des., Trans. ASME, 107 (1), pp 92-96 (Jan 1985) 11 figs, 26 refs

KEY WORDS: Rectangular plates, Bimodular properties, Natural frequencies

Natural vibrations of a simply supported rectangular bimodulus thick plate subjected to a combination of pure bending stress and extensional stress in the plane of the plate is investigated. The governing equations obtained using the average stress method are solved in exact form. The natural frequencies are compared with previous results for ordinary thick plates, and with the neutral surface locations and natural frequencies of bimodular plates without initial stress.

85-1620
Vibrations of Twisted Cantilevered Plates — Experimental Investigation
J.C. MacBain, R.E. Kielb, A.W. Leissa
Aero Propulsion Lab. (AFWAL/POTA), Wright-Patterson AFB, OH 45433
J. Engrg. Gas Turbines Power, 107 (1), pp 187-196 (Jan 1985) 12 figs, 9 tables, 12 refs

KEY WORDS: Cantilever plates, Geometric effects, Natural frequencies, Mode shapes, Experimental data

The experimental portion of a joint study on the vibrational characteristics of twisted cantilevered plates is presented. The overall purpose of the research study was to assess the capabilities and limitations of existing analytical methods in predicting the vibratory characteristics of twisted plates. Thirty cantilevered plates were precision machined. These plates, having five different degrees of twist, two thicknesses, and three aspect ratios representative of turbine engine blade geometries, were tested for their vibration mode shapes and frequencies.

85-1621
Vibrations of Twisted Cantilevered Plates — Summary of Previous and Current Studies
A.W. Leissa, J.C. MacBain, R.E. Kielb
Ohio State Univ., Columbus, OH 43210
J. Sound Vib., 96 (2), pp 159-173 (Sept 22, 1984) 4 figs, 2 tables, 50 refs

KEY WORDS: Cantilever plates, Rectangular plates, Shells

This work summarizes a comprehensive study made of the free vibrations of twisted, cantilevered plates of rectangular planform. Numerous theoretical and experimental investigations previously made have resulted in frequency results which disagree considerably. To clarify the problem a joint research effort was initiated to obtain comprehensive theoretical and experimental results for models having useful ranges of aspect ratios, thickness ratios and twist angles. The theoretical and experimental results are summarized and compared.

SHELLS

85-1622
Postbuckling Resonance Analysis of Thin Shells
A. Tesar
Institute of Structures and Architecture, Slovak Academy of Sciences, Bratislava, Czechoslovakia
Intl. J. Numer. Methods Engrg., 20 (12), pp 2221-2234 (Dec 1984) 12 figs, 17 refs

KEY WORDS: Shells, Resonant frequencies

The nonlinear finite solution of the postbuckling instability behavior of thin shell structures in resonance regions of vibration is studied. The development of reliable and efficient techniques for handling the dynamic postbuckling behavior is emphasized. An illustrative solution associated with the postbuckling resonance response of thin shells is presented.

85-1623
A Study on the Vibrations of Axisymmetric Shells
J. Ansari, Yung-Ha Yum, Jang Moo Lee
Seoul National Univ., Kwanaku, Seoul 151, Korea
Intl. Modal Analysis Conf., Proc. 3rd, Jan

28-31, 1985, Orlando, Florida, Vol. II, pp 1138-1144, 10 figs, 3 tables, 4 refs

KEY WORDS: Modal analysis, Shells of revolution, Bells, Finite element technique, Computer programs

The axisymmetric and asymmetric responses to free and forced vibrations of various types of shells of revolution are studied through the finite element analysis utilizing curved and/or conical elements. A computer program package is developed. Results are verified through impulse modal testing.

85-1624
Free Vibrations of Noncircular Shells Having Circumferentially Varying Thickness
K. Suzuki, A.W. Leissa
Yamagata Univ., Yonezawa, Japan
J. Appl. Mech., Trans. ASME, 52 (1), pp 149-154 (Mar 1985) 7 figs, 1 table, 17 refs

KEY WORDS: Cylindrical shells, Natural frequencies, Mode shapes, Power series method, Exact methods

An exact method using power series expansions is presented for solving free vibration problems for noncircular cylindrical shells having circumferential thickness variation. The method is used to obtain the first known results for this class of problems. Frequencies and mode shapes are presented for a set of elliptical cylindrical shells having second degree thickness variation in each quadrant.

85-1625
Simple Fracture Mechanics Based Method for Fatigue Life Prediction in Thick-Walled Cylinders
D.P. Kendall
Army Armament Res. and Dev. Ctr., Watervliet, NY
Rept. No. ARLCB-TR-84023, SBI-AD-E440 249, 33 pp (July 1984) AD-A145 978

KEY WORDS: Cylindrical shells, Cracked media, Fatigue life, Computer programs

A method is proposed for predicting the fatigue life of thick-walled cylinders based on numerical integration of the fatigue crack growth curve as determined from a fracture mechanics analysis. The effects of autofrettage residual stresses, crack shape, and of the compressive portion of the stress intensity factor are accounted for. A simple computer program for performing the calculation of fatigue life is presented.

85-1626
Vibrations of Completely Free Shallow Shells of Rectangular Planform
A.W. Leissa, Y. Narita
Ohio State Univ., Columbus, OH 43210
J. Sound Vib., 96 (2), pp 207-218 (Sept 22, 1984), 6 figs, 6 tables, 11 refs

KEY WORDS: Shells, Plates, Natural frequencies, Mode shapes, Ritz method

Although much has been written about the free vibrations of rectangular plates having completely free boundaries, very little has appeared for the case when the plates have curvature: i.e., shallow shells. A solution of the problem is presented here for shells having arbitrary (but constant) curvature. The Ritz method is used, with displacement functions assumed in the form of polynomials. Convergence studies were made to determine the number of terms required for reasonable solution accuracy. Numerical results were obtained for the frequencies and mode shapes of three types of shells. These are compared with those of a flat plate.

85-1627
Model for Flexible Tanks Undergoing Rocking
M.A. Haroun, H.M. Ellaithy
Univ. of California, Irvine, CA 92717
ASCE J. Engrg. Mech., 111 (2), pp 143-157 (Feb 1985), 5 figs, 1 table, 10 refs

KEY WORDS: Storage tanks, Cylindrical shells, Seismic excitation

An analytical mechanical model for flexible cylindrical tanks is developed taking into consideration the effect of rigid base rocking motion and lateral translation. Explicit analytical expressions for the parameters of the model are given, and numerical values of these parameters are displayed in charts.

85-1628
Axisymmetric Static and Dynamic Buckling of Orthotropic Shallow Spherical Cap with Circular Hole
P.C. Dumir, M.L. Gandhi, Y. Nath
Applied Mechanics Dept. I.I.T. Delhi, New Delhi-110016, India
Computers Struc., 19 (5/6), pp 725-736 (1984) 15 figs, 9 refs

KEY WORDS: Caps, Spherical shells, Hole-containing media, Dynamic buckling

Nonlinear axisymmetric static and dynamic buckling of a clamped isotropic and cylindrically orthotropic elastic cap with central circular hole have been investigated. The cases of a shallow cap with a free hole and with a hole plugged by rigid central mass are considered. Analysis has been carried out for a uniformly distributed load and a ring load at the hole.

RINGS

85-1629
Stress Intensity Factors for a Circular Ring with Uniform Array of Radial Cracks of Unequal Depth
S.L. Pu
Army Armament Res. and Dev. Ctr., Watervliet, NY
Rept. No. ARLCB-TR-84021, SBI-AD-E440 252, 35 pp (June 1984), AD-A145 893

KEY WORDS: Rings, Cracked media, Stress intensity factors

The plane problem of a uniform array of unequal depth radial cracks originating at the internal boundary of a pressurized circular ring is considered. The 12-node quadrilateral isoparametric elements with collapsed singular elements around crack tips are used to compute stress intensity factors at crack tips. Numerical results are also obtained for cases of three and four radial cracks.

PIPES AND TUBES

85-1630
A Frequency Approach to Mathematical Modeling of a Nuclear Power Plant Piping System
V. Skormin
EBASCO Services Inc., Advanced Technology Div., New York, NY 10048
J. Vib., Acoust. Stress, Rel. Des., Trans. ASME, 107 (1), pp 106-111 (Jan 1985), 2 tables, 12 refs

KEY WORDS: Piping systems, Nuclear power plants, Frequency domain method, Mathematical models

A methodology is presented for identification of a nuclear power plant piping system, which employs mathematical description in the form of transfer function matrix, frequency domain technique for estimation of system dynamic parameters, statistical technique for verification of model configuration and evaluation of parameter estimates, adaptive approach for current model updating. Model applications for estimation and monitoring of forcing functions, displacements, and stresses due to transient processes and steady state vibrations in the piping system are proposed.

85-1631
Pipe Tests to Evaluate High Amplitude Response and Damping
A.G. Ware
EG and G Idaho, Inc., Idaho Falls, ID
Rept. No. EGG-M-13684, 16 pp (1984), DE84016120

KEY WORDS: Pipelines, Nuclear reactor components, Damping coefficients, Experimental data

A series of vibrational tests on 76-mm and 203-mm (3-in. and 8-in.) Schedule 40 carbon steel piping was conducted to determine the changes in structural damping due to various parametric effects. This paper presents the overall program plan, selected test results, and current and future research.

85-1632

The Acoustic Simulation and Analysis of Complicated Reciprocating Compressor Piping Systems, I: Analysis Technique and Parameter Matrices of Acoustic Elements

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J. Sound Vib., 96 (2), pp 175-194 (Sept 22, 1984) 23 figs, 22 refs

KEY WORDS: Piping systems, Reciprocating compressors, Acoustic pulses, Computer programs

The mathematical formulation, equations, and procedures employed in the development of a comprehensive digital computer program for acoustic simulation and analysis of large and complicated piping systems are described. The analysis technique used is the transfer matrix method. Parameter matrices of 19 acoustic elements are included in this paper. By making use of these parameter matrices and the analysis technique, any complicated practical reciprocating compressor piping system can be modeled or analyzed.

85-1633

The Acoustic Simulation and Analysis of Complicated Reciprocating Compressor Piping Systems, II: Program Structure and Applications

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J. Sound Vib., 96 (2), pp 195-205 (Sept 22, 1984) 4 tables, 11 refs

KEY WORDS: Piping systems, Reciprocating compressors, Acoustic pulses, Computer programs

The main objectives of this investigation are to provide a formulation, including the mean flow effects and suitable for digital computer automation, of the acoustics of complicated piping systems, and to develop a comprehensive digital computer program for the simulation and analysis of complicated reciprocating compressor piping systems. The digital computer program structure and applications of the program developed, written in Fortran IV, are described.

85-1634

Piping Nozzle Spectra Generation Using a Probabilistic Approach with Multiple Support Response Spectra Input

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Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, Florida, Vol. I, pp 37-41, 1 fig, 10 refs

KEY WORDS: Modal analysis, Nozzles, Pipelines

An approach is presented which allows the response spectra to be developed at a piping nozzle using as input the multiple piping support response spectra and the piping dynamic characteristics.

85-1635

General Characteristics, Transition, and Control of Instability of Tubes Conveying Fluid

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Argonne National Lab., Argonne, IL 60439

J. Acoust. Soc. Amer., 77 (3), pp 887-895 (Mar 1985) 17 figs, 9 refs

KEY WORDS: Tubes, Fluid-filled containers, Supports

This paper presents the results of two subsequent test cases on tubes conveying fluid: tubes fixed at the upstream end with a knife-edge support movable along the tube, and cantilevered tubes with a concentrated mass attached to the free end. The pur-

poses of the tests are to study the characteristics of the two different types of support conditions, with emphasis on transition from one instability mechanism to another for the former, and control of instability using a mechanical excitation for the latter.

tubes conveying liquid metal are subjected to repetitive impulsive pressures. Because the tubes are vertical, very long and carry liquid metal, gravity gradient effects are substantial. The complete equation of motion is presented. Modal analysis is used to determine the exact frequencies and mode shapes.

