AD-A112 602 NAVAL RESEARCH LAB WASHINGTON DC SHOCK AND VIBRATION--ETC F/G 20/11
THE SHOCK AND VIBRATION DIGEST, VOLUME 4, NUMBER 5,(U)
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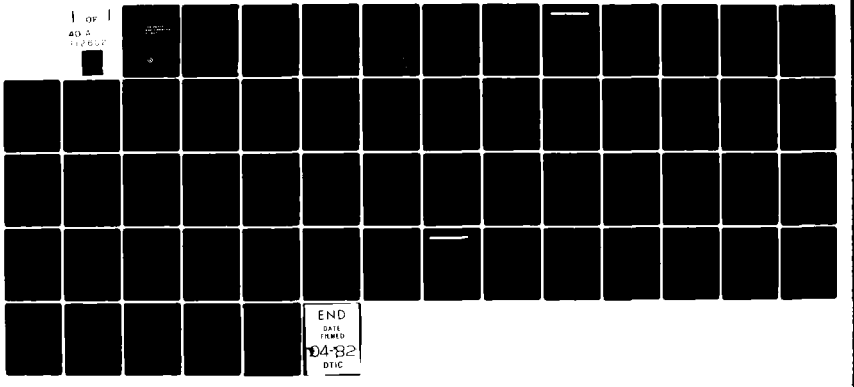

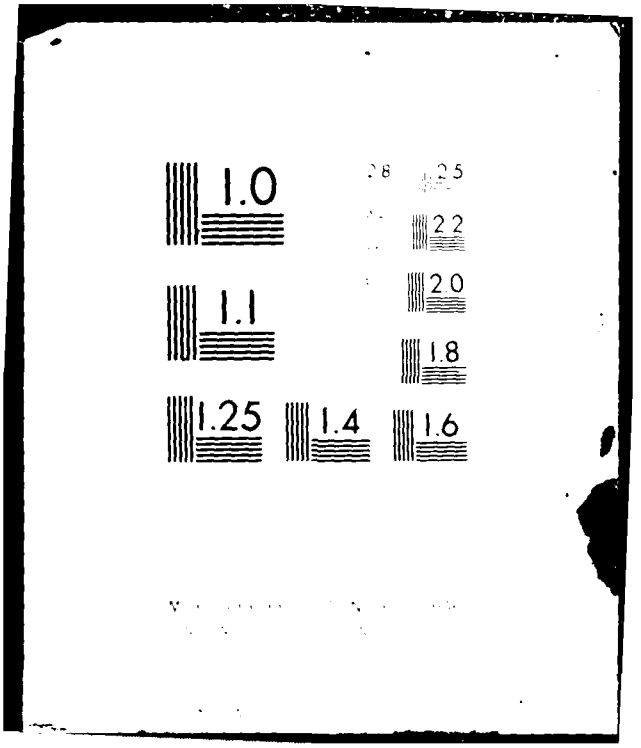
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VOLUME 4, NO. 5
MAY 1972

THE SHOCK AND VIBRATION DIGEST

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THE SHOCK AND VIBRATION DIGEST

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STAFF

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The Shock and Vibration Digest is a monthly publication of the Shock and Vibration Information Center. It carries current abstracts of interest to the shock and vibration community, book reviews, feature articles and news items. News items and articles to be considered for publication should be submitted to:

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This periodical is for sale on subscription at an annual rate of $25.00. Subscriptions are only accepted for the calendar year, beginning with the January issue. Back issues are available at the following rates: Volume 1 (1969) $5.00; Volume 2 (1970) $7.50; and Volume 3 (1971) $10.00. Orders may be forwarded at any time, in any form, to SVIC, Code 6020, Naval Research Laboratory, Washington, D. C. 20390. Issuance of this periodical is approved in accordance with the Department of the Navy Publications and Printing Regulations, NAVEXOS P-35.

EDITORS RATTLE SPACE

SYSTEM MODELING

The task of modeling a system to analyze or test it for dynamic response to environmental disturbances is one of the most important functions performed in early-stage shock and vibration activities. However, the modeling task is usually unrecognized and therefore submerged in a maze of other activities such as instrumentation and mathematics.

Modeling is the step that translates a problem from its physical reality to the abstraction of analysis or experimentation. It is, I propose, one of the few creative processes in engineering and this is probably why so little is explicitly written about it in the literature. In the case of the analyst, he seals his fate for success or failure in the simulation of the physical world at this early stage in the problem development. The bad model may result in an elegant answer to the wrong problem. All the good mathematics or experimental equipment will not overcome the initially bad model.

In examining the shock and vibration area, the fundamental phenomena that govern the dynamic behavior of a system are often expressed as discrete or distributed mass, stiffness and damping constants. Their magnitudes and locations must be appropriately apportioned to describe the system to the requirements of the analysis. The question of linearity is pertinent because important response phenomena may not be predicted by a linearized model. The relative stiffness and absolute mass and damping values determine the validity of the model. A particularly troublesome factor in the modeling is that the measure of difficulty of the mathematics in solving for the modeled system response must be traded off against the detail of the problem solution. In other words it is illogical to finely model a simple system and use cumbersome mathematics to determine detailed response when only gross results are required. Therefore, it is imperative that the engineer know what he wants and what tools are available to accomplish the analysis, at the time of careful consideration of the model construction.

More often than not experimental models are used for verification of system response and characterization of system phenomena. Physical characterization is largely routine testing on models that yield data relatable to analysis. In this case, size effects and sometimes loading rates are important in the design of the test specimens used to obtain the data. The more important experimental area to the average shock and vibration engineer is the system response verification wherein analytical simulations are validated. Full-scale testing -- not always realizable because of economics -- is desirable. Subscale testing involves consideration of material, size, and loading effects in the design of the model. Scaling is an area in itself, and again, as in analysis, the problem of detail enters the picture. If gross verification is required, finely constructed, elaborately instrumented models are unjustified and wasteful; if local vibration response of the system is being checked, gross instrumentation will not suffice.

The process of modeling, often unconsciously performed and improperly implemented, is an important function in the engineering analysis of physical systems. Basic textbooks are written in a phenomena or classic problem oriented manner usually no mention is made of the judgement involved in application of this material to physical problems. Early in his career, the student is unguided in regard to this aspect of problem solution; he is neglectfully left to grope in the dark for several years, after which he may or may not become a good engineer. It is clear to me that realistic modeling is one of the abilities that the good engineer possesses. Then why is there no emphasis on it in schools, fundamental texts, or the literature?

R. L. E.

JUNE

HUMAN ACOUSTICS
Place: Cleveland, Ohio
Dates: June 5-8
Objective: Understanding and practice will be provided in (a) acoustical measurements, (b) procedures for calibrating hearing aids and air and bone conduction audiometers, and (c) procedures for Walsh-Healy noise exposure measurements.

Contact: Director of Communications, B&K Instruments, Inc., 5111 West 164th St., Cleveland, Ohio 44142

ACOUSTICAL MATERIALS AND STRUCTURES: DESIGN, TESTING AND APPLICATIONS
Place: Cleveland, Ohio
Dates: June 5-8
Objective: The measurement of transmission loss, sound absorption, and vibration damping of materials and structures in laboratory and field situations will be studied.

Contact: Director of Communications, B&K Instruments, Inc., 5111 West 164th St., Cleveland, Ohio 44142

AIRCRAFT NOISE, THEORY AND APPLICATIONS
Place: Univ. Tenn. Space Inst.
Dates: June 5-9
Objective: The present knowledge on aircraft noise, its generation effects and control will be surveyed. Emphasis will be on the understanding of the physical nature of the noise sources based on available test and measurement data. The discussion will include: noise data from subsonic and supersonic aircraft and rockets, general aerodynamic noise theory, jet noise and compressor noise, methods of noise reduction, boundary-layer noise, atmosphere, propagation and absorption, psychological effects and operational methods.

Contact: Jules Bernard, Manager Short Course Programs, Univ. Tenn. Space Inst., Tullahoma, Tenn. 37388

INSTRUMENTATION FOR TECHNICAL ANALYSIS
Place: Univ. Mich.
Dates: June 5-16
Objective: An introductory lecture and laboratory course will be offered to give engineers the ability to use strain gages, precision potentiometers, differential transformers, light-sensing devices, and the analog computer to analyze mechanical systems.

Contact: Engr. Summer Conf., Chrysler Ctr., North Campus, Univ. Mich., Ann Arbor, Mich. 48105

MATRIX COMPUTATION
Place: Univ. Mich.
Dates: June 19-23
Objective: A careful study of current algorithms for the solution of matrix problems, especially algebraic eigenvalue problems will be presented. Both theoretical and computational aspects will be considered.

Contact: Engr. Summer Conf., Chrysler Ctr., North Campus, Univ. Mich., Ann Arbor, Mich. 48105

NUMERICAL METHODS, OPTIMIZATION TECHNIQUES, AND SIMULATION FOR ENGINEERS
Place: Univ. Mich.
Dates: June 19-30
Objective: The application of digital computers, numerical methods, and optimization techniques to chemical and mechanical engineering problems will be discussed including simulation of process equipment.

Contact: Engr. Summer. Conf., Chrysler Ctr., North Campus, Univ. Mich., Ann Arbor, Mich. 48105

NUMERICAL ANALYSIS AND DIGITAL COMPUTER METHODS IN ENGINEERING
Place: Univ. Calif. (L.A.)
Dates: June 19-30
Objective: This course will familiarize engineers working in the design and analysis engineering systems with numerical analysis and digital computer methods. Emphasis will be placed on the theoretical background of numerical applications to various fields of engineering and computer techniques in arriving at numerical solutions.

Contact: P.O. Box 24902, Continuing Ed. Engr. Sci., Univ. Extension, UCLA, Los Angeles, Calif.

ADVANCED ELECTRONIC INSTRUMENTATION FOR ENGINEERS
Place: Univ. Mich.
Dates: June 26-30
Objective: This course has been designed to provide the practicing engineer with a broad exposure to electronic instrumentation. This will materially enhance his capability to solve real-time instrumentation problems found in manufacturing plants today. The course will include lectures, demonstrations, and laboratory work.

Contact: Engr. Summer Conf., Chrysler Ctr., North Campus, Univ. Mich., Ann Arbor, Mich. 48105

JULY

DYNAMICS OF VEHICLES AND OCCUPANTS IN SEVERE MOTION
Place: Univ. Mich.
Dates: July 10-14
Objective: The use of the digital computer and computer graphic terminals in predicting motions and forces in vehicles and vehicle occupants under conditions of severe maneuvers and crash will be examined.
Contact: Engr. Summer Conf., Chrysler Ctr., North Campus, Univ. Mich., Ann Arbor, Mich. 48105

NOISE AND VIBRATION CONTROL
Place: Mass. Inst. Tech.
Dates: July 30-Aug. 5
Objective: This program is directed toward engineers who anticipate responsibility for the design of noise control or for the writing of noise specifications or legislation or who may be involved in the management of company-wide noise-control programs.
Contact: Director of the Summer Session, MIT, Cambridge, Mass. 02139

AUGUST

NOISE REDUCTION IN MECHANICAL SYSTEMS: FUNDAMENTALS AND ADVANCED CONSIDERATIONS
Place: Univ. Mich.
Dates: Aug. 7-18
Objective: Practicing engineers and engineering management will be offered an up-to-date, comprehensive, and practical working knowledge of noise reduction engineering and criteria for allowable noise.
Contact: Engr. Cummer Conf., Chrysler Ctr., North Campus, Univ. Mich., Ann Arbor, Mich. 48105

MOTOR VEHICLE PERFORMANCE -- MEASUREMENT AND PREDICTION
Place: Univ. Mich.
Dates: Aug. 16-18
Objective: The advances being made to make the measurement and assessment of motor vehicle performance (braking, cornering, roadholding, ride, etc.) a highly objective activity will be emphasized.
Contact: Engr. Summer Conf., Chrysler Ctr., North Campus, Univ. Mich., Ann Arbor, Mich. 48105

VIBRATION AND SHOCK TESTING
Place: Santa Barbara, Calif.
Dates: Aug. 21-25
Objective: The course is designed for quality assurance, evaluation and test personnel who are concerned with maximum reliability of missiles, aircraft, submarines, electronics, process industries, etc., where vibration and shock are hazardous environments. The seminar will concentrate on modern laboratory practice, equipment and techniques with a minimum of theory and mathematics.
Contact: Tustin Inst. Tech., Inc., 22 E. Los Olivos St., Santa Barbara, Calif. 93105