85-1636

Dynamic Characteristics of Heat Exchanger Tubes Vibrating in a Tube Support Plate Inactive Mode

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Rept. No. ANL-84-39, 87 pp (June 1984)
DE84014844

KEY WORDS: Tubes, Heat exchangers, Nuclear power plants, Damping coefficients, Natural frequency

Tubes in shell-and-tube heat exchangers, including nuclear plant steam generators, derive their support from longitudinally positioned tube support plates (TSPs). Typically there is a clearance between the tube and TSP hole. The purpose of this study is to investigate the tube-TSP interaction dynamics. Results of an experimental study of damping and natural frequency as functions of tube-TSP diametral clearance and TSP thickness are reported. Calculated values of damping ratio and frequency of a tube vibrating within an inactive TSP are also presented together with a comparison of calculated and experimental quantities.

85-1637

Analysis of Modal Characteristics of Coolant Tubes for Inertial Fusion Applications

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Fusion Technology Institute, University of Wisconsin, Madison, WI 53706
Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, FL, Vol. II, pp 751-756, 8 figs, 3 refs

KEY WORDS: Modal analysis, Tubes, Nuclear reactor components, Cooling systems

Conceptual designs for inertial fusion reactors have been proposed in which flexible

85-1638

Simulation and Optimization of Transient Oscillations, Flow, and Sound in Complex Piping Systems

Yao-Chung Chiang
Ph.D. Thesis, Univ. of Wisconsin-Madison, 269 pp (1984) DA8415551

KEY WORDS: Pipelines, Transient response, Simulation

A generalized computer-based algorithm for the simulation and optimum design of transient phenomena in a complex piping system is utilized in this study for the optimum design of such a system. The media can be gas under pressure, liquid or multiphase continuum. Some of the illustrative examples used are the optimum design of hydraulic rams, air-flow type sound generating systems, and cooling pipelines in nuclear reactors.

DUCTS

85-1639

Signal Processing Criteria and Statistical Error Analysis for Acoustic Measurements in Duct Systems

A.F. Seybert
Univ. of Kentucky, Lexington, KY 40506
J. Vib., Acoust., Stress, Rel. Des., Trans. ASME, 107 (1), pp 74-80 (Jan 1985) 7 figs, 2 tables, 13 refs

KEY WORDS: Ducts, Acoustic measurement, Signal processing techniques, Statistical analysis, Error analysis

A one-dimensional acoustic theory for random sound fields is presented. The theory

is applied to the description of a random sound field in a tube of finite length terminated at the source and passive ends by arbitrary acoustical impedances. The theory is used to illustrate the spatial and spectral features of the acoustic field.

BUILDING COMPONENTS

85-1640
Development of a Simplified Field Method of Measuring Sound Insulation
L.J. Lee
Heriot-Watt Univ., Chambers St., Edinburgh EH1 1HX, Scotland, UK
Appl. Acoust., 18 (2), pp 99-113 (1985) 7 figs, 12 refs

KEY WORDS: Walls, Acoustic insulation, Rating, Measurement techniques, Regulations

A simplified field method of measuring the sound insulation of partitions has been proposed and its development is described. The selection of the source type and the weighting function for the measurement of the overall sound pressure levels and the effects of loudspeaker and room response are discussed.

85-1641
A Modified Formula for Absorption Influence on Sound Transmission through Partitions: Part 2 — Flanking Between Coupled Rooms in Terms of Modified Partition Area
G. Rosenhouse
Israel Inst. of Technology, Haifa 32000, Israel
Appl. Acoust., 18 (1), pp 35-39 (1985) 1 ref

KEY WORDS: Walls, Sound transmission, Acoustic absorption

The object of the analysis described in this paper is to establish a means of extending the common formula for sound transmission between coupled rooms to cases where flanking is taken into account. This is achieved by recourse to the concept of modified partition area.

85-1642
Statistical Energy Analysis, Structural Resonances, and Beam Networks
M.J. Sablik, R.E. Beissner, H.S. Silvus, M.L. Miller
Southwest Res. Inst., San Antonio, TX 78284
J. Acoust. Soc. Amer., 77 (3), pp 1038-1045 (Mar 1985) 6 figs, 28 refs

KEY WORDS: Beams, Buildings, Statistical energy methods, Structural resonance

The statistical energy analysis method is applied to a beam network in a building structure. A method of taking structural resonances into account is introduced into the analysis via the use of discretized modal densities. Transfer functions computed from the model beam network are compared over a wide frequency range to experimentally measured transfer functions from an equivalent beam network in an existing building structure in which one of the beams is vibrationally excited.

85-1643
Coupled Transient Response of Tiles Bonded Elastically to a Finite Flexible Plate
M. El-Raheb, P. Wagner
California Inst. of Technology, Pasadena, CA 91109
J. Acoust. Soc. Amer., 77 (3), pp 1027-1037 (Mar 1985) 9 figs, 2 tables, 7 refs

KEY WORDS: Tiles, Bonded structures, Impulse response, Modal analysis

Several methods to study a system of tiles bonded elastically to a finite flexible plate responding to an impulse are presented. A one-dimensional (1-D) approximation to the system is constructed using Timoshenko beam theory and transfer matrices. Also presented are parametric studies of the effect of bond stiffness and the effect of

stiffening from inplane stresses produced by large out-of-plane deflections. A two-dimensional model is constructed from the eigenfunctions of the 1-D model in a Galerkin method using pairwise products of the 1-D modes as trial functions.

85-1644
Transmissibility as a Means to Diagnose Damage in Structures
M. Akgun, F.D. Ju, T.L. Paez
Univ. of New Mexico, Albuquerque, NM 87131
Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, FL, Vol. II, pp 701-707, 6 figs, 6 refs

KEY WORDS: Framed structures, Diagnostic techniques, Transmissivity, Modal analysis

Transmissibility changes in a structure caused by damage are investigated as a feasible means to diagnose the structural damage. Transmissibility is defined as the ratio of the peak acceleration at the response location to the amplitude of the sinusoidal excitation in a planar frame structure. Transmissibilities at different locations in an undamaged structure and in a structure with known damage are computed. Results are compared to relate the changes in transmissibilities to the damage.

85-1645
Damages at Structural Parts Caused by Fatigue Load (Schäden an schwingend beanspruchten Bauteilen)
B. Kaiser
Staatlicher Materialprufanstalt Darmstadt, Fed. Rep. Germany
VDI-Z., 126 (20), pp 775-781 (Oct 1984) 14 figs, 22 refs (In German)

KEY WORDS: Structural members, Metal, Fatigue life, Corrosion fatigue

Statistics show that damage in metallic structural members due to fatigue load is responsible for a considerable number of failures in machinery, plant and aircraft construction. The paper deals with the fatigue mechanism of metallic material without macro-defects, and the effects of additional corrosion and typical signs of fatigue fractures are described.

DYNAMIC ENVIRONMENT

ACOUSTIC EXCITATION

85-1646
Finite Element Modeling of Annular-Like Acoustic Cavities
Chaw-Hua Kung, R. Sing
Ohio State Univ., Columbus, OH 43210
J. Vib., Acoust., Stress, Rel. Des., Trans. ASME, 107 (1), pp 81-85 (Jan 1985) 6 figs, 7 tables, 11 refs

KEY WORDS: Cavities, Acoustic properties, Finite element technique, Natural frequencies, Mode shapes

A finite element technique has been developed to find natural frequencies and modes of undamped three-dimensional acoustic cavities. This method utilizes the analogy between a special form of the discretized transient heat conduction equations and discretized equations of acoustic pressure oscillation. The proposed technique is verified by applying it to several cavities of known theoretical eigensolutions.

85-1647
Structural-Acoustic Coupling in Complex Shaped Cavities
A. Sestieri, D. Del Vescovo, P. Lucibello
Universita di Roma, Via Eudossiana, 18 --Roma 00184, Italy
J. Sound Vib., 96 (2), pp 219-233 (Sept 22, 1984) 7 figs, 17 refs

KEY WORDS: Cavities, Helmholtz resonators, Noise reduction

Structural-acoustic interaction is a topic of increasing interest in the study of vehicle

noise control. Particular attention has been devoted towards analytical and numerical methods for analysis of acoustic problems of complex shaped cavities. Among them non-local methods are very appropriate for the low and medium frequency range. The integral formulation of the Helmholtz equation allows the sound pressure level, radiated by a vibrating panel, to be determined.

85-1648
Hydroelasticity and the Field Radiated by a Slender Body into an Unbounded Fluid
G. Coupry, C. Soize
Office National d'Etudes et de Recherches Aerospatiales (ONERA) 92322 Chatillon Cedex, France
J. Sound Vib., 96 (2), pp 261-273 (Sept 22, 1984) 7 figs, 1 table, 7 refs

KEY WORDS: Cylindrical shells, Frequency response function, Sound waves, Wave radiation

A new approach is described for prediction of the frequency response function and sound radiation of slender elastic bodies immersed in an unbounded compressible fluid and excited in the low frequency range. The method proposed is not the standard hydrodynamic slender body theory: it is based on the general three-dimensional formulation. The slender body assumption is used only to solve explicitly the integral equation of the Helmholtz problem. Experiments have been carried out to validate the theory.

85-1649
The Effect of Some Physical Parameters upon the Laboratory Measurements of Sound Transmission Loss
R.W. Guy, A. DeMay, P. Sauer
Concordia Univ., 1455 de Maisoneuve Blvd. W., Montreal H3G 1M8, Quebec, Canada
Appl. Acoust., 18 (2), pp 81-98 (1985) 11 figs, 1 table, 15 refs

KEY WORDS: Sound transmission loss, Geometric effects, Experimental data

A series of experimental results are reported for the transmission loss of three panel types for varying panel area, orientation, receiving and source room. It is found that panel area can play a significant role in the measured result and that coincidence frequency is also influenced by panel size and orientation.

85-1650
Some Microcomputer Applications in Acoustics
G.W. Burrows, D.J. McNeill
Liverpool Polytechnic, Byrom Street, Liverpool 3 3AF, UK
Appl. Acoust., 18 (1), pp 41-53 (1985) 3 figs, 5 refs

KEY WORDS: Experimental data, Acoustic measurement, Data processing

A microcomputer-based system has been developed for use in experimental work in acoustics. A standard low cost microcomputer is used to interact with a variety of equipment to provide automatic facilities for controlling experimental conditions; automatic data acquisition and storage; data display; and data transfer to mainframe systems.

85-1651
Flow-Induced Noise of a Sonar Dome — Part 1
V. Bhujanga Rao
Naval Science and Technological Lab., Visakhapatnam 530 006, India
Appl. Acoust., 18 (1), pp 21-33 (1985) 6 figs, 17 refs

KEY WORDS: Domes, Sonars, Fluid-induced excitation

A semi-analytical, semi-experimental method of predicting the flow-induced noise inside a sonar dome is proposed. The valildity of the analytical approach and error analysis of the experimental techniques are discussed.

85-1652

Acoustic Impedance Measurements with a Sound Intensity Meter

J.F. Allard, A. Aknine
Laboratoire d'Acoustique, Faculté des Sciences, Route de Laval, 72017 Le Mans Cedex, France
Appl. Acoust., 18 (1), pp 69-76 (1985) 7 figs, 6 refs

KEY WORDS: Acoustic impedance, Experimental data, Measuring instruments

Acoustic impedance measurements are made by evaluating, with a sound intensity meter, sound pressure and normal velocity close to absorbing material samples. Measurements are made both in a Kundt interferometer and in the free field. Free field measurements are accurate for frequencies high enough to allow one to neglect the finite dimension effect of the absorbing material sample.