SEPTEMBER

NOISE: DESCRIPTION, ABATEMENT AND EFFECTS ON MAN
Place: Univ. Tenn.
Dates: Sept. 11-15
Objective: The course will begin at a basic level requiring no prior training in acoustics. The fundamentals of acoustic theory, the effects of noise on the ear and body, and noise criteria including the requirements of the Occupational Safety and Health Act will be covered.
Contact: Univ. Tenn., Dept. Conf. Inst., 1345 Circle Park, Knoxville, Tenn. 37916

FINITE ELEMENT ANALYSIS OF PLATES AND SHELLS
Place: Univ. Tenn.
Dates: Sept. 11-15
Objective: Finite element procedures; matrix assembly techniques, equation solving, etc. will be reviewed. This course is intended for graduate engineers and applied mathematicians with some knowledge of plates and shells.
Contact: Univ. Tenn., Dept. Conf. Inst., 1345 Circle Park, Knoxville, Tenn. 37916

ABSTRACT CATEGORIES FOR THE SHOCK AND VIBRATION DIGEST

ANALYSIS AND DESIGN

- Analogs and Analog Computation
- Analytical Methods
- Impedance Methods
- Integral Transforms
- Nonlinear Analysis
- Numerical Analysis
- Optimization Techniques
- Perturbation Methods
- Stability Analysis
- Statistical Methods
- Variational Methods
- Finite Element Modeling
- Modeling
- Computer Programs
- Digital Simulation
- Parameter Identification
- Design Information
- Design Techniques
- Standards and Specifications
- Surveys
- Tutorial

ENVIRONMENTS

- Acoustic
- Periodic
- Random
- Seismic
- Shock
- General Weapon
- Transportation

PHENOMENOLOGY

- Composite
- Damping
- Elastic
- Fluid
- Inelastic
- Soil
- Thermoelastic
- Viscoelastic

EXPERIMENTATION

- Data Reduction
- Diagnostics
- Equipment
- Experiment Design
- Facilities
- Instrumentation
- Procedures
- Scaling and Modeling
- Simulators
- Specifications
- Techniques

COMPONENTS

- Absorbers
- Beams, Strings, Rods
- Bearings
- Blades
- Columns
- Controls
- Ducts
- Frames
- Gears
- Isolators
- Linkages
- Mechanical
- Membranes
- Panels
- Pipes
- Plates and Shells
- Rings
- Springs
- Structural

SYSTEMS

- Absorber
- Acoustic Isolation
- Active Isolation
- Aircraft
- Artillery
- Bioengineering
- Bridges
- Building
- Cabinets
- Construction
- Earth
- Electrical
- Helicoptors
- Human
- Isolation
- Material Handling
- Mechanical
- Metal Working and Forming
- Off-Road Vehicles
- Optical
- Package
- Pressure Vessels
- Pumps, Turbines, Fans, Compressors
- Rail
- Reactors
- Reciprocating Machine
- Road
- Rotors
- Satellite
- Self-Excited
- Ship
- Spacecraft
- Structural
- Transmissions
- Turbomachinery
- Useful Application

DOCUMENT INFORMATION

Copies of articles abstracted are not available from the Shock and Vibration Information Center (except for those generated by SVIC). Inquiries should be directed to library resources, authors, or the original publishers. According to prefixed letters on document numbers, articles can be obtained from the following agencies:

AD, N — Defense Documentation Center, Document Library, Cameron Station, Alexandria, Va. 22314

ASME - American Society of Mechanical Engineers, 345 E. 47th St., New York, N.Y. 10017

NASA - National Aeronautics and Space Administration, Scientific and Technical Information Division, Washington, D.C. 20546

NSA - Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 (or NTIS)

PB - National Technical Information Service, Dept. Commerce, Springfield, Va. 22151

SAE - Society of Automotive Engineers, 2 Pennsylvania Plaza, New York, N.Y. 10001

Patent descriptions should be requested from the U.S. Patent Office, Washington, D.C. 20231. Doctoral theses are available from University Microfilms (UM), 313 No. Fir St., Ann Arbor, Mich.

Addresses following the authors' names in the abstracts refer only to the first author listed.

ANALYSIS AND DESIGN

ANALYTICAL METHODS

(Also see No. 891)

72—766

DYNAMIC BEHAVIOR OF LAMINATED COMPOSITE CYLINDRICAL SHELLS UNDER INITIAL STRESSES
Abhat, O.C.B. (Southern Methodist Univ.)
(1971) 113 pp

Key Words: cylindrical shells, dynamic response, free vibrations, laminates

Analytical methods for the treatment of the free vibrations of multilayered, anisotropic, circular cylindrical shells subjected to initial stresses with various boundary conditions are discussed. A method to solve the uncoupled differential equations of motion for the problems of vibrations of shells and the elastic stability of shells is presented. The results are compared with experimental or theoretical results of other authors for relatively simple problems. A detailed investigation is included of the dynamic behavior of laminated shells under radial pressures with or without axial loads at the ends. The effects of wall thicknesses, lengths, boundary conditions, and loadings on the dynamic response of the shell are discussed. The ratio of applied load to the critical load of a shell is found to be an important factor in determining the effects of initial stresses on the natural frequencies of the shell. It is observed that the initial stresses can have a significant effect on the natural frequencies of a vibrating shell.
UM 72-6349

72—767

OPTIMAL GRADIENT MINIMIZATION SCHEME FOR FINITE ELEMENT EIGENPROBLEMS
Fried, I. (Dept. of Math., Boston Univ., Boston, Mass.)
J. Sound and Vib. 20(3), 333-342 (Feb. 8, 1972) 16 refs

Key Words: eigenvalue problems, finite element techniques

A gradient minimization technique is developed for the solution of the general algebraic eigenproblem $Kx = \lambda Mx$ arising from the application of the finite element method. The essence of the technique consists of simultaneous linear and directional searches so as to obtain the highest rate of convergence. The effect of round-off errors on the obtainable accuracy in the eigenvalues and eigenvectors is established as a function of the properties of K and M. An a posteriori error estimate and a practical termination criterion are also given.

NONLINEAR ANALYSIS

(Also see Nos. 770, 825)

72—768

ON SETTING UP A TRANSIENT PROCESS IN PIECEWISE LINEAR SYSTEMS
Likhovid, P.I. (The Inst. of Hydromechanics AS UkrSSR)
Soviet Applied Mechanics 3(11), 65-71 (Nov. 1967) (Transl. of Prikladnaya Mekhanika 3(11), 102-109 (1967) by Consultants Bureau, New York) 9 refs

Key Words: linear systems, transient response

The problem of determining a transient process in nonlinear systems with many degrees of freedom is considered. It is assumed that the nonlinear restoring force has a characteristic consisting of straight line segments. Unified systems of differential equations, characterizing the motion on each of the segments, are set up by introducing two parameters. A method is proposed for solving these equations in terms of elementary functions, not requiring additional determination of the arbitrary constants. The solutions are set up over the segments with the use of the compatibility conditions on the boundaries of these segments. An example of a transient process in a three-mass system is given.

72—769

THE EFFECT OF RANDOM STEP CHANGES OF SYSTEM PARAMETERS ON THE STABILITY OF STEADY VIBRATION OF NONLINEAR SYSTEMS
Tondl, A. (Staatliches Forschungs-institut f. Maschinenbau, Běchovice bei Prag, ČSSR)
Ingenieur-Archiv 41 (1), 61-72 (1971) 6 refs

Key Words: nonlinear systems, periodic response, stability

A method is proposed for analyzing the effect of random step changes of system parameters on the stability of steady solution of a nonlinear system in case this steady solution is not the only one. The method is based on the assumption that the time between successive step changes is comparatively long against the period of steady vibration so that transients become stabilities after each parameter change. The parameter is free to vary on a finite interval of values.

NUMERICAL ANALYSIS

(Also see No. 772)

STABILITY ANALYSIS

(Also see Nos. 785, 841, 853, 886)

72—770

DYNAMIC STABILITY OF LINEAR AND NONLINEAR STOCHASTIC SYSTEMS
Stoltz, R.A. (Univ. Pennsylvania)
(1971) 322 pp

Key Words: dynamic stability, linear systems, nonlinear systems, stochastic processes

This dissertation deals with the mean-square stability of linear and nonlinear dynamic systems subjected to stochastic parametric excitations, and having physical system parameters which may be characterized as random variables. The fundamental method of analysis utilized is an extension of the direct method of Lyapunov to stochastic systems. The concept of a stability bound "confidence level" is introduced in the analysis of linear systems having randomly varying physical system parameters. A radially loaded, circular cylindrical shell with a nonlinear strain-displacement relationship is investigated in order to determine the quantitative influence of the system nonlinearity on the regions of mean-square stability.
UM 72-6239

72—771

DYNAMIC STABILITY OF A CYLINDRICAL SHELL IN AN ACOUSTIC MEDIUM
Deng, D.Z. (The Ohio State Univ.) (1971)
84 pp

Key Words: cylindrical shells, dynamic stability, environmental effects, forced vibrations

The effect of an acoustical medium on the dynamic stability of forced vibrations of a cylindrical shell is studied. Two solutions are developed: (1) taking into account the coupling effect of extension and bending of the shell; and (2) neglecting the extension of the shell. The author studied the response, taking into consideration the kinematic nonlinearities of the shell after it is parametrically excited. The results show that instability regions are shifted because of the "added mass" and the influence of damping is minor. The relative damping for the breathing mode is so large that the forced resonance does not exist practically.
UM 72-4466

72—772

A STUDY OF SUBHARMONIC RESPONSE IN NONLINEAR SYSTEM MODELS
Moseley, N.R. (Stanford Univ.) (1971)
115 pp

Key Words: mathematical models, nonlinear systems, periodic excitation, subharmonic oscillation

This report investigates the system model $G(u,\dot{u},\ldots,\overset{n}{u},t) = F(t)$, where $F(t)$ is a periodic excitation. Using an approximate solution of the form

$$\tilde{u}(t) = \sum_{R=o}^{UH} \left[U_c(R) \cos R\,\omega_o t + U_s(R) \sin R\,\omega_o t \right],$$

analytical theorems and computer results are obtained that yield information into the nature of the existence and nonexistence of subharmonic components in the response. The stability of the system is determined using Floquet theory. Two computer programs are employed: STABILITY which determines stability by direct integration; and LOCAL STAB which determines stability by semiexhaustive comparison of the MSE's associated with the variational equation. Finally, several specific systems are investigated in order to demonstrate the usefulness and validity of the theorems and computer programs.
UM 72-5960

STATISTICAL METHODS

72—773

FILTERED POISSON PROCESS FOR RANDOM VIBRATION
Racicot, R.W. and Moses, F. (U.S. Army Watervliet Arsenal, Watervliet, N.Y.)
J. Engineering Mech. Div., ASCE, 98 (EM1), 159-176 (Feb. 1972) 26 refs

Key Words: failure probability, random excitation, safety factors

The probability of failure analysis of structures excited by randomly varying dynamic forces is considered. A solution is given for the random filtered Poisson process model which has often been proposed to characterize dynamic forces associated with superposition of pulses including random wind, earthquake and highway vehicle loadings. A numerical procedure using the familiar Fourier series technique is used for inverting the characteristic functions of a Poisson process. This gives univariate and bivariate probability density distributions and crossing rates for the time-varying stress or deflection of a single degree-of-freedom system excited by forces described by the Poisson process. A new method for finding first-passage probabilities is also employed which is applicable to both Gaussian and Poisson processes and has been verified by simulation. A specific application is given for wind loaded structures. Results are presented in the form of reliability data showing the safety factor needed to achieve a specified overall failure probability.