85-1653

Solution of the Acoustic Transmission Problem by a Perturbed Born Series

G.T. Schuster
Columbia Univ., New York, NY 10027
J. Acoust. Soc. Amer., 77 (3), pp 880-886 (Mar 1985) 4 figs, 11 refs

KEY WORDS: Sound transmission, Perturbation theory

An interactive modeling scheme, based upon perturbing the surface boundary integral equations about a reference model in which the Green's function is known, is presented. This Green's function is computed by a boundary integral equation method. The new perturbed equation can be efficiently solved by a Born series and for convenience is designated as the perturbed Born series (PBS). The PBS differs from the series solution to the familiar Lippmann-Schwinger integrals in that it solves a boundary integral which is computationally inexpensive.

85-1654

A Characterization of Arctic Undersea Noise

J.G. Veitch, A.R. Wilks
Princeton Univ., Princeton, NJ 08544
J. Acoust. Soc. Amer., 77 (3), pp 989-999 (Mar 1985) 15 figs, 2 tables, 7 refs

KEY WORDS: Underwater sound

Arctic undersea noise is investigated and partially characterized by a probability model suggested by exploration of a sample of such noise. The large size of the data set makes this possible. The model is that of a mixed spectrum, with stationary Gaussian noise intermixed with random sinusoids, and occasional high intensity impulsive noise bursts, which are very short-lived. The validity of the model is checked by testing model predictions against the actual data.

85-1655

The Periodic Extension of Stepwise Coupled Modes

R.B. Evans, K.E. Gilbert
Naval Ocean Res. and Dev. Activity, NSTL Station, MS 39529
J. Acoust. Soc. Amer., 77 (3), pp 983-988 (Mar 1985) 8 figs, 9 refs

KEY WORDS: Sound waves, Wave propagation, Underwater sound

The method of stepwise coupled modes for studying acoustic propagation is extended to apply to periodic repetitions of a sequence of depth variations. The extension is based on an eigenvalue analysis of the propagator matrix for one period of the depth sequence. Numerical examples are given which compare propagation loss in a waveguide with periodic bottom roughness to that in a waveguide with a smooth bottom.

85-1656

Propagation of Acoustic Normal Modes in a Homogeneous Ocean Overlaying Layered Anisotropic Porous Beds

M. Badiey, T. Yamamoto
Univ. of Miami, Miami, FL 33149
J. Acoust. Soc. Amer., 77 (3), pp 954-961 (Mar 1985) 8 figs, 3 tables, 15 refs

KEY WORDS: Sound waves, Wave propagation, Underwater sound

Attenuation of acoustic normal modes propagating in a shallow ocean overlaying naturally consolidated anisotropic sand beds is calculated using Biot's theory for porous media. The propagator matrix method is utilized in the analysis to model layered transverse isotropic porous media. The effects of anisotropies in permeability and elastic moduli are studied numerically.

85-1657
Boundary Effects on Transient Radiation Fields from Vibrating Surfaces
D. Guyomar, J. Powers
Naval Postgraduate School, Monterey, CA
J. Acoust. Soc. Amer., 77 (3), pp 907-915 (Mar 1985) 12 figs, 17 refs

KEY WORDS: Sound waves, Wave radiation, Wave diffraction

The transient radiation or diffraction from a planar source imbedded in an infinite baffle is analyzed for three different baffle conditions (rigid, free-space, and soft). For an excitation separable in time and space, it is shown that the field is related to the normal derivative of the input field only. A method is also given for computing the transient fields based on a wave decomposition in the spatial frequency domain. This method is a time generalization of the angular spectrum theory that presents transient wave propagation as a time-varying spatial filter, allowing a linear systems interpretation of the diffraction.

SHOCK EXCITATION

85-1658
Three-Dimensional Finite Element and Dynamic Analysis of Composite Laminate Subjected to Impact
J.D. Lee, S. Du, H. Liebowitz
Univ. of Minnesota, Minneapolis, MN 55455
Computers Struc., 19 (5/6), pp 807-813 (1984) 8 figs, 6 refs

KEY WORDS: Layered materials, Fiber composites, Impact response, Finite element technique

A three dimensional finite element and dynamic analysis has been made for a layered fiber-reinforced composite laminate subjected to a given impact loading. Central difference method is employed in this analysis. The numerical results for the transient response of the laminate are presented.

85-1659
Earthquake Engineering: Buildings, Bridges, Dams, and Related Structures. September, 1980 - February, 1983 (Citations from the NTIS Data Base)
NTIS, Springfield, VA
251 pp (Nov 1984) PB85-850162

KEY WORDS: Seismic response, Buildings, Bridges, Dams, Bibliographies

This bibliography contains 270 citations concerning the dynamic response of buildings, bridges, and dams to earth movements and seismic waves. Topics include structural design considerations in active areas, economic aspects, and soil-structure interactions during seismic events. Mathematical models used to predict structural response are also treated.

85-1660
Constitutive Model for Dynamic Loading of Concrete
W. Suaris, S.P. Shah
Univ. of Miami, Coral Gables, FL 33124
ASCE J. Struc. Engrg., 111 (3), pp 563-576 (Mar 1985) 7 figs, 16 refs

KEY WORDS: Concrete, Impact excitation, Constitutive equations, Crack propagation

The constitutive model presented herein models microcracking through the use of a continuous damage parameter for which a vectorial representation is adopted. The rate of increase of the damage is dependent on the state of strain as well as on the time rate of strain. The constitutive equations are derived from the strain energy function which is influenced by the accumulated damage. The constitutive model is calibrated using uniaxial tension and uniaxial compression test data.

85-1661

Nonlinear Analysis of Composite Laminates

Jinn-Kuen Chen

Ph.D. Thesis, Purdue Univ., 161 pp (1984) DA8423340

KEY WORDS: Layered materials, Finite element technique, Nonlinear theories, Impact response

Nonlinear static and dynamic responses of composite laminates were investigated using the finite element method. A nine-node isoparametric quadrilateral element was developed to formulate the finite element equations for a laminated plate under initial deformations and initial stresses according to the Mindlin plate theory and von Karman large deflection assumptions. Static large deflection and postbuckling of plates, impact response of a laminate under initial stresses, free vibration and impact response of buckled composite plates, and nonlinear transient and impact analyses of laminated plates with/without initial stresses were studied.

85-1662

Contact Behavior, Impact Response and Damage in Graphite-Epoxy Laminates Subjected to Initial Stresses

B. Sankar

Ph.D. Thesis, Purdue Univ., 114 pp (1984) DA8423421

KEY WORDS: Layered materials, Beams, Indentation

Analytical methods were developed to study the problem of indentation of a beam by a rigid cylinder. The contact coefficient was found to depend on the transverse Young's modulus. At smaller loads, initial stresses have no significant effect on the contact behavior. Numerical methods were developed to compute the response due to low velocity impact. A higher order, rectangular, plane strain finite element was used to model laminated beams under initial stresses. A detailed analysis was conducted to study the effect of initial stresses on the impact response of a graphite-epoxy laminated beam.

85-1663

A Simplified Approach to Elastic-Plastic Response to General Pulse Loads

P.S. Symonds, J.M. Mosquera

Brown Univ., Providence, RI 02912

J. Appl. Mech., Trans. ASME, 52 (1), pp 115-121 (Mar 1985) 7 figs, 1 table, 18 refs

KEY WORDS: Impulse response, Elastic plastic properties

A method is described for estimating permanent and maximum (elastic plus plastic) deflections of a structure subjected to a force pulse loading of arbitrary shape and duration. The concept of artificially separating the response into purely elastic and purely plastic (i.e., rigid-plastic) stages is adopted.

VIBRATION EXCITATION

85-1664

Flexibility and Transient Effects in Multibody Systems

M.L. Amirouche

Ph.D. Thesis, Univ. of Cincinnati, 248 pp (1984) DA8420857

KEY WORDS: Branched systems, Natural frequencies, Mode shapes, Finite segment method

New and recently developed concepts useful for extraction of natural frequencies and mode shapes of a tree-like structure are presented. The incorporation of flexibility effects make the analysis applicable for monitoring the transient effects of structures. The procedures presented use a finite-segment analysis to develop a computer formulation of the governing dynamical equations.

MECHANICAL PROPERTIES

DAMPING

85-1665
The Interaction Between Mistuning and Friction in the Forced Response of Bladed Disk Assemblies
J.H. Griffin, A. Sinha
Carnegie-Mellon Univ., Pittsburgh, PA 15213
J. Engrg. Gas Turbines Power, 107 (1), pp 205-211 (Jan 1985) 9 figs, 5 tables, 26 refs

KEY WORDS: Dampers, Coulomb friction, Tuning, Bladed disks, Turbine blades

This paper summarizes the results of an investigation to establish the impact of mistuning on performance and design of blade-to-blade friction dampers of the type used to control resonant response of turbine blades in gas turbine engines. In addition, it discusses the importance of friction slip force variations on the dynamic response of shrouded fan blades.

85-1666
Experimental Analysis of Damper Behavior of Squeeze Film Dampers for Gas Turbine Engines
S.C. Kaushal, V.A. Kumar, K. Lakshmikantan
G.T.R.E., Bangalore, India
J. Engrg. Gas Turbines Power, 107 (1), pp 165-169 (Jan 1985) 10 figs, 11 refs

KEY WORDS: Squeeze film dampers, Gas turbine engines, Experimental data

The experimental evaluation of performance of squeeze film dampers without centralizing retaining springs is discussed. Rotor amplitudes in the damper plane and damping coefficient were considered to assess the system performance. Tests were conducted on two damper configurations that were to go in the rotor assembly of a gas turbine engine. Land width and film thickness were varied, and experiments were conducted for different values of excitation frequency, oil supply pressure, and unbalance.

FATIGUE

85-1667
SEM Investigations of Fatigue Crack Propagation in RR 58 Aluminum Alloy
D.W. Cameron, R.H. Jeal, D.W. Hoeppner
Univ. of Toronto, Toronto, Ontario M5S 1A4
J. Engrg. Gas Turbines Power, 107 (1), pp 238-241 (Jan 1985) 10 figs, 3 refs

KEY WORDS: Fatigue life, Aluminum

Aluminum alloy RR 58 was viewed during exposure to cyclic loading, which is applied using a load frame inserted into a scanning electron microscope. Thus observation of surface interactions of the material microstructure with a propagating crack is feasible. Photomicrographs and dynamic, real-time video-recordings used to document the processes are displayed and the nature of the observations presented in relation to existing physical understanding of fatigue.

85-1668
Fatigue and Fracture Branch: A Compendium of Recently Completed and On-Going Research Projects
W. Elber
NASA Langley Res. Ctr., Hampton, VA
Rept. No. NASA-TM-85825, 76 pp (June 1984) N84-30331

KEY WORDS: Fatigue life, Fracture properties, Metals, Composite materials, Airframes

This compendium of recently completed and ongoing research projects provides technical

descriptions and key results of all such projects expected to lead to publication of significant findings. The common thread to all these studies is the application of fracture mechanics analyses to engineering problems in metals and composites, with particular emphasis on airframe structural materials.

85-1669
Energy Fluctuation Scale and Diffusion Models
S.R. Winterstein, C.A. Cornell
Stanford Univ., Stanford, CA 94305
ASCE J. Engrg. Mech., 111 (2), pp 125-142 (Feb 1985) 6 figs, 29 refs

KEY WORDS: Fatigue life, Stochastic processes

The energy fluctuation scale of a narrow-band Gaussian response is introduced. It is shown that bandwidth measures are simply related to both the spectral density and correlation functions of the response; less sensitive to high frequency information and precise envelope definition than traditional bandwidth measures; and consistent with diffusion models of various response quantities of interest. These diffusion models are found to simplify the practical analysis of a wide range of reliability problems.

85-1670
Constitutive Modeling of Engine Materials
D.A. Wilson, K.P. Walker
Pratt and Whitney, West Palm Beach, FL
Rept. No. AFWAL-TR-84-4073, 84 pp (July 1984), AD-A146 630

KEY WORDS: Fracture properties, Constitutive equations, Viscoplastic properties, Crack propagation

The capability to predict the growth of cracks in critical structural components operating at elevated temperatures where time-dependent behavior occurs is investigated. A viscoplastic constitutive model for INCO 718 is developed to determine this behavior in the area of the crack tip. The model constants are obtained from monotonically increasing, cyclic, and sustained loading.

85-1671
Analysis of the Reflection of Point Force-Induced Crack Surface Waves by a Crack Edge
L.M. Brock, H.P. Rossmanith
Univ. of Kentucky, Lexington, KY 40506
J. Appl. Mech., Trans. ASME, 52 (1), pp 57-61 (Mar 1985), 4 figs, 10 refs

KEY WORDS: Wave reflection, Cracked media

Dynamic stress fields near cracks follow in part from the reflection of crack surface waves by the crack edges. To gain insight into the reflection process, the problem of stationary normal and tangential point forces applied to one surface of a stationary semi-infinite crack is considered. Analytical expressions for the crack surface reflection-generated particle velocity waves are presented.

WAVE PROPAGATION

85-1672
Research on Acoustical and Optical Scattering, Optics of Bubbles, Diffraction Catastrophies, Laser Generation of Sound, and Shock Induced Cavitation
P.L. Marston
Washington State Univ., Pullman, WA
Annual Summary Rept. No. 4, 81 pp (Sept 1984), AD-A146 703

KEY WORDS: Wave propagation, Wave scattering, Sound waves, Shock waves

The research summarized concerns a variety of phenomena associated with the propagation and scattering of acoustical, optical, and shock waves. The topics considered fall under the following four categories: acoustical scattering theory and experiments, scattering of light from bubbles in liquids and other problems in electromagnetic scattering of value to acoustics and naval technology, characterization of sound generated in water by modulated laser beams, and rapid cavitation induced by the reflection of shock waves.

85-1673
Progressing and Oscillatory Waves for Hybrid Synthesis of Source-Excited Propagation and Diffraction
L.B. Felsen
Polytechnic Inst. of New York, Rt. 110, Farmingdale, NY 11735
J. Appl. Mech., Trans. ASME, 52 (1), pp 27-32 (Mar 1985), 7 figs, 22 refs

KEY WORDS: Wave propagation, Wave diffraction

Time-harmonic and transient propagation and diffraction phenomena can be described alternatively by progressing and oscillatory waves that express the wave motion in terms of direct and multiple wavefronts or rays, and in terms of resonances or modes, respectively. Each description is convenient and physically appealing when it requires few contributing elements.

85-1674
Reflection and Transmission of Elastic Waves by a Periodic Array of Cracks
Y.C. Angel, J.D. Achenbach
Northwestern Univ., Evanston, IL 60201
J. Appl. Mech., Trans. ASME, 52 (1), pp 33-41 (Mar 1985) 7 figs, 15 refs

KEY WORDS: Wave transmission, Wave reflection, Cracked media

The interaction of elastic waves with a planar array of periodically space cracks of equal length is investigated. For normal incidence, reflection and transmission of longitudinal and transverse wave has been considered. Application of finite Fourier transform techniques reduces the solution of the mixed-boundary value problem for a typical strip to that of a singular integral equation. The solution has been obtained numerically.

85-1675
An Inverse Scattering Problem of Elastic Waves
M.A. Hooshyar
Univ. of Texas at Dallas, Richardson, TX 75080
J. Acoust. Soc. Amer., 77 (3), pp 844-849 (Mar 1985), 5 figs, 1 table, 13 refs

KEY WORDS: Elastic waves, Wave scattering

The problem of deducing the elastic parameters of an inhomogeneous isotropic medium with spherically symmetric parameters, from the elastic-wave scattering information, is considered. It is shown that the problem can be reduced to a quantum mechanical inverse scattering problem at fixed energy, if the scattering amplitude as a function of angle for the transverse wave of polarization perpendicular to the scattering plane is known for two different values of frequency.

EXPERIMENTATION

MEASUREMENT AND ANALYSIS

85-1676
Remote Vibration Measurement by Time-Averaged Holographic Interferometry
T.D. Dudderar, J.A. Gilbert, R.A. Franzel, J.H. Schamell
AT&T Bell Labs., Murray Hill, NJ
Exptl. Tech., 9 (1), pp 25-27 (Jan 1985), 4 figs

KEY WORDS: Vibration measurement, Holographic techniques, Interferometric techniques

This report describes the first successful demonstration of the use of fiber optics in the study of vibrating objects by time-averaged holographic interferometry (HI), as well as the first recording of remote holograms without the use of an output lens to image the transmitted object onto the hologram. These experiments further extend

the practical range of fiber-optic HI and demonstrate the convenience, flexibility and applicability of such systems, even in the presence of significant mechanical disturbance.

85-1677
Reverberation Time Measurements According to the Interrupted Noise Method: Precision Methods for Computer-Controlled Equipment
K. Bodlund
Statens Provningsanstalt, Boras, Sweden
Rept. No. SP-RAPP-1983-35, NT/TECHN-26, 144 pp (Mar 1984) PB85-108223

KEY WORDS: Measurement techniques, Reverberation time, Frequency analyzers

This project covers the requirements for standardization of the rules of computer-controlled reverberation time measurements with real-time frequency analyzers. The dependence on different test variables are studied with extensive laboratory experiments. A short summary of the variables, the experiences and the conclusions is presented.

85-1678
Preliminary Study of Using a Strain-Gauged Balance and Parameter Estimation Techniques for the Determination of Aerodynamic Forces on a Model in a Very Short Duration Wind Tunnel
A.P. Brown, R.A. Feik
Aeronautical Res. Labs., Melbourne, Australia
Rept. No. ARL/AERO-TM-358, 32 pp (Dec 1983) AD-A146 473

KEY WORDS: Force measurement, Aerodynamic loads, Wind tunnel testing

A preliminary study of a proposed method of measuring aerodynamic forces on a supported model in an intermittent very short duration wind tunnel with a relatively high airflow dynamic pressure is presented. A semiconductor strain gauged cantilever beam balance is used to record strain time histories associated with model displacement in response to aerodynamic force. The practical feasibility of obtaining sufficiently resolvable strains for the prescribed tunnel conditions with the given strain gauge configuration is established. The proposed method uses a system identification procedure to determine the system dynamic response characteristics using a known calibration force input.

85-1679
Measuring Method of Driver's Noise Exposure for Machine Powered Garden Vehicles
A. Liljeroos
Valtion Teknillinen Tutkimuskeskus, Espoo, Finland
Rept. No. VTT/RN-343, ISBN-951-38-2092-, 47 pp (1984) PB85-108801

KEY WORDS: Noise measurement, Measurement techniques, Agricultural machinery

The noise exposure of the driver of a machine powered garden vehicle is measured. Results are greatly affected by the type of ground on which the measurement is performed.

85-1680
Acoustic Emission Evaluation of Plasma-Sprayed Thermal Barrier Coatings
C.C. Berndt
NASA Lewis Res. Ctr., Cleveland, OH 44135
J. Engrg. Gas Turbines Power, 107 (1), pp 142-146 (Jan 1985) 3 tables, 48 refs

KEY WORDS: Acoustic emission, Thermal insulation

Acoustic emission techniques have recently been used in a number of studies to investigate the performance and failure behavior of plasma-sprayed thermal barrier coatings. Failure of the coating is a complex phenomena, especially when the composite nature of the coating is considered in the light of possible failure mechanisms. It can be expected that both the metal and ceramic components of a composite thermal protection system influence the macroscopic behavior and performance of the coating. The aim of the present work is to summarize the state-of-the-art in terms of this initial work and indicate where future progress may be made.

85-1681

Magnetostatic Wave Frequency Analyzer Apparatus

R.E. Floyd
Dept. of Air Force, Washington, DC

U.S. Patent Appl. No. 6-627-699, 17 pp (July 1984)

KEY WORDS: Frequency analyzers

A magnetostatic wave frequency analyzer apparatus utilizing forward volume waves is described. A single input transducer is arranged opposite a plurality of output transducers to receive the different frequencies of the generated magnetostatic forward volume wave. A geometric ground plane is positioned in the propagation path between the input transducer and the plurality of output transducers to demonstrate the propagation characteristics of magnetostatic forward volume waves in the 2-6 GHz range.

85-1682

A Possible Error of Impulse Test and the Way of Its Improving

Liang Zhong
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Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, Florida, Vol. II, pp 802-808, 7 figs, 1 table

KEY WORDS: Experimental modal analysis, Impact tests, Testing techniques

On the basis of theoretical analysis of the energy in tested objects and experiments, an improved method is developed. Under these test conditions, the modified impulse excitation results are in good agreement with that of the sinusoidal excitation.

85-1683

Experimental Error? No! Experimenter's Error! A Measurement Engineer's View of Experimental Modal Analysis

P.K. Stein
Stein Engineering Services Inc., Phoenix, AZ

Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, Florida, Vol. II, pp 824-830, 2 figs, 2 tables, 5 refs

KEY WORDS: Experimental modal analysis, Testing techniques

Experimental data must be subjected to internal validation, rather than be compared to theoretical computations which are themselves imbued with never-realized boundary conditions, material-property assumptions, and initial conditions (such as the total integrated history of the hardware involved). Some of the internal validation techniques available for experimental data, which must be included in the experimental procedure, are discussed.

85-1684

Practicalities of Acquiring Valid Data During Modal Tests

G.B. Patrick
Entek Scientific Corporation

Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, Florida, Vol. II, pp 845-849, 1 fig, 4 refs

KEY WORDS: Experimental modal analysis, Testing techniques

This paper presents common errors of beginning and experienced test engineers, and provides some practical guidelines for modal testing. Subjects covered include data requirements, hardware considerations, data evaluation, boundary conditions, and data reduction.

85-1685

Proper Use of Weighting Functions for Impact Testing

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Bruel & Kjaer Instruments, Inc., Marlborough, MA 01752

Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, Florida, Vol. II, pp 1102-1106, 9 figs, 4 refs

KEY WORDS: Experimental modal analysis, Testing techniques, Impact tests

Force and exponential windows are commonly used to weigh the time signals when impact methods are used for structural dynamics testing. In modern signal processing instrumentation, these windows can be selected and adjusted by the user. Improper application of the windows can result in measurement errors. This paper discusses how to evaluate the force and response signals to determine the proper type and amount of weighting to apply.

85-1686

Uses and Abuses of Modal Testing

D.J. Ewins

Imperial College of Science and Technology, London, England

Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, Florida, Vol. I, pp xiii-xvii

KEY WORDS: Experimental modal analysis

This paper calls for concerted efforts to ensure that the maximum benefits possible are gained from the application of modal analysis and testing techniques to practical vibration problems. Attention is drawn to the need to consider carefully the objectives and aims of each such application, leading to the selection of the most appropriate measurement and analysis methods.

85-1687

Modal Analysis as a Tool to Enhance Disc Drive Performance

J. Castagna

PRIAM Corporation, San Jose, California

Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, Florida, Vol. II, pp 1067-1071, 12 figs

KEY WORDS: Experimental modal analysis, Mode shapes, Computer storage devices

A case history of the use of experimental modal analysis to characterize the dynamic behavior of a disc drive assembly is discussed. A problem frequency is identified and modal analysis is used to determine the mode shape of the component. The interaction of the experimentally determined mode and that of the simulation model is discussed.

85-1688

Inverse Eigenvalue Problems and Identification of Physical Parameters of Vibration System

Xu Yangshen, Chen Zhongyi

Zhejiang Univ., Hangzhou, People's Rep. of China

Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, Florida, Vol. II, pp 1129-1133, 8 figs, 5 tables, 6 refs

KEY WORDS: Experimental modal analysis, Eigenvalue problems, Experimental data, Rotors, Multistory buildings

Identification of the physical parameters of a vibration system has an important meaning in engineering. The relationship between inverse eigenvalue problems in matrix and identification of physical parameters of a vibration system is established, and a new method to identify the physical parameters of a vibration system is presented.