72—774

BEHAVIOR OF LINEAR OSCILLATION SYSTEMS WHICH ARE EXCITED BY STOCHASTIC IMPULSE TRAINS (PART 1)
Renger, A. (Deutsche Akad. d. Wissenschaften zu Berlin)
Maschinenbautechnik 20 (11), 538-542 (Dec. 1971) 11 refs

Key Words: dynamic response, linear systems, stochastic processes

The dynamic behavior of linear stable oscillation systems, which are excited by stochastic impulse trains of periodical nonsteady type is investigated. The time dependent dispersions of stochastic system movements of a general decouplable n-mass system and a special two-mass system are excited. The existence of resonance appearance is proved. (In German)

72—775

RANDOM VIBRATIONS OF ELASTIC STRUCTURAL SYSTEMS
Shyu, T.P. (Syracuse Univ.) (1971) 90 pp

Key Words: cylindrical shells, parametric response, random excitation, rectangular plates

The theory of the Markoff process and the associated Fokker-Planck equation are used to investigate the parametric vibration on a simply-supported rectangular plate and a simply-supported cylindrical shell axially and symmetrically subjected to various random excitations along one side of the edge of a plate and around both ends of a shell. Numerical solutions for some rectangular plates and cylindrical shells under in-plane or axially applied white noise spectra are illustrated. The comparisons between numerical solutions and approximate solutions are plotted in figures.
UM 72-6622

FINITE ELEMENT MODELING

(Also see Nos. 767, 836)

72—776

ANALYSIS OF NONLINEAR, DYNAMIC COUPLED THERMOVISCOELASTICITY PROBLEMS BY THE FINITE ELEMENT METHOD
Oden, J.T. and Armstrong, W.H. (Alabama Univ. Research Inst., Div. of Graduate Programs and Research, Huntsville, Alabama)
AFOSR-71-1078TR (June 1971) 40 pp

Key Words: finite element technique, numerical analysis, thermoviscoelasticity

The numerical solution of a class of nonlinear problems in transient, coupled, thermoviscoelasticity is investigated. Equations of motion and heat conduction are derived for finite elements of thermomechanically simple materials and these are adapted to special classes of thermorheologically simple materials. The analysis involves the solution of large systems of nonlinear integrodifferential equations in the nodal displacements and temperatures and their histories. As a representative example, the general equations are applied to the problem of transient response of a thick-walled hollow cylinder subjected to time-varying internal and external pressures, temperatures, and heat fluxes. The integration scheme used to solve

the nonlinear equations employs a linear acceleration assumption, representation of nonlinear integral terms by Simpson's rule, and the iterative solution of large systems of nonlinear algebraic equations at each reduced time step by the Newton-Raphson method. Various numerical results are given and are compared with the linearized, isothermal, and quasi-static solutions.
AD 725704

MODELING

(Also see Nos. 772, 776, 835, 836, 837, 842, 859, 870, 872, 882, 902)

72—777

MODAL MODELING TECHNIQUES FOR VEHICLE SHAKE ANALYSIS
Davis, J.C. (Chevrolet Motor Div., General Motors Corp.)
Soc. Automotive Engrs., Preprint #720045
11 pp, 5 refs

Key Words: building block approach, modal models, motor vehicles, simulation

The basic theory of modal modeling, including the concepts of mode shape scaling and residual compliances is explained. Some sample vehicle shake simulation studies are also discussed.

72—778

MATHEMATICAL MODELING OF DISCRETE NONCONSERVATIVE DYNAMIC SYSTEMS
Walker, J.A. (Dept. Mech. Engr. and Astronaut. Sci., Northwestern Univ., Evanston, Ill.)
Intl. J. Solids Structures 8 (2), 249-259 (Feb. 1972) 15 refs

Key Words: dynamic systems, mathematical modeling

Many studies have shown that arbitrarily small differences between two nonconservative dynamic systems can result in completely different stability characteristics of the two systems. This can be interpreted as implying that mathematical modeling is of questionable value in the analysis and design of physical nonconservative systems. Using basic results from Lyapunov stability theory the author proposes two rules for avoiding such infinite-sensitivity models for the mathematical modeling of discrete dynamic systems. Several general types of modeling error are considered, and these rules are shown to assure finite sensitivity models.

COMPUTER PROGRAMS

(Also see No. 847)

72—779

DYNAMIC RELAXATION ANALYSIS OF MULTIPLE SPAN SLABS
Cassell, A.C.; Hobbs, R.E.; Bridgett, M.S.; and Awotwi, P.A.K. (Imperial Col. Sci. and Tech., Great Britain)
The Struc. Engr. 49 (12), 549-559 (Dec. 1971) 21 refs

Key Words: bridges, computer programs, dynamic relaxation, elastic plates, slabs

The theoretical basis of a suite of computer programs for the analysis of bridge slabs is presented. The slabs are treated as thin elastic plates and solutions are obtained by dynamic relaxation. Orthotropic, variable thickness and constant thickness slabs are considered, of rectangular, skew and curved shapes. Comparisons with other theoretical and experimental results are given.

72—780

SKIN-STRINGER PANEL NORMAL MODE RESPONSE EXPERIMENTAL DATA AND FINITE ELEMENT COMPUTER PROGRAM -- DOCUMENTATION
Rudder, F.F., Jr.
Lockheed-Georgia Co., Marietta
NASA-CR-111988 (1971),
Suppl. to NASA-CR-1959, 194 pp

Key Words: acoustic excitation, experimental results, structural response

Detailed experimental data from all the specimens described in the report "Effects of Design Details on Structural Response to Acoustic Excitation", NASA-CR-1959, are discussed and presented in tabular form.
N72-12905

72—781

SPREAD -- A COMPUTER PROGRAM FOR DESIGNING FLAT SPRINGS
Wolberg, J.R. and Nickerson, E.H. (Dept. Mech. Engr., Technion-Israel Inst. Tech.)
Soc. Automotive Engrs., Preprint #720016, 5 pp, 2 refs

Key Words: computer programs, SPREAD (computer program), springs

SPREAD allows the user to perform complex stress and force analyses with little or no mathematical or computer experience. Extensive use

of the program reveals that the resulting springs are much less prone to redesign than springs designed in the classical manner. The designs are usually more efficient, and the resulting product is closer to optimum when the program is used. The total savings in time, money, and effort have often been dramatic.

DIGITAL SIMULATION

(Also see Nos. 779, 879, 881, 882)

PARAMETER IDENTIFICATION

(Also see No. 770)

DESIGN INFORMATION

72—782

EFFECT OF SHROUD GEOMETRY ON THE PRESSURE DISTRIBUTED AROUND A CIRCULAR CYLINDER
Zdravkovich, M.M. and Volk, J.R. (Dept. Mech. Engr., Univ. Salford, Salford M5 4WT, England)
J. Sound and Vib. 20(4), 451-455 (Feb. 22, 1972) 8 refs

Key Words: cylinders, shrouds, vibration control, vortex shedding

Results of an investigation of the distribution of the mean static pressure around a circular cylinder fitted with various shrouds, for the subcritical and transition Reynolds number range are presented. Those shrouds were chosen which suppress flow-induced vibrations. These seem to have a particular effect on the pressure distribution; namely, the flat part of the corresponding pressure coefficient curve vs the circumferential angle is reduced behind the cylinder.

DESIGN TECHNIQUES

(Also see No. 899)

72—783

A COMBINED EXPERIMENTAL AND ANALYTICAL PROCEDURE FOR IMPROVING AUTOMOTIVE SYSTEM DYNAMICS
Klosterman, A.L. (Struc. Dynamics Res. Corp.)
Soc. Automotive Engrs., Preprint #720093, 11 pp, 10 refs

Key Words: building block approach, dynamic analysis, dynamic simulation, motor vehicles, trucks

Powerful capabilities for use in the analysis of complex automotive systems have recently been developed. These capabilities bring newly developed electronic testing equipment together with powerful computational techniques to perform a total system dynamic design analysis. The analysis tool developed is called the "building block approach", whereby complex system behavior is defined by analyzing and combining the dynamic behavior of simpler components and subassemblies. The dynamic behavior of each component is obtained from a separate analytical investigation or from a specific type of experimental test procedure. Component data are then combined mathematically to predict dynamic behavior of the full system under the prescribed loading conditions. With the system simulation completed, design changes in any or all components can be evaluated. The effect of changes in any component on the operating behavior, vibration, noise, and stress can be ascertained. This paper describes the basic dynamic design analysis techniques which are available, and the automated testing methods and computer programs necessary to make the approach practical and successful. To demonstrate the application of this approach to automotive systems, the dynamic simulation of a heavy truck frame, cab, and cab mount system is described.

STANDARDS AND SPECIFICATIONS

(Also see Nos. 816, 856)

SURVEYS

(Also see No. 788)

72—784

SHOCK AND VIBRATION DATA *ANALYSIS STANDARD*
Bendat, J.S. (Amer. Natl. Standards Inst., New York, N.Y.)
S/V, Sound and Vib. 6(2), p 12 (Feb. 1972)

Key Words: standards

The standard, "Methods for Analysis and Presentation of Shock and Vibration Data", ANSI S2.10-1971, is now available. The standard is designed to acquaint the user with general principles for analysis and presentation of shock and vibration data, and to describe concisely several methods of reducing data to forms that can be subsequently applied. The standard includes references to technical literature for elucidation of mathematical literature and an outline to these details.

TUTORIAL

72—785

DYNAMICS AND STABILITY OF MECHANICAL SYSTEMS WITH FOLLOWER FORCES
Herrmann, G.
Stanford Univ., Palo Alto, Calif. NASA-CR-1782 (Nov. 1971) 240 pp

Key Words: follower forces, mechanical systems, stability

A monograph on problems of stability of equilibrium of mechanical systems with follower forces is presented. Concepts and criteria of stability are reviewed briefly, together with means of analytical specification of follower forces. Non-dissipative systems with two degrees of freedom are discussed, and destabilizing effects attributable to various types of dissipative forces both in discrete and continuous systems, are treated. The analyses are accompanied by some quantitative experiments and observations on demonstrational laboratory models.
N72-12907

ENVIRONMENTS

ACOUSTIC

(Also see Nos. 771, 780, 796, 806, 815, 822, 831, 844, 845, 855, 864, 865, 873, 878, 882, 896, 903, 904, 905)

72—786

A PRECISION HF NOISE POWER MEASUREMENT SYSTEM
Arthur, M.G. (Natl. Bur. Standards, Boulder, Colo.)
ISA Transactions 10(3), 264-268 (1971)
8 refs

Key Words: measuring instruments, noise measurement

A precision high-frequency noise power measurement system used at the National Bureau of Standards is described. It includes reference standard noise generators operating at approx 77 and 373°K and an instrument for comparing the noise power of a noise source against the reference standards. The comparison instrument is a sum-and-difference correlation radiometer. Both the standards and the comparison instrument operate at 3, 30, and 60 MHz, and can be used with noise sources having source impedances of 50 ohms, unbalanced. Measurement uncertainty is typically less than 1 percent for sources with noise temperatures from 75 to 30,000°K.

72—787

SONIC BOOM EXPOSURE EFFECTS -- GENERAL CONSIDERATIONS ON SONIC BOOM RESEARCH
Balazard, J. (Direction des Recherches et Moyens d'Essais, Ministere d'Etat Charge de la Defense Nationale, Paris, France)
J. Sound and Vib. 20(4), 499-503 (Feb. 22, 1972)

Key Words: sonic boom

How studies of sonic boom effects require research in different scientific disciplines and how the various research facilities used meet the experimental requirements are discussed. In addition, ways in which the experience acquired from studies on sonic boom effects might be extended to general considerations on effects studies of other agents in the environment is discussed.

72—788

A SURVEY OF NOISE LEVELS ON-BOARD *PLEASURE BOATS*
Campbell, R.A. (Vet. Admin. Hosp., Miami, Fla.)
S/V, Sound and Vib. 6(2), 28-29 (Feb. 1972), 5 refs

Key Words: motor boats, noise measurement

Noise levels on-board pleasure boats were surveyed. Under normal operating conditions the noise levels in the majority of power boats at and above cruising speeds are comparable to those measured in jet airliner cockpits. These levels are sufficient to render speech communication and radio monitoring virtually impossible and to produce danger of hearing loss with prolonged daily exposure.

72—789

SONIC BOOM EXPOSURE EFFECTS -- PART III: WORKSHOP PERSPECTIVE
Richards, E.J. and Rylander, R. (Loughborough Univ., Loughborough, England)
J. Sound and Vib. 20(4), 541-544 (Feb. 22, 1972)

Key Words: human factors engineering, noise tolerance, sonic boom

A workshop to examine how humans are affected by exposure to sonic booms is described.

72—790

NUMERICAL STUDY OF SOUND REFRACTION BY A JET FLOW -- PART II: WAVE ACOUSTICS

Schubert, L.K. (Univ. Toronto, Inst. for Aerosp. Studies, Toronto, Ontario, Canada)

J. Acoust. Soc. Am. 51(2), 447-463 (Feb. 1972) 36 refs

Key Words: finite difference technique, sound waves, wave propagation

The equations appropriate to the propagation of sound in a realistic jet flow have been solved by finite difference methods for the case of a sinusoidal point source on the axis of a subsonic jet. Each numerical solution provides detailed phase and amplitude information throughout the sound field. At the high frequency limit the finite difference results agree with ray-tracing results. Also, the computed farfield directivity patterns generally agree with available experimental data and lend further support to the view that the downstream "valley" in jet noise is attributable to refraction rather than to the inherent directivity of the sound generated within the region of turbulence. Unexpected findings are that the flow beyond 100 nozzle diameters continues to deepen the refraction valley significantly, and that the sound pressure level reduction at a fixed point on the axis at first increases as the source is moved downstream from the nozzle. For the application of the refraction results to the computation of jet noise directivity, it is found that the distortion of the constant phase surfaces can be neglected except at high frequencies.

72—791

NUMERICAL STUDY OF SOUND REFRACTION BY A JET FLOW -- PART I: RAY ACOUSTICS

Schubert, L.K. (Univ. Toronto, Inst. for Aerosp. Studies, Toronto, Ontario, Canada)

J. Acoust. Soc. Am. 51(2), 439-446 (Feb. 1972) 19 refs

Key Words: aircraft noise, sound rays

Sound rays are traced numerically from a point source on the axis of a jet flow with realistically chosen velocity profiles. The directivity patterns computed from the ray paths have no cone of absolute silence, in contrast with analytic results for nonspreading jets. A related observation is that the surfaces of constant phase are utlimately spherical. Nevertheless, the computed axial refraction valleys are much deeper than those observed in jet noise studies. The difference is caused by diffraction, which tends to offset refraction effects at all but the highest (ray-acoustic) frequencies.

72—792

TRANSIENT ACOUSTIC SCATTERING BY A FREE (PRESSURE RELEASE) SPHERE

Shaw, R.P. and English, J.A. (Dept. Engr. Sci., State Univ. N.Y., Buffalo, N.Y.)

J. Sound and Vib. 20(3), 321-331 (Feb. 8, 1972) 13 refs

Key Words: acoustic excitation, spherical cavities, transient response, wave diffraction

The transient scattering of plane and spherical waves by a pressure release spherical surface is studied by means of a Kirchhoff integral equation formulation. Numerical values are obtained for the normal velocities on the scattering surface and are compared to those obtained by modal solutions. An improvement in early time response is seen.

72—793

FEDERAL AVIATION ADMINISTRATION AIRCRAFT NOISE ABATEMENT PROGRAM, FY 1971-1972

Sperry, W.C. (Fed. Aviation Admin., Office Noise Abatement, Washington, D.C.)

Paper presented at the Seminar on Noise Pollution and the Urban Environment, Madison, Wis., (Nov. 16-17, 1970), 54 pp

Key Words: aircraft noise, noise reduction

The FAA aircraft noise abatement program is reviewed. The goals of the program and the objectives of research for noise evaluation and control are given. Itemized operational procedures for noise abatement include: takeoff procedures, approach procedures, takeoff and approach routes, cruise procedures and routes, and limiting operations. Bibliographies of FAA aircraft noise reports and environmental papers are included along with lists of FAA noise pollution and exhaust emission projects.
N72-11958

72—794

LONGITUDINAL MODE ACOUSTIC LOSSES IN SHORT NOZZLES

Zinn, B.T.
Naval Weapons Ctr., China Lake, Calif.

NWC-TP-5206 (Aug. 1971) 24 pp

Key Words: acoustic damping, longitudinal response

Acoustic damping by a "short nozzle" is discussed. The concept is not original but is written in such a manner that it can be read by an engineer without the need to resort to the plethora of more sophisticated analyses available in the literature.
AD 728754

PERIODIC
(Also see Nos. 884, 895, 906)

RANDOM
(Also see Nos. 830, 868)

SEISMIC
(Also see Nos. 864, 875, 899)

SHOCK
(Also see Nos. 805, 843, 885)

72—795
ANIMAL RESPONSE TO SONIC BOOMS
Bell, W.B. (Virginia Polytechnic Inst. and State Univ., Blacksburg, Va. 24060)
J. Acoust. Soc. Am. 51(2), 758-765 (Feb. 1972) 31 refs

Key Words: animal response, sonic boom

This paper reviews reports and studies of animal response to sonic booms. Individual domestic or pet animals may react to a boom, a simple startle response being the most common reaction. However, specific reactions differ according to the species involved, whether the animal is alone, and perhaps whether there has been previous exposure. The effect of boom on eggs being hatched under commercial conditions was examined in detail. A mass hatching failure of the Dry Tortugas Sooty Tern occurred in 1969, and the circumstantial evidence suggests that physical damage to the eggs by severe sonic booms caused by low-level supersonic flights was responsible.

PHENOMENOLOGY

COMPOSITE
(Also see Nos. 766, 828)

DAMPING
(Also see Nos. 814, 821, 823, 849)

FLUID
(Also see Nos. 790, 791, 823, 833, 847, 898)

INELASTIC
(Also see No. 900)

72—796
THE ACOUSTICS OF TURBULENCE NEAR SOUND-ABSORBENT LINERS
Williams, J.E.F. (Dept. Math., Imperial Col., London, England)
J. Fluid Mech. 51(Pt. 4), 737-749 (Feb. 22, 1972) 13 refs

Key Words: acoustic linings, noise generation, turbulence

Acoustic liners are often perforated screens backed by sound-absorbent material. Turbulence can interact with these screens to generate additional sound. The dynamics of the generation process is examined in this paper, where the liner is modeled as an infinite rigid plane boundary with a homogeneous array of circular orifices or rigid pistons.

SOIL
(Also see No. 802)

72—797
SOIL PARAMETERS REQUIRED TO SIMULATE THE DYNAMIC LATERAL RESPONSE OF MODEL PILES IN STIFF CLAY
Brown, R.A. and Coyle, H.M.
Texas A and M Univ., Col. Station, Coastal and Ocean Engr. Div.
TAMU-SG-71-218 (Aug. 1971) 125 pp

Key Words: dynamic response, mathematical models, pile structures, simulation

The dynamic response of model piles is predicted using an analytical solution. The nonlinear soil load displacement characteristics were modeled with a modified Kelvin-Voigt rheological model. The field data and the predicted response of the piles are compared and correlated. Using the correlation and laboratory triaxial tests on the soil, the soil parameters required to achieve satisfactory agreement between field and predicted response of the pile are evaluated. Results of this study indicate that the two soil parameters, the soil spring and soil quake, which represent the nonlinear characteristics of the

soil are functions of the pile diameter. Together these two soil parameters greatly influence the magnitude and distribution of the bending moments with depth. The amount of soil damping is a function of the pile velocity of frequency of vibration and is significant for the velocities and frequencies encountered in this study.
COM-71-01101

THERMOELASTIC
(Also see Nos. 776, 821)

VISCOELASTIC
(Also see Nos. 776, 849)

EXPERIMENTATION

DATA REDUCTION

72—798
SOME SOURCES OF ERROR IN COMMUNITY NOISE MEASUREMENT
Schultz, T.J. (Bolt Beranek and Newman, Inc., Cambridge, Mass.)
S/V, Sound and Vib. 6(2), 18-27 *(Feb. 1972) 28 refs*

Key Words: error analysis, noise measurement, statistical analysis

Making full-fledged statistical analyses of the fluctuating levels of community noise can be a time-consuming and expensive procedure. In order to economize on time and money, various short cut methods are proposed. This article considers some of the errors that may result from several such methods.

72—799
AN APPROACH TO TIME-VARYING SPECTRAL ANALYSIS
Shih-Chi, L. (Bell Telephone Lab., Whippany, N.J.)
J. Engineering Mech. Div., ASCE, 98(EM1), 243-253 (Feb. 1972) 8 refs

Key Words: shock response, spectrum analysis, vibration response

An approach to the time-varying spectral analysis for shock and vibration data are presented. The approach follows and extends Page's concept of instantaneous power spectra. Various input-output relations for simple linear systems are derived. The error involved in the evaluation of the time-varying spectra of the response and conditions that reduce it are discussed in some detail. Numerical spectra and energy distribution functions of four shock functions are provided and discussed.

DIAGNOSTICS
(Also see Nos. 801, 871)

72—800
MEASUREMENT AND ANALYSIS OF WHEEL-RAIL FORCES
Peterson, L.A.; Freeman, W.H.; and Wandrisco, J.M. (Bessemer and Lake Erie Railroad Co., Pittsburgh, Pa.)
ASME Paper No. 71-WA/RT-4

Key Words: interaction: rail-wheel, measurement techniques

A method used to continuously measure, record, and analyze the lateral and vertical forces between wheels and rails of several types of railroad freight cars under a variety of car and track conditions is described. The method, using analog-to-digital conversion and computerized data handling, produces results relating to a multitude of car and track behavior subject areas. Especially important is the definition, development, and verification of performance "signatures" which are generated in a unique and characteristic manner by each car when negotiating a given curve.

72—801
NOISE SOURCE DEFINITION -- EXTERIOR PASSENGER VEHICLE NOISE
Vargovick, R.J. (Ford Motor Co.)
Soc. Automotive Engrs, Preprint #720274, 6 pp 10 refs

Key Words: automobiles, noise generation, noise measurement

A program to determine the contribution of each car noise source (engine/exhaust, fan, and tire/roadway) to the total exterior drive-by noise of a passenger vehicle is described. A 1970 high and low power sedan and a 1970 high and low power sporty compact are utilized in the test sequence. Octave-band and dBA sound levels are recorded with the microphone positioned 25 ft away for various modes of vehicle operation at cruise and wide open throttle conditions.

Results indicate for cruise (road-load) conditions that: (1) Except for high performance vehicles, the predominant source of exterior vehicle noise above 500 Hz is tire/roadway noise; (2) the major sources of exterior noise below 500 Hz are both engine/exhaust noise and tire/roadway noise; and (3) fan noise is an insignificant contributor to passenger vehicle exterior noise at present noise levels.

EQUIPMENT

(Also see Nos. 786, 850)

72—802

DEVELOPMENT OF A DYNAMIC HIGH-PRESSURE TRIAXIAL TEST DEVICE
Ehrgott, J.Q. and Sloan, R.C.
Army Engr. Waterways Experiment Station, Vicksburg, Miss., AEWES-TR-S-71-15, (Nov. 1971) 70 pp

Key Words: dynamic testing, soils, test equipment

A dynamic high-pressure triaxial test device developed for use in formulating soil and rock constitutive relations used in blast-induced ground shock calculations is presented. The device is capable of imposing controlled impulsive-type confining pressures up to 15 kips sq in. on specimens up to 3-in. diam; peak pressures can be achieved in as little time as 3 msec, and all pressure can be removed in 20 msec. These dynamic confining pressures can be time synchronized with similar dynamic axial load pulses with magnitudes up to 100 kips.
AD 734312

72—803

THE MEASUREMENT OF THE STATIC AND DYNAMIC ONE-DIMENSIONAL BEHAVIOR OF LARGE GRANULAR MATERIALS
Emerson, M.W.C. (Univ. of Illinois at Urbana-Champaign)
(1971) 317 pp

Key Words: dynamic testing, sand, soils

Measurements made of the one-dimensional stress-strain behavior of large particulate materials are reported. The particles vary in size from fine sand to coarse gravel with an average maximum diameter of smaller than 3 in. The particle shape, composition, and gradation of the gravels vary. Tests conducted to observe the effects of saturation prior to and subsequent to loading are described. Static and dynamic one-dimensional compression tests conducted on samples of backfill taken from selected missile sites are discussed. A modification to the existing 4 ft diam, 1500 KIP capacity dynamic load generator to allow measurement of the dynamic and static constrained moduli of soils was designed, constructed and proof tested. The modification allows the testing in one-dimensional compression of a specimen 4 ft diam, 12 in. thick.
UM 72-6922

72—804

FREQUENCY CHARACTERISTICS OF A HYDRAULIC DRIVE WITH A RESTRICTOR
Gudilkin, Yu. I.
Russian Engineering J. 51 (4), 35-39 (1971) 3 refs

Key Words: amplitude data, vibrators (machinery)

Relationships are given for the determination of the amplitude of forced oscillations and the phase shift in the hydraulic drive (with restrictor) of a vibration rig with a large inertial load. The rig operates with large pressure drops in the hydraulic cylinder on the nonlinear section of the flow characteristic of a spool valve. The author describes the motion of an open-loop drive with a harmonic input action. The formulas for the determination of the frequency characteristics are deduced.