85-1689

Determination of Elastic Constants of Orthotropic Materials by Modal Analysis with Linear Regression Techniques

Daze Tang, I-Chih Wang, J. Kindel

Univ. of Cincinnati, Cincinnati, OH

Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, Florida, Vol. II, pp 1234-1239, 7 tables, 2 refs

KEY WORDS: Experimental modal analysis, Orthotropism, Elastic properties, Regression analysis, Impact tests

A method of determining the elastic constants for orthotropic materials using a linear model regression technique is presented. Natural frequencies obtained from modal analysis testing on an elastic structure can be used to determine the elastic properties of the structure.

85-1690

Scaling of Modal Parameters

R.G. Smiley
Entek Scientific Corporation

Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, Florida, Vol. I, pp 71-74, 2 figs, 6 refs

KEY WORDS: Experimental modal analysis, Modal scaling

Some practical aspects of understanding the relationships between modal mass, modal stiffness, and mode shape are presented. A review of differences between experimentally-derived and analytically-derived (FEM) results is presented.

85-1691

The Multivariate Mode Indicator Function in Modal Analysis

R. Williams, J. Crowley, H. Vold
Structural Dynamics Research Corporation, York House, Stevenage Road, Hitchin, Hertfordshire SB4 9DY England

Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, Florida, Vol. I, pp 66-70, 7 figs, 1 table, 6 refs

KEY WORDS: Experimental modal analysis, Mode indicator function

This paper presents a brief outline of the theory of the multivariate mode indicator and shows how the information generated by this procedure may be used for the extraction of selected modal parameters through function enhancement and frequency domain SDOF techniques. The use of the multivariate mode indicator in the traditional MDOF procedures is also discussed.

85-1692

Some Experiences in Experimental Modal Analysis

Lingmi Zhang
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Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, Florida, Vol. I, pp 7-14, 5 figs, 10 refs

KEY WORDS: Experimental modal analysis, Case histories

Some experiences in experimental modal analysis in the past few years are presented. The complex mod 1 analysis theory and the relation between complex and real mod 1 parameters are discussed. The combined wide band excitation/FFT data analysis and sinewave excitation/digital frequency response analysis are adopted to obtain data accuracy and time savings.

85-1693

Dynamic Analysis of Beams and Plates Subjected to Air-Blast Loading

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Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, Florida, Vol. II, pp 975-982, 17 figs, 3 tables, 7 refs

KEY WORDS: Cantilever beams, Rectangular plates, Experimental modal analysis, Finite element technique, Air blast

This paper presents experimental and finite element numerical results for free vibration and dynamic response of a cantilever beam and square plates. The laboratory and field trials facilities used for the tests are described. The procedure for measuring natural frequency and mode shape using a modal analyzer is outlined.

85-1694

Exponential Window for Burst Random Excitation

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Intl. Modal Analysis Conf., Proc. 3rd, Jan

28-31, 1985, Orlando, Florida, Vol. II, pp 989-995, 18 figs, 2 tables, 5 refs

KEY WORDS: Experimental modal analysis, Measurement techniques, Exponential window method, Frequency response functions

For burst random excitation to combat leakage effectively, the response signals must decay to channel noise levels before the end of the observation window. This may be realized by using a low frequency baseband, or alternatively, post-processing the data into narrowband zoom ranges. This paper suggests the use of an exponential window on both the response and force channels such that wider frequency bands can be selected without introducing leakage.

85-1695

Modal Identification Techniques Assessment and Comparison

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Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, Florida, Vol. II, pp 831-839, 1 table, 46 refs

KEY WORDS: Experimental modal analysis, Frequency domain method, Time domain method, Transfer functions

Discussion of frequency domain methods from Kennedy and Pancu technique of 1947 to the existing transfer function methods, with advantages and limitations, is presented. Evaluation of several time domain methods is comparatively discussed. Future directions and hardware and software needs are summarized.

85-1696

Experimental Determination of Eigen Solutions of Non Self-Adjoint Mechanical Structures

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Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, Florida, Vol. II, pp 768-774, 1 fig, 4 tables, 7 refs

KEY WORDS: Experimental modal analysis, Eigenvalue problems

The case of discretized linear mechanical structures represented by nonsymmetric matrices is considered. The determination of right hand side eigenvectors and left hand side eigenvectors is attempted from experiments. A combined method is proposed.

85-1697

Inverse Modal Transformations for Structural Dynamics Modification

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Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, Florida, Vol. II, pp 949-955, 1 fig, 4 tables, 10 refs

KEY WORDS: Experimental modal analysis, Structural modification techniques

It is convenient to specify the dynamics of lightly damped structures in modal coordinates. However, the structural changes needed to produce these changed characteristics must be implemented at physical locations on the structure -- the stiffness and mass changes must be defined in the physical coordinates. An inverse modal transformation is needed to find physical-coordinate properties in terms of modal-coordinate properties when a truncated set of modes are known. A general pseudo-inverse is presented which transforms specified modal data into useful mass and stiffness matrices in the physical coordinates.

85-1698

MOdal Testing Considerations for Structural Modification Applications

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Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, Florida, Vol. I, pp 46-52, 6 figs, 3 tables, 8 refs

KEY WORDS: Experimental modal analysis, Structural modification techniques

This paper discusses some special considerations in designing a modal test for the purpose of generating a structural modification data base. Simple examples show how various errors in the modal model affect the accuracy of the structural modification predictions. Suggestions are presented for avoiding these errors and for validating the accuracy of the data base. Special attention is given to the error known as modal truncation which results from using a modal model which is not sufficiently complete.

85-1699
The Limitation of Local Structural Dynamic Modification
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Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, Florida, Vol. I, pp 53-58, 5 figs, 9 refs

KEY WORDS: Modal analysis, Structural modification techniques

The fundamental question of the possible extent of improving vibration characteristics of mechanical structures by local modification is investigated. With this information, the engineer can determine a priori whether a change in dynamic performance can be achieved by a proposed design modification. For simple discrete mass and spring modifications, the range of natural frequency alternations can be readily determined using closed form frequency equations of the modified systems. For finite element models, it is shown that the distribution of natural frequencies cannot be altered arbitrarily by local modifications. The general results are demonstrated by numerical examples.

85-1700
Structural Dynamic Modification Using Modal Analysis Data
B.P. Wang, G. Clark, F.H. Chu
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Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, Florida, Vol. I, pp 42-45, 8 figs, 7 refs

KEY WORDS: Modal analysis, Structural modification techniques, Frequency response functions

The effects of local modification on the dynamic characteristics of existing structures are studied experimentally. The frequency response functions of the proposed modified structure are synthesized from the frequency response data of the existing structure and the characteristics of the local modification. The dynamic characteristics of the proposed modified structure can then be identified using the synthesized transfer function.

85-1701
A Comparison of Smurf and Modal Modeling
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Structural Dynamics Res. Corp., Milford, OH 45150
Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, Florida, Vol. II, pp 1053-1059, 20 figs, 6 refs

KEY WORDS: Modal analysis, Structural modification techniques, Frequency response functions, Experimental data

Direct structural modification using experimental frequency response functions (SMURF) has many applications in the troubleshooting environment. It is an excellent tool for determining the validity of experimentally derived modal models. A comparison is presented between predicting a structural modification using the SMURF technique and predicting the modification using an experimentally acquired modal model.

85-1702
Global Method of Modal Identification
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Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, Florida, Vol. II, pp 1145-1151, 8 figs, 5 refs

KEY WORDS: Modal analysis, Global identification technique, Frequency response, Computer programs

Identification methods of mechanical structures generally use a force tuning technique or transfer function smoothing technique. These methods require long experiments to obtain eigensolutions and do not take into account simultaneously all measurements. Time domain methods recently developed do not have this disadvantage, but they require the calculation of impulse responses on all the pickups by means of inverse Fourier transform. The proposed method has the same advantages, but uses direct frequency responses.

85-1703

Identification of Modal Parameters of the Vibratory Systems from Measured Velocity Admittance

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Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, Florida, Vol. II, pp 1121-1128, 5 figs, 2 tables, 13 refs

KEY WORDS: Modal analysis, Parameter identification techniques, Velocity admittance

From the characteristics of velocity admittance, a method of identification of modal parameters is deducted by way of smoothing of the measurements of frequency response of velocity. Several numerical examples show that this method is able to obtain the modal parameters of discrete or continuous systems and can be applied to the damped system which cannot be diagonalized.

85-1704

The Effect of Rotational Degrees of Freedom in System Analysis (SA) via Building Block Approach (BBA)

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Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, Florida, Vol. II, pp 1040-1045, 5 figs, 8 tables, 7 refs

KEY WORDS: Modal analysis, Rotational degrees of freedom, Building block approach, Structural modification techniques

This paper discusses the effect of rotational degrees of freedom in system analysis via the building block approach. The paper describes a correlation example in which an experimental modal model is modified using system analysis to predict the effect of adding a finite element beam. The experimental data include only translational degrees of freedom for connection points.

85-1705

Strategies for the Verification of a Finite Element Model

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Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, Florida, Vol. II, pp 1031-1039, 5 figs, 7 refs

KEY WORDS: Modal analysis, Finite element technique, Experimental data, Mass matrices, Stiffness matrices

There is considerable current interest in comparing the mass and stiffness matrices derived from a finite element model of a structure with those obtained from vibration measurements on the structure itself. In practice the measured mass and stiffness matrices must be deduced from so-called incomplete data. Setting this problem in the context of the approximation of linear operators on appropriate inner product vector spaces allows a unified treatment to be presented. By using the characteristics of the continuous operators which underlie the finite element formulation it is possible to draw attention, at a fundamental level, to the nature of verification strategies.

85-1706

Fast Hilbert Transform and Spectrum in Signalanalytic Applications

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Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, Florida, Vol. II, pp 1107-1114, 5 figs, 11 refs

KEY WORDS: Modal analysis, Hilbert transforms

The Hilbert transform applied to a real time function converts it into an analytic. complex function. Its major advantage in signalanalytic applic. tions lies in the use of enveloping techniques. The Hilbert transform enveloping of an impulse function gives valuable information about the decay rate, and the damping and reflection characteristics of a vibration system. Hilbert transform calculations have been made up to now with the aid of the fast fourier transform (FFT). This paper presents a simple algorithm for the fast hilbert transform (FHT) without the use of FFT. The Hilbert spectrum concept and some application examples are presented.

85-1707

Measurement, Synthesis, and Use of Transmissibility Functions

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Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, Florida, Vol. II, pp 1014-1022, 8 figs, 5 refs

KEY WORDS: Modal analysis, Transmissibility functions, Frequency response functions, Base isolation, Nuclear power plants

Transmissibility functions are frequency response functions between like variables (motion response/motion input) as opposed to admittance functions which are frequency responses between conjugate variables (motion response/force input). While the two types of functions have substantially different properties, both are valuable in dynamic testing and analysis. Some properties of transmissibility functions are summarized and contrasted with those of the more widely used admittance functions.

85-1708

Optimization of Mass and Stiffness Matrices Using a Generalized Inverse Technique on the Measured Modes

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Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, Florida, Vol. I, pp 75-79, 3 tables, 17 refs

KEY WORDS: Modal analysis, Data processing, Optimization, Mass matrices, Stiffness matrices

A method, based on the theory of a generalized inverse of the measured modal matrix, is used to improve the mass and stiffness matrices of a finite element model. The method, using the measured normal modes and frequencies, directly calculates a set of minimum changes in the physical matrices which constrains the resulting mass and stiffness matrices to produce an equivalent eigen-solution. The technique produces insight into the character of the measured modal information such that a sensitivity analysis procedure can be established. The procedure also can be used to identify discrepancies in the measured modes.

85-1709

Linear and Non-Linear Modal Analysis of Aeroelastic Structural Systems

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Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, Florida, Vol. I, pp 21-30, 6 figs, 20 refs

KEY WORDS: Modal analysis, Aeroelasticity, Linear theories, Nonlinear theories

This paper deals with the investigation of linear modal analysis and autoparametric interaction of aeroelastic systems. The normal mode frequencies and the associated mode shapes are obtained in terms of the system parameters. The results show that for certain system parameters the condition of internal resonance is satisfied.