EXPERIMENT DESIGN

(Also see No. 883)

72—805

DATA RETRIEVAL BY ACCIDENT RECONSTRUCTION FOR SAFER VEHICLE DESIGN
Emori, R.I. and Baird, J.D. (Sch. Engr. and Appl. Sci., Univ. Calif., Los Angeles, Calif.)
Soc. Automotive Engrs., Preprint #720284, 7 pp, 11 refs

Key Words: collision research, human factors engineering, mathematical models

The effectiveness of safety design must be justified in terms of real automobile accidents with human occupants. Since it is far too dangerous to use human subjects in full-scale collision experiments, substitutes are usually studied, that is, experiments are performed with dummies and mathematical models. Full-scale collision

experiments with human occupants could be performed by reconstructing real automobile accidents accurately. To retrieve the most needed data for further improvements in safety design and to translate actual accidents as controlled experiments, an engineered method developed to reconstruct accidents is presented. It synthesizes previously validated analytical and experimental knowledge pertinent to automobile collision mechanics. The method was applied to an actual accident, indicating that the methodology is sound and accu. te.

FACILITIES

72—806
SOME EXPERIMENTAL AIRCRAFT ENGINE NOISE FACILITIES IN THE UNITED KINGDOM
Hargest, T.J. (Natl. Gas Turbine Estab., Pyestock, Farnborough, Hampshire, England)
J. Sound and Vib. 20(3), 359-380 (Feb. 8, 1972) 30 refs

Key Words: aerodynamic noise, test facilities

Development of aerodynamic noise theories has demanded greater sophistication of acoustic test facilities and measuring techniques. Experimental work at much reduced scale is usually necessary which entails further complexity. Finally the success of the engine designer must be demonstrated at full-scale with accurate flight trials. Problems of acoustic and aerodynamic similarity encountered at all stages are discussed.

INSTRUMENTATION
(Also see No. 874)

72—807
REAL-TIME SPECTRUM ANALYSIS IN VIBRATION TESTING
Anderson, J.J. (Federal Scientific Corp., New York, N.Y.)
ISA Transactions 10(3), 269-276 (1971) 6 refs

Key Words: frequency analyzers, vibration tests

A narrow-band real-time spectrum analyzer is described. This unique hybrid instrument uses a digital time-compression technique and recirculating memory to allow processing of 100 percent of the input signal. The time-compressed signal -- or corresponding frequency expanded spectrum -- is then analyzed by a sophisticated, analog swept-frequency technique at a rate 500 times faster than available in conventional frequency analyzers. This instrument is the latest generation of test equipment applicable to vibration evaluation. The narrow-band low-frequency real-time performance makes it particularly ideal for diagnosis and prognosis of vibrating machinery.

72—808
CALIBRATION OF SYSTEMS BY DYNAMIC RESPONSE ANALYSIS
Darsey, D.M. (Sandia Labs., Albuquerque, N. Mex.)
ISA Transactions 10(3), 250-263 (1971) 6 refs

Key Words: calibrating, computer programs, dynamic response, instrumentation

A technique of system calibration based on a computer-derived complex transfer function is presented. The theory of the method, a calibration program in FORTRAN, an analysis of errors, and some current applications are discussed.

PROCEDURES
(Also see Nos. 817, 868)

72—809
MEASUREMENT OF AUTOMOTIVE PASSBY NOISE
Soc. Automotive Engrs., Preprint #720275, 11 pp, 3 refs

Key Words: measurement techniques, motor vehicles, noise measurement

Procedures for measurement of noise emitted by various automotive vehicles developed and refined by various technical committees of the SAE are discussed. These procedures are used for evaluation of vehicles during development and also as the basis for noise regulations. Recent work on the parameters involved indicates that the site used, the vehicle operator, and the ambient weather conditions are all significant factors in the accuracy of test results. Revision of these procedures to minimize the variation in results attributable to variation in test parameters, and to become more representative of typical operating modes of the vehicle, is essential.

SCALING AND MODELING

(Also see Nos. 812, 828, 897)

SIMULATORS

(Also see Nos. 889, 890)

72—810

MAKING A ROAD SIMULATOR SIMULATE
Cripe, R.A. (Chevrolet Motor Div., General Motors Corp.)
Soc. Automotive Engrs., Preprint #720095, 12 pp, 8 refs

Key Words: road roughness, test facilities, vehicles, vibration response

A laboratory road simulator system is defined and various problems associated with using such a machine to test vehicles are discussed. Advantages and disadvantages of various methods for applying input forces to the vehicle are discussed. The development of a method for solving the problem of simulating the rolling tire vertical properties is presented. Vertical and fore-aft response correlation resulting from this tire simulation is shown and the types of problems the author has chosen to study with this test system are explained.

72—811

MOTION SIMULATION AND ITS APPLICATION TO RIDE DYNAMICS RESEARCH
Lins, W.F. and Dugoff, H. (U.S. Army Tank-Automotive Command)
Soc. Automotive Engrs., Preprint #720003, 8 pp, 10 refs

Key Words: human factors engineering, test facilities, vibration tolerance

Two motion simulators and their application to research in whole-body vibration are described. One is a four degree-of-freedom device capable of producing vertical, pitch, roll, and yaw motions. The other is a single degree-of-freedom device that produces motion in the horizontal direction. Both have been used to acquire information on whole-body and visual response to vibration. Frequency response plots of some of the acquired data are presented. Procedures for assessing the severity of human vibration responses in terms of absorbed power are described and discussed. Brief descriptions are presented of studies that made use of the equipment and methodology discussed. The first is a concept evaluation of a proposed vehicle for use on the lunar surface. The second is a hardware evaluation of two seating devices for use in a wheeled vehicle in a severe terrain environment.

72—812

MECHANICAL EXCITATION OF OFFSHORE TOWER MODEL
Rains, C.P. and Chakrabarti, S.K. (Marine Res. and Dev., Chicago Bridge and Iron Co., Plainfield, Ill.)
J. Waterways, Harbors and Coastal Engr. Div., ASCE 98 (WW1), 35-47 (Feb. 1972)
5 refs

Key Words: hydrodynamic excitation, offshore structures, test models

A large-scale model of a bottom-pivoted, surface-piercing, cylindrical oil-drilling platform built to obtain experimental data on hydrodynamic coefficients applicable to the structure is presented. The wave force on the structure is simulated by a mechanical device in still water. Thus, the number of variables to calculate the drag and added mass coefficients associated with the structure for use in conjunction with the Morison equation is reduced. For instance, water particle velocity and acceleration are eliminated from the equation. Test runs are made at different simulated sea conditions. Consistent drag and added mass coefficients are obtained using various data reduction techniques.

TECHNIQUES

(Also see Nos. 861, 869)

72—813

ADVANCED NONDESTRUCTIVE TESTING METHODS FOR BEARING INSPECTION
Barton, J.R.; Lankford, J., Jr.; and Hampton, P.L. (Southwest Res. Inst.)
Soc. Automotive Engrs., Preprint #720172, 16 pp, 22 refs

Key Words: ball bearings, nondestructive tests

The principles of the magnetic-perturbation method of flaw detection and the Barkhausen noise residual stress measurement method are briefly reviewed. It is suggested that they provide very powerful tools for assuring improved ball bearing performance. The methods are applied for the evaluation of ball bearing races. Typical experimental results are presented along with metallurgical sectioning correlation.

72—814

AN AUTOMATIC METHOD FOR IDENTIFICATION OF DYNAMIC PROPERTIES OF RUBBER
Goodson, R.E.; Hillberry, B.M.; and Paul, A.S. (Sch. Mech. Engr., Purdue Univ.)
Soc. Automotive Engrs., Preprint #720131, 7 pp, 8 refs

Key Words: dynamic properties, elastomers, material damping, rubber, testing techniques

A new method for determining the spring and damping constants for elastomer materials is presented. The method relies on three concepts: measurement of force and displacement or velocity across the test specimen; precise control of differential phase shift and sensitivity in transducers and electronics over the full operating frequency and amplitude range; and automatic optimal identification of K and C using analog hardware. The technique may be used in conjunction with either a resonant beam or electrohydraulic system, as demonstrated in the paper. Hardware implementing the concepts is described and calibration test results given. It is concluded that the system provides an automatic test procedure which has the potential to reduce errors and maintain consistent results for rubber properties, relatively independent of the test machines and operators.

72—815

ACOUSTICAL HOLOGRAPHY
Neeley, V.I. (Holosonics, Inc.)
Soc. Automotive Engrs., Preprint #720173, 8 pp, 5 refs

Key Words: acoustic holography, nondestructive tests

Acoustical holography is a real-time nondestructive testing technique which produces a visual image of the internal structure of the part being examined. This technique uses ultrasound to visually detect the presence of any anomalous condition in the material under test. Since the visual image presented shows the position and orientation of all flaws, the integrity of the material is immediately determined. The detection of cracks, voids, nonbonds, and other anomalous conditions interior to metals, ceramics, and plastics can be carried out on a high-volume, production-line basis. Various applications to the automotive industry are discussed.

72—816

SINE VIBRATION TESTING IN THE 70'S
Palm, J.E. and Keller, A.C. (Spectral Dynamics Corp., San Diego, Calif.)
S/V, Sound and Vib. 6(1), 14-20 (Jan. 1972) 5 refs

Key Words: specifications, testing techniques, vibration tests

A brief review of typical vibration test specification design is given and the concept of sinusoidal vibration tests using narrow-band tracking filters is developed. It is shown that the evolution of automatic servo controls for vibration exciters has stimulated the design of tracking filters which furnish an optimum match to the feedback loop in use. Different types of vibration tests which involve narrow-band filtering are presented and a brief comparison of different filtering techniques given. Finally, several additional concepts are presented which describe the use of programable filters in automatic test systems.

72—817

SIMULATION OF ROLLOVER WITH A DYNAMIC ROOF CRUSH TEST
Seiffert, U.W. (Volkswagenwerk AG, Germany)
Soc. Automotive Engrs., Preprint #720226, 7 pp, 5 refs

Key Words: collision research, drop tests, impact tests, testing techniques

Tests to simulate rollovers are discussed. The nonreproducibility of the tests and their results are often criticized. Procedures include rollovers initiated by a ramp, initiated by inertial movement of a vehicle positioned on a slope on a car which is stopped rapidly, drop test of an upside-down vehicle, and static roof crush test.

72—818

ACOUSTIC EMISSION RELATED TO NONDESTRUCTIVE TESTING
Tatro, C.A. (Lawrence Radiation Lab., Univ. Calif., Livermore, Calif.)
Soc. Automotive Engrs., Preprint #720175, 6 pp, 8 refs

Key Words: acoustic properties, acoustic tests, nondestructive tests

Acoustic emission technology has developed to the state where broad application to material testing and evaluation is evident. The unique characteristics of acoustic emission as they bear on applicability to nondestructive testing

are emphasized. Among the advantages anticipated for the acoustic emission method, two are especially noteworthy: (1) moving inspection upstream in the production process so that bad production can be eliminated before large fabrication and assembly costs are accumulated; and (2) economical 100 percent NDT inspection of finished components or products.

72—819

REPRODUCTION OF SHOCK SPECTRA WITH ELECTRODYNAMIC SHAKERS
Usher, T., Jr. (Booth, Bruel and Kjaer, Inc., Branford, Conn.)
S/V, Sound and Vib. 6(1), 21-25 (Jan. 1972)
9 refs

Key Words: shock testing, test equipment

New equipment using parallel band-pass filters has recently become available for performing shock testing with electrodynamic or electrohydraulic shakers. This equalizing equipment generates an oscillatory shock pulse with a specified spectrum. Philosophical aspects of "chirp" pulse testing are discussed. A method of determining the limits on the generated shock spectrum from the performance characteristics of a given shaker-amplifier-equalizer system is presented.

72—820

A TECHNIQUE FOR MEASURING "EFFECTIVE" ROAD PROFILES
Whittemore, A.P. (Environmental Activities Staff, General Motors Corp.)
Soc. Automotive Engrs., Preprint #720094, 4 pp, 5 refs

Key Words: measurement techniques, road roughness

A method of measuring the "effective" profile of road surfaces at highway speeds is described. This method is of particular interest to engineers involved in the study of vehicle ride and vibration phenomena on laboratory road simulators, because the measured road profiles include the effects of tire enveloping, thereby eliminating the need to simulate them. Furthermore, the road profiling instrumentation can be adapted to any vehicle which facilitates simulator to road correlation studies.