85-1710
Determining Component Loads and Stresses with Improved System Modeling Techniques
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Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, Florida, Vol. II, pp 941-948, 8 figs, 1 table, 9 refs

KEY WORDS: Complete structures, Modal analysis, Truncation, Finite element technique

With more emphasis being placed upon the performance of complex structures and increased use of modal representations of components, there exists the need to have accurate modal representations of these components in a complex system. This paper discusses the use of static correction terms to improve the modal representation of components by accounting for the effect of truncated higher frequency modes. The determination of the dynamic load field experienced by a component in a system and the resulting strains and stresses are also discussed.

85-1711
Identification of Aeroelastic Phenomenon Employing Bispectral Analysis Techniques
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College of Engineering, Univ. of Texas at Austin
Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, Florida, Vol. II, pp 956-964, 14 figs, 6 refs

KEY WORDS: Flutter, Bispectral analysis, Modal analysis

The application of higher order spectra such as the bispectral analysis technique is used to experimentally identify different classes of auto-parametric responses and finally the onset of flutter. A subcritical flutter testing method is proposed and investigated which employs this bispectral identification technique. To demonstrate the usefulness of the method for subcritical flutter testing a flutter simulation was carried out on a mathematical model. This technique is contrasted with the Zimmerman flutter prediction method currently employed in flight flutter testing.

85-1712
Effect of Delay on the Frequency Response Function
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Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, Florida, Vol. II, pp 965-968, 6 figs, 2 refs

KEY WORDS: Frequency response function, Coherence function technique, Modal analysis

When structures are excited by random force, the coherence function drops at resonance, even if noise is not present on the excitation and response signals, and the frequency response function (FRF) will be lower than expected. This paper demonstrates that such coherence function and FRF behavior is due to the effects of delay.

85-1713
State-Space Approach to Modal Analysis
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Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, Florida, Vol. II, pp 969-974, 11 refs

KEY WORDS: Modal analysis, State space approach

A new approach to modal analysis through the utilization of state space formulation is presented. Identification of the system matrix and thus the modal parameters is attained for both time and frequency domains. The method is shown to be very powerful particularly for damped and overdamped systems.

85-1714
Discretization of Structures for Modal Analysis

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Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, Florida, Vol. II, pp 983-988, 7 figs, 4 tables, 8 refs

KEY WORDS: Modal analysis, Stiffness matrices, Mass matrices, Finite element technique, Frequency response functions

The finite element method and experimental modal analysis are most popular methods for structural modal analysis. The discretization of distributed structural systems is the basis of these two methods. The mass and stiffness matrices obtained for these two methods are investigated.

85-1715
Identification of Forces Generated by a Machine under Operating Condition
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Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, Florida, Vol. II, pp 920-927, 20 figs, 3 refs

KEY WORDS: Force prediction, Frequency response functions, Modal analysis

The appropriate identification of forces generated by a machine while operating is an important task in the quantitative evaluation of the actual level of response of the structure in the dynamic design of the machine. The direct measurement of such forces often encounters some trouble due to the difficulty in mounting transducers, etc. This paper deals with the indirect identification of the forces; that is, the method for predicting the forces based on frequency response functions between artificial excitation force and acceleration response measured in advance and based on actual acceleration of the machine under operating condition.

85-1716
Dynamic Modelling of Mechanical Structure via Undetermined Parameter Methodology
Chen Qiangen, Lu Naiyan, Tong Zhongfang, Cheng Yaodong
Zhejiang Univ., Hangzhou, China
Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, Florida, Vol. II, pp 928-933, 4 figs, 2 tables

KEY WORDS: Modal analysis, Parameter identification technique, Dynamic modeling

A technique is presented for dynamic modeling of a mechanical structure. It is required to establish an equivalent lumped parameter dynamical model for a given structure. By means of undetermined parameter methodology, the dynamic parameters of the mechanical structure are calculated from measured response data.

85-1717
Inverse Perturbation-Psudo Converse for Dynamic Model Modification
Liu Ying-li, Chen Su-Huan
Jilin Univ. of Technology, Changchun, China
Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, Florida, Vol. II, pp 901-907, 11 tables, 4 refs

KEY WORDS: Modal analysis, Perturbation theory, Mathematical models

An inverse perturbation-psudo converse for dynamic model modification is developed. The results of modal parameters identification are used to modify analytical dynamic model. It is unnecessary to perform iteration in this procedure, therefore, it is useful for dynamic model modification of large structures.

85-1718
Maximum Entropy Frequency Response Functions
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Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, Florida, Vol. II, pp 876-881, 9 figs, 8 refs

KEY WORDS: Modal analysis, Maximum entropy spectral analysis, Frequency response functions, Automobiles

The estimation of spectra using the maximum entropy method (MEM) is gaining widespread acceptance in such diverse fields as geophysics and astronomy. MEM provides a better resolution from shorter record lengths than the traditional FFT and window techniques and also eliminates leakage.

85-1719

Understanding Modal Parameter Terminology and Mode Shape Scaling

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Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, Florida, Vol. II, pp 840-844, 7 figs, 4 refs

KEY WORDS: Modal analysis, Mode shapes, Modal scaling

Modal analysis has become a black box technique with frequency response measurements as input and mode shapes as the output. To examine this black box, and in particular mode shape scaling, an illustrative example is presented that relates both the terminology and mathematical concepts to practical applications.

85-1720

A Complex Modal Analysis Method for Damped Vibration Systems (The Representation in the Second Order Differential Form of a Modal Equation and Its Use for Practical Application

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J. Vib., Acoust., Stress, Rel. Des., Trans. ASME, 107 (1), pp 13-18 (Jan 1985), 7 figs, 3 tables, 5 refs

KEY WORDS: Modal analysis

Second order uncoupled differential equations for the general damped vibration systems are derived theoretically. The equations are written in a form similar to the classical real modal equations by using the natural frequency, the modal damping ratio, and the newly defined complex modal mass. Introducing supplementary variables, the response analysis is carried out in a similar manner to the real modal analysis.

85-1721

Modal Synthesis Using Eigenvalue Modification

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Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, Florida, Vol. II, pp 1134-1137, 1 fig, 4 tables, 17 refs

KEY WORDS: Modal synthesis, Structural modification technique

Substructuring and modal synthesis of undamped and damped structures are accomplished using structural modification schemes currently available in some FFT structural analyzers software. The technique permits the casual user to do modal synthesis without confusing terms such as "fixed interface modes," "attachment modes," etc; but using physical connections such as springs and rigid ties.

DYNAMIC TESTS

85-1722

Modal Analysis of Elastic Wave Propagation

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Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, Florida, Vol. II, pp 730-737, 9 figs, 3 refs

KEY WORDS: Modal analysis, Elastic waves, Wave propagation, Rods

The exact analytical solution of wave propagation in an elastic rod serves as a basis to compare with the numerical solutions obtained by using the modal analysis, the central difference, and the Newmark methods. By varying the number of degrees of freedom and the incremental time step, the numerical stability, accuracy, and efficiency of various numerical methods are addressed.

DIAGNOSTICS

85-1723

Modal Tests on Composite Material Structures Application in Damage Detection

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Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, Florida, Vol. II, pp 708-713, 11 figs, 4 tables, 8 refs

KEY WORDS: Experimental modal analysis, Failure detection, Composite materials

The modal analysis approach is used to investigate the possibility of detecting damages in composite material structures. The aim of the work is to check the use of a simple modal analysis by an FFT analyzer and broadband impulse input; i.e. with the measurements of the frequencies and damping coefficients only by one or at the most few points on the structure and therefore without the acquisition of the mode shapes.

85-1724

A New Technology for Diagnosing the Weak Points of Machine Tools with Stroboscopic Holography

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Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, Florida, Vol. II, pp 934-940, 6 figs, 1 table, 10 refs

KEY WORDS: Diagnostic techniques, Machine tools, Lasers, Holographic techniques

A new technology for diagnosing the dynamic characteristics of machine tools by means of stroboscopic laser holography is introduced. With this technique the instantaneous mode shapes of machine tools at any instant of vibration can be recorded.

85-1725

Experimental Measurement of Scattered Surface Waves Using a Laser-Doppler Technique

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J. Acoust. Soc. Amer., 77 (3), pp 1003-1009 (Mar 1985), 7 figs, 9 refs

KEY WORDS: Nondestructive tests, Measurement techniques, Wave scattering, Laser-Doppler method

A laser-Doppler vibrometer was used to detect gated harmonic surface waves traveling along a steel block, together with their reflections from a rectangular plate attached to the block through a viscous couplant. A signal demodulator was designed to allow visualization of the waves on an oscilloscope, and computer data acquisition was performed. The correlation between the positions, number, and amplitudes of the resonances obtained from experiment and theory was analyzed, as was the influence of the couplant.

MONITORING

85-1726

The Way Ahead for Machinery Health Monitoring as a Subset of Plant Control

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Noise Vib. Control, 16 (2), pp 53-56 (Feb 1985), 2 figs, 5 refs

KEY WORDS: Monitoring techniques

The up-take rate of condition monitoring technology over the past 10 years has been much slower than the predictions of the

early 1970s. It is estimated that 90% of all condition monitoring equipment bought over the past 10 years now lies idle for reasons either of basic unsuitability or simple obsolescence. In this article the author has taken the view that condition monitoring will split into two distinct camps: one based on very simple hand-held, manpower intensive instrumentation and the other on automated systems with high AI content and close parallels to the control industry. Elaborating on the latter, some of the hardware currently being developed is described and a range of target projects with high RoI is identified.

85-1727
Minimizing Stresses in Rotating Machinery

Noise Vib. Control, 16 (2) pp 59-61 (Feb 1985) 7 figs

KEY WORDS: Monitoring techniques

Measurement and study of vibration in rotating machinery can yield a great deal of information on the state-of-health of the machine concerned. This article on a dynamic signal analyzer used for this purpose provides an interesting insight into the way in which vibration measurement can influence machine design and predictive maintenance.

85-1728
Rolling Element Bearing Monitoring Using High Gain Eddy Current Transducers
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J. Engrg. Gas Turbines Power, 107 (1), pp 160-164 (Jan 1985) 11 figs, 4 refs

KEY WORDS: Monitoring techniques, Rolling contact bearings

A technique is described which provides early detection of rolling element bearing failure through direct observation of the bearing outer race with a high-gain eddy current probe. Data is presented that compares REBAM -- rolling element bearing activity monitor -- to traditional monitoring approaches that employ case mounted velocity and acceleration transducers. A summary of field results is presented and its suitability to high speed gas turbine monitoring is discussed.

85-1729
Application of Vibration Monitoring to High Volume, Multistation Transfer Machines
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Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, Florida, Vol. II, pp 915-919, 16 figs, 3 refs

KEY WORDS: Monitoring techniques, Machine tools, Diagnostic techniques, Experimental modal analysis

A field study was undertaken to determine the feasibility of applying vibration monitoring to high volume, multistation transfer machines installed in one of the leading automotive engine plants. An accelerometer, a vibration meter and a tape recorder were used to obtain the vibration data.

ANALYSIS AND DESIGN

ANALYTICAL METHODS

85-1730
Modelling of Viscoelastic Materials and Its Application in Dynamic Analysis
Zhong Qinghui, Sun Yueming, Tong Zhongfang, Chen Yaodong
Zhejiang Univ., People's Rep. of China
Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, Florida, Vol. II, pp 1200-1206, 5 figs, 4 refs

KEY WORDS: Modal analysis, Lumped parameter method, Viscoelastic properties, Mathematical models

A lumped parameter visco-elastic model which is appropriate for a representation of dynamic properties of viscoelastic materials with multi-peak spectrum of dynamic stiffness is presented. The representation characteristics, the frequency range of validity, the determination of the initial values and fitting method of the parameters of the model are discussed.

85-1731

A New Method Reducing the Degree of Freedom of Finite Element Model

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Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, Florida, Vol. II, pp 1250-1253, 3 figs

KEY WORDS: Modal analysis, Finite element technique, Multidegree of freedom systems

Considering the influences of continuity, geometry and boundary conditions on the lower frequency vibration of a continuum, this paper introduces three concepts. Condensable nodal system, condensing constraint and a condensable element for the finite element model with a large number degrees of freedom are discussed.

85-1732

Aψ -ω -V Finite Element Formulation for Axisymmetric Flows

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Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, Florida, Vol. II, pp 1240-1244, 1 fig, 10 refs

KEY WORDS: Modal analysis, Finite element technique, Fluid-filled containers

A new method of solving the three dimensional axisymmetric viscous fluid flow problem by the finite element method is presented. A large numerical experimentation has demonstrated its efficiency, particularly for the flow due to a rotating disk in a stationary cylindrical container.

85-1733

Perturbation Method for Complex Eigenvalues of Damped System and Its Associated Iterative Algorithm

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Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, Florida, Vol. II, pp 1060-1066, 1 fig, 2 tables, 3 refs

KEY WORDS: Eigenvalue problems, Damped structures, Perturbation theory, Iteration

In this paper, n^{th}-order perturbation formulas for the complex eigenvalue problem based on the state equation of damped systems are developed by using small parameter expansion. A simplified formulation and an equivalent form are given. An iterative method used to improve the accuracy of the perturbation solution is obtained.

85-1734

Mechanical Impedance/Mobility — An Overview

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Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, Florida, Vol. II, pp 809-813, 2 figs, 18 refs

KEY WORDS: Modal analysis, Mechanical impedance, Mobility method, Reviews

An electrical analogy method has been applied to the determination of some of the desired elements of the solution of mechanical systems by considering the ratio of force to velocity, or its reciprocal. From this approach has developed the method now referred to as the mechanical impedance method. The similarity of the methods of mathematical analysis of elastic mechanical systems and electrical circuits is well known. Therefore, it has been quite natural to apply electrical analogies to the solution of mechanical systems, especially when sinusoidal-forcing functions exist and when electrical circuit modeling has been available.

85-1735

A Low Order Transition Matrix of the State-Space Equations of Motion

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Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, Florida, Vol. II, pp 888-894, 3 figs, 2 tables, 4 refs

KEY WORDS: Modal analysis, Time domain method

In the analysis of time history response data, the transition matrix is required to transform the response $x(t_1)$ to $x(t_2)$. Analytical expressions for this matrix, as function of the model parameters; the mass, stiffness and damping matrices, are available. Alternative expressions as functions of the modal parameters can also be derived. In industrial applications, however, estimates of the model and modal parameters are normally obtained experimentally. This paper develops closed form expression of the transition matrix from this limited modal information, together with the analytical estimates of the mass and stiffness matrices and without recurrence to damping matrix estimates or to the inversion of modal matrices.

85-1736

Substructure Analysis of Complex Structure with Weak Connections Using Matrix Perturbation

Chen Su-Huan, Liu Ying-Li
Jilin Univ. of Technology, Changchun, China

Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, Florida, Vol. II, pp 757-762, 3 figs, 3 tables, 5 refs

KEY WORDS: Modal analysis, Substructuring methods, Matrix methods, Perturbation theory, Eigenvalue problems

This paper extends the capability of the matrix perturbation described in previous papers by introducing substructuring. The substructuring technique deals with a large complex structure with weak connections which are described by a connection matrix in physical space. The eigenvalues and eigenvectors of the substructures can be used to determine the eigenvalues and eigenvectors of the combined structure by using matrix perturbation. The substructuring technique is more economical than component modal synthesis.

85-1737

Dynamic and Static Analysis of Large Structures Using Energy Equivalent Macro-Elements

H.R. Abdul-Salam Alani
Univ. of Colorado at Boulder

Ph.D. Thesis, Univ. of Colorado at Boulder, 206 pp (1984) DA8422581

KEY WORDS: Macroelement method

The demand for large structural systems has increased dramatically. The analysis of these large structural systems using existing tools requires costly computer time and much engineering effort. Consequently, it is desirable to develop a cost effective and sufficiently accurate procedure to analyze these structures. This research develops a method that can transform many structural elements into a single element called a macro-element. As a result of using macro-elements to model an entire structure, computer work and engineering efforts can be effectively reduced.

85-1738

Modal Control of a Class of Distributed Parameter System Using Method of Weighted Residuals

K.K. Tripathi, V.K. Jain
Harcourt Butler Technological Institute, Kanpur 208002, India

Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, Florida, Vol. II, pp 763-767, 6 refs

KEY WORDS: Modal analysis, Modal control technique, Continuous parameter method, Galerkin method, Method of weighted residuals

This paper deals with the problem of obtaining modal control for a class of distrib-

uted parameter systems using the approximation at the beginning by applying Galerkin's method. It has been shown that the modal control law obtained by applying approximation at the end on the distributed control law yield similar results as obtained by applying approximation at the beginning.

85-1739

Concepts of a General Substructuring System for Structural Dynamics Analyses

A.L. Hale, L.V. Warren
Univ. of Illinois at Urbana-Champaign, Urbana, IL 61801

J. Vib., Acoust., Stress, Rel. Des., Trans. ASME, 107 (1), pp 2-12 (Jan 1985) 12 figs, 10 tables, 34 refs

KEY WORDS: Substructuring methods

Multilevel substructuring algorithms in structural dynamics are considered together with their software implementation. The paper emphasizes a consistent data structure for representing objects on hierarchical levels. The data structure permits recursive numerical procedures to be easily implemented.

85-1740

Comparative Study of the Finite Element and Boundary Element Methods as Applied to a Boundary Value Problem of a Harmonic Function

T. Tran-Cong
Aeronautical Res. Labs., Melbourne, Australia

Rept. No. ARL-AERO-TM-363, 21 pp (Apr 1984) AD-A146 018

KEY WORDS: Finite element technique, Boundary element technique, Boundary value problems, Harmonic functions

The finite element and boundary element methods are described with their essential features illustrated using an example of a boundary value problem for a harmonic function. Analysis of the methodical errors is then carried out. This if followed by a consideration of the relative computational advantages of the two methods.

85-1741

On the Aitken Acceleration Method for Nonlinear Problems

Y.K. Chow, S. Kay
National Univ. of Singapore, Singapore

Computers Struc., 19 (5/6), pp 757-761 (1984) 3 figs, 2 tables, 8 refs

KEY WORDS: Numerical methods, Nonlinear theories, Aitken acceleration method

The paper describes the application of a variation of the Aitken acceleration method for nonlinear problems. The approach computes an improved estimate of the solution based on the previous three successive estimates and the process is applied frequently. Significant saving in solution time has been achieved and is demonstrated by three numerical examples which include static and transient problems involving plasticity.

85-1742

Applications of the Conformal Mapping Method to the Solution of Mechanical Vibrations Problems

P.A.A. Laura
Inst. of Applied Mechanics, Puerto Belgrano Naval Base, 8111 Argentina

Shock Vib. Dig., 16 (12), pp 3-7 (Dec 1984) 3 figs, 37 refs

KEY WORDS: Conformal mapping

Traditional applications of the method of conformal mapping are governed by the Laplace equation. However, in recent years the equation has also been used to solve wave propagation problems and those involving membrane and plate vibrations. In many instances it has been possible to obtain elegant approximate analytical solutions and algorithmic procedures; they have been implemented on desk computers and programmable pocket calculators.

85-1743

A Time Domain Identification Technique: The Oversized Eigenmatrix (OEM) Method

Yongxin Yang

Old Dominion Univ., Norfolk, VA 23508
J. Vib., Acoust., Stress, Rel. Des., Trans. ASME, 107 (1), pp 53-59 (Jan 1985) 5 figs, 2 tables, 13 refs

KEY WORDS: System identification technique, Time domain method, Natural frequencies, Damping coefficients, Cantilever beams

A method of identifying natural frequencies and associated damping ratios of a structure from its free decay response is presented. The method is based on the Prony's algorithm with which the idea of using an oversized math model as in ITD to reduce the noise effect is incorporated. Two approaches are proposed for use in distinguishing the true poles from the extraneous poles introduced by oversizing the eigenmatrix.

85-1744
A Nonparametric Identification Technique for a Variety of Discrete Nonlinear Vibrating Systems
Y. Yang, S.R. Ibrahim
Beijing Inst. of Strength and Environment Engrg., Beijing, People's Rep. of China
J. Vib., Acoust., Stress, Rel. Des., Trans. ASME, 107 (1), pp 60-66 (Jan 1985) 7 figs, 6 tables, 8 refs

KEY WORDS: System identification technique, Nonparametric identification technique, Power series method

A relatively simple nonparametric identification technique based on the use of power series expansions for the identification of nonlinearities of a variety of discrete nonlinear vibrating systems has been developed. The input data required can be either forced or free response of the accelerations, velocities, and displacements. The individual masses of the system can also be estimated while knowing their sum and using free response data.

NUMERICAL METHODS

85-1745
A Numerical Study of an Orthotropic Solid under Dynamic Loads
K. Lee
Ph.D. Thesis, State Univ. of New York at Stony Brook, 404 pp (1984) DA8422579

KEY WORDS: Finite difference technique, Orthotropism, Glass reinforced plastics

A numerical study on the effects of fiber orientation and geometry of a two-dimensional, unidirectional, elastic-plastic solid has been performed by using a finite difference method. Several finite difference schemes are discussed.

85-1746
Large-Scale Numerical Analysis of Three-Dimensional Seismic Waves
G.L. Wojcik, D.K. Vaughan
Weidlinger Associates, Menlo Park, CA
Rept. No. R-8403, AFOSR-TR-83-691, 53 pp (May 31, 1984) AD-A144 610

KEY WORDS: Numerical methods, Seismic waves, Time domain method

This report concludes a study of large-scale vectorized numerical analysis applied to time domain seismic wave phenomena in filled basins. Applications include calculations of waves from simple surface or buried sources in a variety of idealized 2-D basin and range models and one large 3-D model. Analysis is based on an explicit, finite element, elastic wave solver designed for vectorized execution on the CRAY-1.

PARAMETER IDENTIFICATION

85-1747
Identification of Vibration Parameters of Flexible Structures
S. Rajaram

Ph.D. Thesis, Virginia Polytechnic Inst. and State Univ., 134 pp (1984) DA8421888

KEY WORDS: Parameter identification technique, Time domain method, Periodic response, Stiffness coefficients, Mass coefficients

Several novel identification methods are investigated to determine the best estimates of higher order structural models directly from on-orbit vibration experiments. The methods presented are relatively immune to the presence of many low frequency modes with repeated or closely spaced natural frequencies, damping, and very high dimensionality.

DESIGN TECHNIQUES

85-1748

Design Oriented Identification of Critical Points in Transient Response

R.V. Grandhi

Ph.D. Thesis, Virginia Polytechnic Inst. and State Univ., 120 pp (1984) DA8421867

KEY WORDS: Transient response, Theory of adaptive identifiers, Spline technique, Design techniques

This research work describes three techniques for reducing the computational effort involved in identifying critical time points. The first approach is an adaptive search technique, well suited for exactly known response. The second technique is based on approximating the stress response using spline techniques. Spline interpolation is suggested for exactly known transient response and least squares spline approximation is useful for noisy response. The possibility of grouping several closely spaced local peaks to identify a single super peak from each group is investigated.

85-1749

Treatment of General Boundary Conditions and Point-Wise State Variable Constraints in Optimum Design for Static and Dynamic Response

Ching-Chieh Hsieh

Ph.D. Thesis, Univ. of Iowa, 237 pp (1984) DA8423569

KEY WORDS: Design sensitivity analysis, Optimum design, Boundary condition effects

The methods for design sensitivity analysis of static and dynamic response of structural systems when general boundary conditions are imposed during the analysis phase are presented. Although they are derived with Lagrange multiplier treatment of general boundary conditions, it is shown that they are applicable with any treatment of general boundary conditions.

COMPUTER PROGRAMS

85-1750

MSC/pal: An FE Companion for the PC

K. Blakely, R. Lahey, D. McLean

The MacNeal-Schwendler Corp., Los Angeles, CA

Computers Mech. Engrg., 3 (4), pp 32-41 (Jan 1985) 14 figs, 3 refs

KEY WORDS: Computer programs, Finite element techniques

The MSC/pal, a three-dimensional static and dynamic FE analysis package that runs on a personal computer, is described.