COMPONENTS

ABSORBERS

(Also see No. 905)

72—821

IMPACT TESTING OF HIGH-DENSITY SEMIRIGID URETHANE FOAM FOR AUTOMOTIVE BUMPER APPLICATIONS
Limbert, F.J. and Persin, W.J. (Mobay Chemical Co.)
Soc. Automotive Engrs., Preprint #720132, 9 pp, 5 refs

Key Words: automobile bumpers, collision research, impact tests, urethane foam

Evaluations of semirigid urethane foam specimens of various high densities subjected to simulated heavy-mass impacts, such as in low-speed automobile collisions, are presented. The dynamic test results show excellent material-energy absorption with essentially no compression sets, even after many repeated impacts of high deflection. These findings, coupled together with the well-known tough physical properties of urethanes, provide an outstanding candidate material that can be used to effectively reduce the damage to support structures and contact surfaces, not only in automotive applications but in any other application requiring a reduction of shock forces.

72—822

APPLICATION OF LEAD-VINYL NOISE BARRIERS IN TRANSPORTATION EQUIPMENT
Meteer, C.L. (Ferro Corp.)
Soc. Automotive Engrs., Preprint #720222, 7 pp, 4 refs

Key Words: noise reduction, transportation systems

Lead-vinyl coated fabrics, new composite vinyl films, and molding compounds that have application as flexible sound barriers in transportation and recreational equipment are reviewed. The material consisting of fine lead particles disbursed in PVC compounds for coating, casting films, extrusion, injection molding, thermal form sheets, and rotational casting combines the high mass of lead and the properties and formability of vinyl. These composites provide a limp high-mass sound barrier material.

72—823

FLUID SLOSH DAMPERS
Sayar, B.A. (Georgia Inst. Tech.) (1971)
186 pp

Key Words: slosh reduction

Oscillating fluids impart forces on their containers, and if such containers are attached to other moving media, the imparted forces of the sloshing fluids will be transmitted to the moving body and will influence its motion. The use of such forces in damping the amplitudes of the vibratory systems is described. The shape of the container is selected to be spherical, the fluid in its first antisymmetric mode is modeled as a damped pendulum, and the main vibratory system is modeled as a mass-spring-dashpot system. The coupled free motion of the main system and the auxiliary system (fluid) is studied analytically and experimentally. The influence of the variation in each parameter of the coupled system upon the damping of the main system is studied for the linear fluid motion, while for the nonlinear fluid oscillations only the effect of large initial displacements is investigated. The analysis of linear fluid motion indicates the possibility of designing very efficient fluid slosh dampers at or about the critical value of viscous damping when tuned at the critical tuning frequency. Logarithmic decrements of damping are calculated from the analytical and experimental response of the main system and are compared. To check the validity of the pendulum model in the nonlinear range of fluid motion, the oscillating fluid under forced vibration is analyzed.
UM 72-5052

BEAMS, STRINGS, RODS

72—824

ON VIBRATING STRINGS AND INFORMATION THEORY
Barrett, T.W. (Dept. of Physiology and Biophysics, Univ. Tenn. Medical Units, Memphis, Tenn.)
J. Sound and Vib. 20(3), 407-412
(Feb. 8, 1972), 9 refs

Key Words: spectral analysis, strings, vibration response

The concrete problem addressed is the relation of information provided by vibrating strings to that provided by systems describable with equations of one degree of freedom. Whereas the mathematical physics of vibrating strings is based on the wave equation (a second-order differential equation of at least two degrees of freedom) a quantum model of information theory has only been considered for a mechanical system of one degree of freedom. The abstract solution obtained is: a complete signal representation information-wise exists in Hilbert space. In correspondence with an increasing degree of freedom to vary in any system, is an increasing number of phase representations of the signal producible by the system in that space.

72—825

NONLINEAR FREE VIBRATION OF A SIMPLY-SUPPORTED BEAM
Iyengar, N.G.R. and Murthy, P.N. (Dept. Aeronaut. Engr., Indian Inst. Tech., Kanpur-16, India)
J. Sound and Vib. 20(3), 277-286
(Feb. 8, 1972), 17 refs

Key Words: beams, free vibration, nonlinear programing, springs, technique

An account is given of a study of free vibrations of a simply-supported beam with nonlinear material properties. The material is of the Ramberg-Osgood type. Nonlinear programing technique was used to find the response of the system. The variation of frequency with amplitude is obtained for different values of material properties. The results indicate that the beam behaves like a soft spring for the type of nonlinearity introduced by the material. This method can be used for all modes directly without reference to the lower modes.

72—826

DETERMINATION OF THE NATURAL FREQUENCIES OF MULTICONDUCTOR OVERHEAD TRANSMISSION LINES
Simpson, A. (Dept. Aeronaut. Engr., Univ. Bristol, Bristol, England)
J. Sound and Vib. 20(4), 417-449
(Feb. 22, 1972), 10 refs

Key Words: cables (ropes), catenaries, dynamic stiffness, natural frequencies

Dynamical stiffness relations are developed for elastic catenary segments and two classes of line spacers in order to facilitate the frequency and modal analyses of "bundled" overhead transmission lines. Frequency equations are exemplified for the low-frequency oscillation modes of a quadruple catenary with a central flexible spacing element and several natural frequencies and mode shapes are determined.

72—827

THE EFFECT OF STRESS RELAXATION ON THE VIBRATION OF A VISCOELASTIC STRING
Stevens, K.K. (Dept. Engr. Mech., Ohio State Univ., Columbus, Ohio)
J. Sound and Vib. 20(3), 257-268 (Feb. 8, 1972), 17 refs

Key Words: forced vibration, free vibration, strings, viscoelastic media

Some of the qualitative aspects of the free and forced lateral vibration of a relaxing string are investigated. First-order approximations for the amplitude and phase angle are obtained by using asymptotic methods. It is shown that the relaxing tension gives rise to what can be considered to be a time-dependent natural frequency and an equivalent negative damping, and can lead to a transition through resonance. Some experimental evidence of such transitions through resonance is presented. The results obtained indicate that in most practical cases the amplitude of the forced response can be obtained with sufficient accuracy by merely substituting the variable tension into the expression for the amplitude of a string with constant tension.

72—828

THE DYNAMIC PROPERTIES OF FIBER REINFORCED PLASTIC BEAMS
Wright, G.C.
Southampton Univ., Inst. Sound and Vib. Res., England, ISVR-TR-51 (Sept. 1971) 54 pp

Key Words: composite materials, dynamic properties, measurement techniques, reinforced beams

A single accurate method of measuring the dynamic flexural modulus and loss factor of a material is described. The method uses new ways of exciting the specimen and of measuring its displacement. Several types of composite material using glass and carbon fibers to reinforce epoxide and polyester resins are tested and the results given. Departures from linear behavior are explained.
N72-12926

BEARINGS

(Also see Nos. 887, 889, 890)

CONTROLS

(Also see Nos. 853, 854)

FRAMES

(Also see No. 879)

72—829

BEHAVIOR AND ENERGY DISSIPATION OF REINFORCED CONCRETE FRAMES SUBJECTED TO HIGH-LEVEL BASE MOTIONS
Gulkan, P. (Univ. Ill. at Urbana-Champaign) (1971), 303 pp

Key Words: frames, reinforced concrete, seismic response, test models

The response of reinforced concrete portal frames subjected to intense steady-state and simulated earthquake base motions as investigated by testing structural models on the University of Illinois Earthquake Simulator is reported. A total of 11 structural models of 2 different sizes are tested. Seven of these are subjected to dynamic base motions: the remaining four are tested statically in a reversible loading setup to ascertain their behavior when subjected to force reversals. The initial force-displacement relationship of an uncracked frame loaded monotonically is used as the primary index for describing behavior under subsequent reversals of force. Calculated and measured static response are compared. By assuming that the energy supplied to a frame during a dynamic test was to be dissipated within a fictitious linear viscous dashpot, substitute damping ratios are obtained. A simple iterative method is devised to estimate the maximum response of a frame subjected to a known base motion from a linear response spectrum.
UM 72-6943

ISOLATORS

72—830

OPTIMUM CONFIGURATION OF VIBRATION ISOLATORS FOR SYSTEMS WITH RANDOM EXCITATIONS
Fujiwara, N.; Murotsu, Y.; and Nakagawa, K. (Col. Engr., Univ. Osaka Prefecture, Sakai, Japan)
Japan Soc. Mech. Engrs., Bull. 14(78), 1289-1295 (Dec. 1971), 5 refs

Key Words: optimization, vibration isolators

This paper discusses the optimum configuration of isolators for systems with stationary random excitations. Optimum control theory in the frequency domain is applied to obtain an optimum isolating system that minimizes the response of the system to the excitations under certain conditions. A possible method of solving the optimization problems is presented for multidegree-of-freedom systems and illustrated on a few typical systems. The optimum isolators thus obtained may in general be characterized by active elements rather than conventional spring-dashpot elements.

PANELS

72—831

RESPONSE OF AEROSPACE STRUCTURES TO REENTRY AERODYNAMIC EXCITATION
Carlin, D., Jr.
Lockheed Missiles and Space Co., Huntsville, Ala. Huntsville Res. and Engr. Ctr., NASA-CR-121041, (Oct. 1971), 115 pp

Key Words: aerodynamic excitation, reviews, spacecraft, space shuttles, structural response

A bibliography on aerodynamic excitation and associated structural response is presented. Very little applicable data under actual reentry conditions exists but many wind tunnel tests and some in-flight data are found. Aerodynamic excitation and proposed space shuttle configurations and reentry trajectories are studied. Attached turbulent boundary layer, separated turbulent boundary layer, and base pressure fluctuations are the regions of aerodynamic excitation most applicable to exterior panels of space shuttle-type vehicles; prediction techniques are presented for these environments. Methods for predicting the response of panel structures to acoustic excitation are investigated.
N72-12914

PIPES

72—832

RESONANCE IN PIPES HAVING VARIABLE CHARACTERISTICS
Chaudry, M.H. (Intl. Power and Engr. Consultants, Ltd., Vancouver, B.C., Canada)
J. Hydraulics Div., ASCE, 98 (HY2), 325-333 (Feb. 1972), 12 refs

Key Words: frequency response, natural frequency, piping, Runge-Kutta method

By using the Runge-Kutta method, the field matrix for a pipeline having variable characteristics along its length is derived. This matrix can be used to determine the resonant frequencies and the frequency response of the system. The friction losses are neglected and sinusoidal discharge and pressure oscillations are assumed. An example is solved and it is found that results of reasonable accuracy can be obtained by replacing the pipe having variable characteristics by a pipe having piecewide constant characteristics.

72—833

INFLUENCE OF VARIATIONS OF TRANSIENT VELOCITY ON RESONATING FREQUENCIES
Thornley, A.R.D. (City Univ., London, England)
ASME Paper No. 71-WA/FE-20

Key Words: hydraulic systems, natural frequencies

Incidents of hydraulic resonance have occurred recently at the pumped-storage hydroelectric schemes at Cruachan (Scotland), Ffestiniog (North Wales), and Villarino (Spain). In all cases, a pressurized seal on a turbine inlet valve was the source of excitation. The tunnels and pipework upstream of the turbine inlet valves are analyzed using well-known impedance methods to predict possible resonating frequencies. It is demonstrated that considerable caution is required in attempting to predict resonating frequencies attributable to the significant influence of the speed of the pressure transients -- a parameter that is frequently not known with an accuracy of better than 5 percent.

PLATES AND SHELLS

(Also see Nos. 766, 771, 775, 779)

72—834

FREQUENCY COEFFICIENTS OF A SPHERICAL SHELL FOR VARYING THICKNESS AND OPENING ANGLE, WITH GUIDED PINNED, CLAMPED AND PINNED BOUNDARY CONDITIONS
Georgopoulos, G.
North Caroline State Univ., Dept. of Mech. and Aerosp. Engr., Raleigh, N. C.)
(Jan. 1972), 34 pp

Key Words: frequency coefficients, mathematical models, spherical shells

The frequency coefficients of a spherical shell are defined. The finite element method is then utilized for deriving the analogous mathematical

model, and an IBM 360 computer is used for obtaining numerical results. The frequency coefficients of a spherical shell for varying thickness and opening angle, with guided clamped, guided pinned, clamped, and pinned boundary conditions are then plotted.
AD-728308

72—835

ON CONCENTRATION OF DYNAMIC STRESSES IN A PLATE WITH TWO HOLES
Golovchan, V.T. (The Institute of Mechanics, AS UkrSSR)
Soviet Applied Mechanics 3(11), 18-21 (Nov. 1967)(Transl. of Prikladnaya Mekhanika 3(11), 23-28 (1967) by Consultants Bureau, New York), 19 refs

Key Words: harmonic excitation, hole-containing media, plates

A solution is presented for the problem of stress concentration in an infinite plate with two identical circular holes with a harmonic pressure applied to their boundaries.