85-1751

Dynamic Modelling of Structures Using a Personal Computer

H.R. Martin

Univ. of Waterloo, Waterloo, Ontario, Canada

Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, Florida, Vol. II, pp 1093-1101, 6 figs, 2 tables, 5 refs

KEY WORDS: Dynamic modeling, Bond graph technique, Linkages, Springs

This paper discusses the Bondgraph approach to modeling of structures and linkages. It highlights the power of the software package TUTSIM for carrying out "what if" type analyses and allows the inclusion of nonlinear effects such as soft and hard springs. In the case of linkages, dead zones and hysteresis can be simulated.

85-1752
Mode Shape Representation Using Computer Graphics Techniques
C. Kung
Howard Univ., Washington, DC 20059
Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, Florida, Vol. II, pp 789-793, 13 figs, 12 refs

KEY WORDS: Graphic methods, Computer aided techniques, Mode shapes

In solving large eigenvalue problems, the modal database established using either computational or experimental results can be substantial. Graphic representation of the mode shapes is essential for the understanding of the problems. A survey of the current techniques to represent and animate mode shapes using computer graphics display is given. A technique to enhance the realism of mode shape representation is also proposed.

GENERAL TOPICS

BIBLIOGRAPHIES

85-1753
Modal Analysis Bibliography — An Update — 1980-1983
Leanne D. Mitchell, Larry D. Mitchell
Tejay Co., Box 641, Blacksburg, VA 24060
Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, Florida, Vol. II, pp 1268-1284

KEY WORDS: Experimental modal analysis, Bibliographies

This bibliography is a partial list of the 1980-1983 Modal Analysis citations the authors have collected. Citations not included are in the areas of seismic topics, design and analytic (finite element, nonlinear and elastomechanics) methods.

85-1754
Modal Analysis Bibliography — An Update — 1980-1984
Leanne D. Mitchell, Larry D. Mitchell
Tejay Co., Box 641, Blacksburg, VA 24060
Intl. Modal Analysis Conf., Proc. 3rd, Jan 28-31, 1985, Orlando, Florida, Vol. II, pp 1254-1267

KEY WORDS: Modal analysis, Bibliographies

This bibliography is a partial list of the 1980-1984 Modal Analysis citations the authors have collected. The authors' bibliography in the IMAC 2 Proceedings concentrated on experimental modal analysis.

85-1755
Soil Structure Interactions. 1970 - September, 1984 (Citations from the NTIS Data Base)
NTIS, Springfield, VA
182 pp (Oct 1984) PB84-876176

KEY WORDS: Soil-structure interaction, Bibliographies

This bibliography contains 199 citations concerning interactions resulting from cyclic and static loads on soils. Topics include plastic and elastic behavior of homogeneous and non-homogeneous clay and granular soils as a result of loads exerted by piles, foundations, buried pipes and culverts, tanks and tunnels. Mathematical modeling studies are presented. Some attention is given to pavement and offshore structures.

USEFUL APPLICATIONS

85-1756
Case Histories of Selection Criteria for Random Vibration Screening

R.G. Lambert
General Electric Co., Utica, NY
J. Environ. Sci., 28 (1), pp 19-25 (Jan/Feb 1985) 6 figs, 3 tables, 6 refs

KEY WORDS: Screening, Random vibration

Criteria are described for selecting the random vibration screening level and duration such that defects are uncovered without consuming significant useful life prior to service use. Miner's Linear Damage Rule is used as the basis for the derived damage expressions. Three real-world case histories are included to demonstrate the application of these criteria.

AUTHOR INDEX

CALENDAR

1985

SEPTEMBER

2-7 International Gas Turbine Symposium and Exposition [Gas Turbine Div., ASME; Chinese Natl. Aero-Technology Import and Export Corp.; Chinese Soc. of Aeronautics and Astronautics] Beijing, People's Rep. China (Intl. Gas Turbine Ctr., 4250 Perimeter Park South, Suite 108, Atlanta, GA 30341 -(404) 451-1905)

9-11 19th Midwestern Mechanics Conference [Ohio State Univ.] Columbus, OH (Dept. of Engrg. Mech., Ohio State Univ., 155 W. Woodruff Ave., Columbus, OH 43210 - (614) 422-2731)

10-13 Design Automation Conference [ASME] Cincinnati, OH (ASME)

10-13 Failure Prevention and Reliability Conference [ASME] Cincinnati, OH (ASME)

10-13 Vibrations Conference [ASME] Cincinnati, OH (ASME)

15-17 Petroleum Workshop and Conference [ASME] Kansas City, MO (ASME)

16-20 DIAGNOSTICS - 85 [Technical Univ. Poznan / Polish Academy Sciences] Leszno, Poland (Diagnostics -85, Prof. C. Cempel, Tech. Univ. Poznan, Piotrowo 3, P.O. Box 5, 60-695 Poznan, Poland)

17-19 Mathematics in Signal Processing, Bath, UK (Institute of Mathematics, Maitland House, Warrior Square, Southend-on-Sea, Essex SS1 2JY, UK)

18-20 INTER-NOISE '85 [Intl. Inst. Noise Control Engrg.] Munich, Fed. Rep. Germany (E. Zwicker, Institut f. Elektroakustik, TU Munchen, Arcisstr. 21, 8000 Munchen 2, Fed. Rep. Germany)

23-25 International Congress on Acoustic Intensity, Senlis, France (M. Bockoff, CETIM, B.P. 67, 60304 Senlis, France)

24-27 Conference on Noise Control '85, Krakow, Poland (Institute of Mechanics and Vibroacoustics AGH, ul. Mickiewicza 30, 30-059 Krakow, Poland)

OCTOBER

2-4 International Acoustics Symposium, Pretoria, South Africa (Symposium Secretariat IRS, CSIR, P.O. Box 395, Pretoria 0001, South Africa)

6-8 Diesel and Gas Engine Power Technical Conference [ASME] West Middlesex, PA (ASME)

8-10 Lubrication Conference [ASLE/-ASME] Atlanta, GA (ASLE/ASME)

8-11 Stapp Car Crash Conference [SAE] Arlington, VA (SAE)

14-17 Aerospace Congress and Exposition [SAE] Los Angeles, CA (SAE)

20-24 Power Generation Conference [ASME] Milwaukee, WI (ASME)

22-24 14th Turbomachinery Symposium [Turbomachinery Labs.] Houston, TX (Dara Childs, Turbomachinery Labs., Dept. of Mech. Engrg., Texas A&M Univ., College Station, TX 77843)

22-24 56th Shock and Vibration Symposium [Shock and Vibration Information Ctr., Washington, D.C.] Monterey, CA (Dr. J. Gordan Showalter, Acting Director, SVIC, Naval Res. Lab., Code 5804, Washington, D.C. 20375-5000 - (202) 767-2220)

NOVEMBER

4-8 Acoustical Society of America, Fall Meeting [ASA] Nashville, TN (ASA)

11-14 Truck and Bus Meeting and Exposition [SAE] South Bend, IN (SAE)

17-22 American Society of Mechanical Engineers, Winter Annual Meeting [ASME] Miami Beach, FL (ASME)

24-26 Australian Acoustical Society Annual Conference, Leura, Australia (A. Lawrence, Graduate School, University of N.S.W., Box 1, Kensington, N.S.W. 2033, Australia)

DECEMBER

11-13 Western Design Engineering Show [ASME] Anaheim, CA (ASME)

1986

JANUARY

28-30 Reliability and Maintainability Symposium [ASME] Las Vegas, NV (ASME)

MARCH

5-7 Vibration Damping Workshop II [Flight Dynamics Laboratory of the Air Force Wright Aeronautical Labs.] Las Vegas, NV (Mrs. Melissa Arrajj, Administrative Chairman, Martin Marietta Denver Aerospace, P.O. Box 179, Mail Stop M0486, Denver, CO 80201 - (303) 977-8721)

24-27 Design Engineering Conference and Show [ASME] Chicago, IL (ASME)

APRIL

8-11 International Conference on Acoustics, Speech, and Signal Processing [Acoustical Society of Japan, IEEE ASSP Society, and Institute of Electronics and Communication Engineers of Japan] Tokyo, Japan (Hiroya Fujisaki, EE Department, Faculty of Engineering, University of Tokyo, Bunkyo-ku, Tokyo 113, Japan)

13-16 American Power Conference [ASME] Chicago, IL (ASME)

29-1 9th International Symposium on Ballistics [Royal Armament Research and Development Establishment] RMCS, Shrivenham, Wiltshire, UK (Mr. N. Griffiths, OBE, Head/XT Group, RARDE, Fort Halstead, Sevenoaks, Kent TN14 7BP, England)

MAY

12-16 Acoustical Society of America, Spring Meeting [ASA] Cleveland, OH (ASA Hqs.)

JUNE

3-6 Symposium and Exhibit on Noise Control [Hungarian Optical, Acoustical, and Cinematographic Society; National Environmental Protection Authority of Hungary] Szeged, Hungary (Mrs. Ildiko Baba, OPAKFI, Anker koz 1, 1061 Budapest, Hungary)

4-6 Machinery Vibration Monitoring and Analysis Meeting [Vibration Institute] Las Vegas, NV (Dr. Ronald L. Eshleman, Director, The Vibration Institute, 101 W. 55th St., Suite 206, Clarendon Hills, IL 60514 - (312) 654-2254)

JULY

20-24 International Computers in Engineering Conference and Exhibition [ASME] Chicago, IL (ASME)

21-23 INTER-NOISE 86 [Institute of Noise Control Engineering] Cambridge, MA (Professor Richard H. Lyon, Chairman, INTER-NOISE 86, INTER-NOISE 86 Secretariat, MIT Special Events Office, Room 7-111, Cambridge, MA 02139)

24-31 12th International Congress on Acoustics, Toronto, Canada (12th ICA Secretariat, P.O. Box 123, Station Q, Toronto, Ontario, Canada M4T 2L7)

SEPTEMBER

14-17 International Conference on Rotordynamics [IFToMM and Japan Society of Mechanical Engineers] Tokyo, Japan (Japan Society of Mechanical Engineers, Sanshin Hokusei Bldg., 4-9, Yoyogi 2-chome, Shibuyak-ku, Tokyo, Japan)

OCTOBER

5-8 Design Automation Conference [ASME] Columbus, OH (ASME)

5-8 Mechanisms Conference [ASME] Columbus, OH (ASME)

19-23 Power Generation Conference [ASME] Portland, OR (ASME)

20-22 Lubrication Conference [ASME] Pittsburgh, PA (ASME)

NOVEMBER

30-5 American Society of Mechanical Engineers, Winter Annual Meeting [ASME] San Francisco, CA (ASME)

CALENDAR ACRONYM DEFINITIONS AND ADDRESSES OF SOCIETY HEADQUARTERS

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

AIAA American Institute of Aeronautics and Astronautics
1633 Broadway
New York, NY 10019

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

ASCE American Society of Civil Engineers
United Engineering Center
345 E. 47th St.
New York, NY 10017

ASLE American Society of Lubrication Engineers
838 Busse Highway
Park Ridge, IL 60068

ASME American Society of Mechanical Engineers
United Engineering Center
345 E. 47th St.
New York, NY 10017

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

ICF International Congress on Fracture
Tohoku University
Sendai, Japan

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

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

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

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

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

ISA Instrument Society of America
67 Alexander Dr.
Research Triangle Pk., NC 27709

SAE Society of Automotive Engineers
400 Commonwealth Dr.
Warrendale, PA 15096

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

SESA Society for Experimental Mechanics (formerly Society for Experimental Stress Analysis)
14 Fairfield Dr.
Brookfield Center, CT 06805

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

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

SVIC Shock and Vibration Information Center
Naval Research Laboratory
Code 5804
Washington, D.C. 20375-5000

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