72—836

APPROXIMATION METHOD FOR COMPUTATION OF NATURAL FREQUENCIES OF SPIRAL SECTIONS
Grubitzsch, W. (VEB Pumpspeicherwerke Hohenwarte, Bereich Wissenschaft u. Technik, Dresden, Germany)
Maschinenbautechnik 20(11), 532-537 (Nov. 1971) 10 refs

Key Words: cylindrical shells, finite element techniques, natural frequencies, springs

The finite element method is applied to compute the lowest natural frequencies of idealized spiral sections, which consist of homogeneous, both-way oblique chopped cylindrical shells. (In German)

72—837

A NEW FAMILY OF CURVILINEAR PLATE BENDING ELEMENTS FOR VIBRATION AND STABILITY
Henshell, R.D.; Walters, D.; and Warburton, G.B. (Dept. Mech. Engr., Univ. Nottingham NG7 2RD, England)
J. Sound and Vib. 20(3), 381-397 (Feb. 8, 1972), 21 refs

Key Words: finite element technique, plates, vibration response

A new family of nonconforming plate bending elements is derived. The basic element is a quadrilateral with four nodes. Extensions to this element provide for midside nodes making 8 and 12 nodes in all and enabling the element to have curved sides. The isoparametric two-dimensional transformation is used to straighten the element sides. Nodal displacements on these elements are all geometrical (one transverse and two slopes) and hence the element may be used in very general folded plate structures with stiffening ribs. Examples of results are given to show the order of accuracy which can be achieved by using the elements. The examples also show the order of permissible distortion from the basic rectangular shape.

72—838

VIBRATION CHARACTERISTICS OF Z-RING-STIFFENED 60 DEG CONICAL SHELL MODELS OF A PLANETARY ENTRY SPACECRAFT
Naumann, E.C. and Mixon, J.S.
Natl. Aeronaut. and Space Admin., Langley Res. Ctr., Langley Station, Va.
NASA-TN-D-6557 (Dec. 1971), 57 pp

Key Words: analytical results, conical shells, experimental results, natural frequencies, spacecraft, test models

An experimental investigation of the vibration characteristics of a 60 deg conical shell model of a planetary entry vehicle is described and the results presented. Model configurations include the shell with or without one or two Z-ring stiffeners and with or without a simulated payload. Tests are conducted with the model clamped at the small diameter and with the model suspended at the simulation payload. Additionally, calculated results obtained from application of several analytical procedures reported in the literature are presented together with comparisons between experimental and calculated frequencies and meridional mode shapes.
N72-12912

72—839

VIBRATIONS OF ISOTROPIC PLATES UNDER VARIOUS BOUNDARY CONDITIONS
Vasilakis, J.D. and Simkins, T.E.
Watervliet Arsenal, N.Y., WVT-7115 (Mar. 1971), 27 pp

Key Words: experimental results, isotropic plates, natural frequencies, rectangular plates

The natural frequencies of rectangular isotropic plates under various boundary conditions including clamped, free and simply supported edges as found experimentally are reported. Excitation is provided by an electronic shaker table. The results are tabulated and sand patterns

showing the nodal lines are presented. This work is performed to provide experimental results for the chordwise bending theory. Results compare well with experiment.
AD-725481

72—840

FORCED AND FREE VIBRATIONS OF DISKS
Zimmermann, P. (Technische Universität Berlin Fachbereich 9, Lehrstuhl A für Mechanik D-1 Berlin 12, Strasse des 17 Juni 135.)
Ingenieur-Archiv. 40(6), 377-401 (1971), 12 refs

Key Words: disks, forced vibrations, free vibrations, hole-containing media, plates

In the first part of this paper the author presents the steady state field components for circular disks and rings and infinitely extended plates with circular holes for harmonically time-dependent stresses or displacements at the boundaries. Moreover, equations for the natural frequencies of free vibrations evolve from the foregoing. Based on these results, the second part is concerned with the steady state solution of displacements and stresses for finitely and infinitely extended plates, excited at the center by singular forces, moments and expansive forces.

SPRINGS
(Also see No. 781)

STRUCTURAL

72—841

DYNAMIC BUCKLING OF SOME ELASTIC SHALLOW STRUCTURE SUBJECT TO PERIODIC LOADING WITH HIGH FREQUENCY
Huang, N.C. (Dept. of Aerosp. and Mech. Engr., Univ. of Notre Dame, Notre Dame, Ind.)
Intl. J. Solids Structures 8(3), 315-326 (Mar. 1972), 8 refs

Key Words: dynamic buckling, periodic excitation

Dynamic buckling of elastic shallow structures subjected to periodic loading is investigated by means of two simple model structures. When the frequency and the magnitude of the oscillatory load are sufficiently high, the cycle averaging technique can be employed to formulate an autonomous system for the cycle-averaged motion of the structure. The energy method is then utilized for determining the upper and lower bounds of the critical load for dynamic buckling.

72—842

LARGE AMPLITUDE AXISYMMETRIC VIBRATIONS OF MODERATELY THICK SPHERICAL CAPS
Singh, P.N.; Sundararajan, V.; and Das, Y.C. (Dept. Mech. Engr., Bihar Inst. Tech., Sindri, Bihar, India)
J. Sound and Vib. 20(3), 269-276 (Feb. 8, 1972), 22 refs

Key Words: axisymmetric vibrations, large amplitudes, rotatory inertia, spherical shells, transverse shear deformations

Large amplitude axisymmetric flexural vibrations of moderately thick spherical caps made of homogeneous, isotropic and linearly elastic material are analyzed. "Transverse shear" and "rotatory inertia" effects are included. One approximate second-order nonlinear total differential equation is obtained as the final governing equation. This is solved numerically to obtain the period vs amplitude relationship. Dynamic buckling and the transitions from a slightly curved plate to a shallow shell are discussed.

SYSTEMS

AIRCRAFT
(Also see No. 793)

72—843

THEORY OF AN AIR CUSHION LANDING SYSTEM FOR AIRCRAFT
Digges, K.H.
Air Force Systems Command, Air Force Flight Dynamics Lab., Wright-Patterson AFB, Ohio,
AFFDL TR-71-50 (June 1971), 327 pp

Key Words: air cushion landing systems

The Air Cushion Landing System is a scheme to replace the wheeled landing gear on aircraft by a peripheral jet air cushion. The concept employs a flexible elastic membrane or "trunk" which is attached to the bottom of the aircraft fuselage. During flight, the trunk shrinks elastically and hugs the bottom of the fuselage like a deicing boot. When a flow of air is applied to the inside of the trunk, the elastic material stretches and forms an elongated doughnut-shaped protrusion on the underside of the aircraft. The air flow is ducted by the trunk to the fuselage periphery and exhausted through a large number of

holes or slots. As a result, a pressure builds up under the aircraft when the ground is approached. The pressure is sufficient to support the aircraft and absorb the vertical landing velocity. The study develops analytical relationships between the variables associated with the Air Cushion Landing System.
AD-728647

72—844

RESEARCH STUDY OF COST EFFECTIVENESS OF AUXILIARY LAUNCH SYSTEMS APPLICABLE TO COMMERCIAL TRANSPORTS FOR PURPOSES OF NOISE ABATEMENT
Highley, F.M. (All American Engineering Co., Wilmington, Del.)
FAA-EQ-71-1 (June 1971), 268 pp

Key Words: aircraft noise, cost effectiveness, noise reduction

A cost effectiveness study to determine the feasibility of reducing the noise associated with aircraft takeoff by applying auxiliary launch power during aircraft acceleration on the ground is described. Auxiliary launch system categories considered are: reaction jets, catapults, aircraft exhaust augmentation, and accelerating vehicle systems. The optimum system studied is the Steam Zipper catapult. It was selected on the basis of its ability to handle the full range of aircraft, its high speed capability, shorter launch stroke, ease of achieving bidirectional capability, and economy of operation.

72—845

GROUND NOISE MEASUREMENTS DURING LANDING, TAKEOFF, AND FLYBY OPERATIONS OF A FOUR-ENGINE TURBOPROPELLER STOL AIRPLANE
Hilton, D.A.; Henderson, H.R.; and Maglieri, D.J.
Natl. Aeronaut. and Space Admin., Langley Res. Ctr., Langley Station, Va.
NASA-TN-D-6486, (Dec. 1971), 40 pp

Key Words: aircraft noise, noise measurement

Noise measurements are reported which were obtained for a four-engine turbopropeller STOL airplane during a Federal Aviation Administration flight evaluation program at the National Aviation Facilities Experimental Center. These measurements involve landing-approach, takeoff-climbout, and flyby operations of the airplane. A total of 13 measuring positions are used to define the noise characteristics around a simulated STOL port. The results are presented in the form of both physical and subjective measurements. An appendix is included to present tabulated values of various subjective reaction units which may be significant for the planning and operation of STOL ports. The main source of noise produced by the vehicle is the propeller, and noise levels decrease generally in accordance with the inverse-distance law for distances up to about 457 m. For similar slant ranges, somewhat lower noise levels are experienced during flyby than during takeoff or landing.
N72-11948

72—846

DESIGN FOR ACCEPTABLE AIRCRAFT VIBRATION
Woods, A.G. (Hawker Siddeley Aviation Ltd., Hatfield, Hertfordshire, England)
J. Sound and Vib. 20(3), 353-358 (Feb. 8, 1972, 4 refs

Key Words: aircraft vibration, human tolerance, simulation, vibration control, vibration response

Some past problems relating to aircraft vibration are summarized and methods employed to overcome them described. The use of simulation to predict the effect of changes in undercarriage characteristics on aircraft response, and to assess human response to vibration are discussed. In a situation where the aircraft response is known, the difficulty in judging the acceptability in relation to pilot and passenger comfort is pointed out.

72—847

DIGITAL SIMULATION OF AIRPLANE HYDRAULIC SYSTEMS
Zielke, W. (Tech. Univ. Munich, Munich, Germany)
ASME Paper No. 71-WA/FE-21

Key Words: aircraft, digital simulation, dynamic response, hydraulic systems

Numerical techniques to simulate the dynamics of airplane hydraulic systems on a digital computer are described, and a general user-oriented computer package HYTRAN is presented. Time histories of pressures, flows, piston positions, etc. for hydraulic systems specified by the user can thereby be calculated. All significant nonlinearities are preserved in the analysis, and a distributed parameter presentation of transmission line dynamics is applied, utilizing the method of characteristics. Particular emphasis is placed on surges in the line system, but the dynamics of pressure compensated pumps, servoactuators, and accumulators are included by

solving their dynamic equations simultaneously with the line equations.

ARTILLERY

(Also see No. 888)

BRIDGES

(Also see No. 779)

BUILDINGS

72—848

SONIC BOOM INDUCED BUILDING STRUCTURE RESPONSES INCLUDING DAMAGE

Clarkson, B. L. and Mayes, W. H. (NASA Langley Res. Ctr., Hampton, Va.)

J. Acoust. Soc. Am. 51(2), 742-757 (Feb. 1972), 61 refs

Key Words: buildings, sonic boom, structural response

Concepts of sonic boom pressure loading of building structures and the associated responses are reviewed, and results of pertinent theoretical and experimental research programs are summarized. The significance of sonic boom load-time histories, including waveshape effects, are illustrated with the aid of simple structural elements such as beams and plates. Also included are discussions of the significance of such other phenomena as three-dimensional loading effects, air cavity coupling, multimodal responses, and structural nonlinearities. Measured deflection, acceleration, and strain data from laboratory models and full-scale building tests are summarized, and these data are compared, where possible, with predicted values. Damage complaint and claim experience due both to controlled and uncontrolled supersonic flights over communities are summarized with particular reference to residential, commercial, and historic buildings. Sonic boom induced building responses are compared with those from other impulsive loadings due to natural and cultural events and from laboratory simulation tests.

72—849

VIBRATION DAMPERS FOR TALL BUILDINGS

S/V, Sound and Vib. 6(2), p 10 (Feb. 1972)

Key Words: multistory buildings, vibration dampers, viscoelastic damping

Vibration dampers employing viscoelastic shear-damping mechanisms developed to control wind-induced sway of the 100-story World Trade Center buildings in New York are discussed. A viscoelastic shear-damping mechanism is selected because of the high energy dissipation per unit weight and per unit cost that is available from properly applied viscoelastic materials.

CABINETS

(Also see No. 846)

HELICOPTORS

(Also see Nos. 856, 858, 859)

72—850

CONCEPTS FOR A THEORETICAL AND EXPERIMENTAL STUDY OF LIFTING ROTOR RANDOM LOADS AND VIBRATIONS -- PHASE 5C: DEVELOPMENT OF EXPERIMENTAL METHODS

Hohenemser, K. H. and Crews, S. T. (Sch. Engr. and Appl. Sci., Washington Univ., St. Louis, Mo.)

NASA-CR-114388 (June 1971), 41 pp

Key Words: rotor blades, test equipment

Test equipment and calibration tests are described. The test equipment consists of a two-bladed rotor of 16-in. diam, the blades of which are elastically hinged in flapping. The feathering shaft of the blades can be harmonically rotated with the help of a cam mechanism located inside the hollow rotor shaft. The frequency range measured in the rotating system can be adjusted between 0 and 80 Hz and the rotor speed between 0 and 40 Hz. The test equipment is for measuring the flapping response of the blades to harmonic feathering excitation.

N72-11891

72—851

CONCEPTS FOR A THEORETICAL AND EXPERIMENTAL STUDY OF LIFTING ROTOR RANDOM LOADS AND VIBRATIONS -- PHASE 5A: EFFECTS OF TORSIONAL BLADE FLEXIBILITY ON SINGLE-BLADE RANDOM GUST RESPONSE STATISTICS

Hohenemser, K.H. and Gaonkar, G.H. (Sch. Engr. and Appl. Sci., Washington Univ., St. Louis, Mo.)

NASA-CR-114386 (June 1971), 49 pp

Key Words: aerodynamic characteristics, random excitation, rotary wings

Quasi-steady aerodynamics are assumed in addition to a torsion mode where the amplitude is proportional to the distance from the rotor center. Aerodynamic torsional moment inputs are limited to the region of reverse flow where the aerodynamic center and the section center of gravity are separated by half the blade chord. Thus, negligible effects of blade torsional flexibility are obtained for rotor conditions with negligible reverse flow effects. Numerical examples refer to conditions with 1.6 rotor advance ratio. The random flapping response is only moderately affected by torsional flexibility. However, large random torsional loads and deflections occur even if flapping is completely suppressed. The coupling of the actual flapping motion into the blade torsional motion produces a substantial increase in the random torsional loads or deflections.

N72-11889

72—852

CONCEPTS FOR A THEORETICAL AND EXPERIMENTAL STUDY OF LIFTING ROTOR RANDOM LOADS AND VIBRATIONS -- PHASE 5B: ANALYSIS OF GUST ALLEVIATION METHODS AND ROTOR DYNAMIC STABILITY

Hohenemser, K.H. and Yin, S.K. (Sch. Engr. and Appl. Sci., Washington Univ., St. Louis, Mo.)

NASA-CR-114387 (June 1971), 87 pp

Key Words: aerodynamic characteristics, random excitation, random response, rotary wings

The effects of various gust alleviation methods on the random blade response in flapping are studied analytically, assuming a rigid rotor support. The analytical model assumes rigid flapping blades with elastic root restraints. Linearized equations which are approximately valid at low lift conditions are used. Because of the interblade coupling from the feedback devices, the method of multiblade generalized coordinates is most convenient and is extended to include coning, differential coning, and warping of the rotor. The numerical examples cover the dynamic stability characteristics as affected by feedback gains of three- to six-bladed rotors. The number of blades has large effects on stability limits and modal time functions at these limits. The random flapping response of the blades to atmospheric turbulence is determined at 1.6 rotor advance ratio using feedback gains below the stability limit. The most effective reduction of the flapping response per unit gain is achieved with a rotor coning angle feedback.

N72-11890

72—853

THE STABILITY AND CONTROL BEHAVIOR OF THE HINGELESS BOELKOW ROTOR SYSTEM

Huber, H. (Messerschmidt-Boelkow-Blohm, G.m.b.H. Ottobrunn, West Germany)

Proc. of Deutsche Gesellschaft f. Luft- u. Raumfahrt Comm. on Helicopters and American Helicopter Soc. Meeting, Ottobrunn, West Germany, Dec. 1970, pp 241-282

Key Words: helicopter vibration, hingeless rotors, rotary wings, vibration damping

The controllability, vibration damping, and static and dynamic stability of helicopters with hingeless rotors are examined. The feedback effects resulting from the special construction of the blades are described. In addition to elastic feedback effects based on the direct flapping angle feedback, torsional coupling effects are examined, appearing when the center of gravity and the aerodynamic center of the blade profile are shifted. The results of parametric studies, showing the influence of such blade-integrated feedback systems on control and stability characteristics of the hingeless rotor, are given, and the obtainable variation in flight-mechanical properties of rotors is shown. Tests with the BO-105 helicopter verify the treatment developed. (In German)

N72-11008

72—854

SUBOPTIMAL CONTROL OF THE MOTION OF AN ELASTIC HELICOPTER ROTOR BLADE IN HIGH SPEED FLIGHT

Lückel, J. (Institut B für Mechanik, T.U. München, D-8 München 2, Arcisstr. 21, Germany)

Ingenieur-Archiv. 40 (6), 353-376 (1971) 23 refs

Key Words: aerodynamic excitation, rotary wings, transient response

The motion of helicopter rotor blades in high speed flight is very sensitive to disturbing gusts, while the bending loads of the single blades highly increase. Therefore, in building up a controller, at least the flapwise bending distortion of the blades must be considered. A simplified equation of motion with flapwise bending is derived and transformed with the method of eigenfunctions. Thus it is possible to compute the transient response of an elastic rotorblade under the influence of aerodynamic loads with flapwise distortion. For the motion of a rigid rotorblade, in the linearized base being described by a differential equation of second order with time-varying coefficients, a suboptimal controller with low authority and bounded control is built up using a quadratic cost function. The controller's efficiency for the nonlinear case of rigid and elastical blades is investigated. Despite very small control angles and vertical gusts of 10 m/s the controller greatly decreases the flapping motion and the bending loads.

72—855

HELICOPTER NOISE IN CENTRAL LONDON
Williams, J.M. and Berthoud, R.
Social and Community Planning Research, London, England (Nov. 1970) 39 pp

Key Words: helicopter noise, noise tolerance

An experimental situation from which to assess the possible effects of helicopters landing and taking off in the center of London, is reported. A helistop is a scaled down heliport with minimal facilities. The purpose of the experiment was to measure the noise created by the machines, and to investigate the extent to which this noise, and any other side-effects, distracted or annoyed people who lived or worked in the vicinity. The overall conclusion is largely favorable to the helistop, in that not many people complained of the noise or disapproved of the use of the site.
N72-11953

HUMAN

(Also see No. 789)

72—856

A PROTOTYPE INDEX FOR ENVIRONMENT NOISE QUALITY
Goldstein, S.N. (The Mitre Corp., McLean, Va.)
S/V, Sound and Vib. 6(2), 30-33 (Feb. 1972), 2 refs

Key Words: noise tolerance, standards

A prototype technical standard for environmental noise is proposed in terms enabling an index of noise quality to be defined and calculated. The standard takes into account the damaging aspects of chronic exposure to loud noise as well as psychologically disturbing aspects of typical community noises which are not loud enough to be physically dangerous. Inasmuch as the standard is intended to portray environmental quality rather than to reflect damage risk criteria, it is generally conservative with respect to work-related noise standards, such as those specified by the Walsh-Healey Act.

72—857

EFFECTS OF NOISE ON HUMAN EFFICIENCY AND SOME INDIVIDUAL DIFFERENCES
Hockey, G.R.J. (Dept. of Psychology, Univ. Durham, Durham, England)
J. Sound and Vib. 20(3), 299-304 (Feb. 8, 1972), 23 refs

Key Words: human factors engineering, noise tolerance

This paper begins with a brief review of research on the way in which loud noise affects the efficiency of human work, leading to an examination of some differences between individuals in the extent to which efficiency is affected. Noise is regarded as producing a narrowing of attention toward work components of high priority, an effect which is seen as providing a basis for understanding previous contradictory interpretation in this area. Extroverted people seem more susceptible to this narrowing of attention, while the performance of introverts is more stable. Some related research on individual differences in performance, and preference for noise environments is also discussed.

72—858

HUMAN ASPECTS OF VIBRATION AND NOISE IN HELICOPTERS
Jackson, C.E.P. and Grimster, W.F. (Res. Dept., Westland Helicopters Ltd., Yeovil, Somerset, England)
J. Sound and Vib. 20(3), 343-351 (Feb. 8, 1972), 3 refs

Key Words: helicopter vibration, human factors engineering, noise tolerance

A résumé is given of the types and sources of helicopter vibration. Methods of vibration testing and monitoring are dealt with, together with the relative merits of various methods of vibration reduction. The paper describes levels which are acceptable in service in terms of a velocity

limit and the ISO/BSI proposals. Internal and external noise are briefly discussed and some information is given on results of internal cabin noise reduction.

72—859

MATHEMATICAL MODEL OF AN AIRBAG FOR A THREE-DIMENSIONAL OCCUPANT SIMULATION

King, A.I.; Chou, C.C.; and Mackinder, J.A. (Biomechanics Res. Ctr., Wayne State Univ., Detroit, Mich.)

Soc. Automotive Engrs., Preprint #720036, 10 pp, 4 refs

Key Words: air bags, collision research, mathematical models, safety restraint systems

A mathematical model of an airbag restraint system for automobile drivers, including the simulation of the simultaneous collapse of the steering column is presented. The model is designed to work in conjunction with a three-dimensional occupant model. It is capable of assessing the relative effects of airbag size, pressure, deployment rate, venting area, contact force, steering column collapse force, and column collapse distance. The results of the model are compared with experimental runs in which anthropometric dummies are used as test subjects. Good correlation is obtained for torso kinematics. The model can be conveniently used for a parametric study to aid the design of airbag restraint systems.

72—860

AWAKENING EFFECTS OF SIMULATED SONIC BOOMS AND AIRCRAFT NOISE ON MEN AND WOMEN

Lukas, J.S. (Stanford Res. Inst., Menlo Park, Calif.)

J. Sound and Vib. 20(4), 457-466 (Feb. 22, 1972), 8 refs

Key Words: aircraft noise, human factors engineering, noise tolerance, sonic boom

In the course of several studies, 22 male and female subjects, ranging in age from 5 to 75 years, have been stimulated while asleep by simulated sonic booms (ranging in intensity from 0.6 to 5.0 lb/ft^2 (239.5 N/m^2), as if measured out of doors at ground level) and by indoor recordings of subsonic jet flyover noise (ranging in intensity from 101 to 119 PNdB, as if measured out of doors.

72-861

IMPACT AND VIBRATION TEST EQUIPMENT DESIGN AND EXPERIMENTATION

Phillips, N.S.; Scranton, R.S.; and Carr, R.W.
Beta Industries, Inc., Dayton, Ohio

AMRL-TR-71-62 (July 1971), 40 pp

Key Words: human factors engineering, impact tests, test instrumentation, vibration tests

Test hardware which would permit biodynamic research to be conducted on both the AMRL IMPMODE and AMRL MONOMODE at their excitation limits is described. Existing Body Retraction Apparatus is modified to permit qualification and human testing. An instrumentation system including transducers, signal conditions, and recorders is assembled to support the associated testing. Qualification testing is accomplished on all three devices with human testing conducted on the Body Retraction Apparatus. The program produces rugged test hardware for use in biodynamic experiments to investigate vibration exposure limits for human subjects and the inertial response of individual body segments during impact and vibration. In addition, a device and technique for investigating human tolerance to forcible retraction is presented.
AD-726119

72-862

SONIC BOOM EXPOSURE EFFECTS II.2: SLEEP EFFECTS

Rice, C.G. (Inst. Sound and Vib. Res., Univ. Southampton, Southampton, England)

J. Sound and Vib. 20(4), 511-517 (Feb. 22, 1972), 40 refs

Key Words: human factors engineering, noise tolerance, sonic boom

The following report reviews the quantitative data which express sleep interference in terms of certain aspects of sleep patterns (sleep stage and accumulated sleep time), individual differences (age, sex, temperament, responsiveness), and stimulus variables (type of sound and intensity). The effects of such interference on performance, health and attitudes are also briefly commented upon. The findings of laboratory studies and their relationship to the real life situation are discussed, together with suggestions for standardization of some of the experimental techniques used in different laboratories, in order to receive the maximum information from research efforts on sleep disturbance caused by sonic boom. Annoyance responses which are heavily influenced by sleep disturbances are discussed by Borsky.

72-863

EXPERIMENTS ON THE EFFECT OF SONIC BOOM EXPOSURE ON HUMANS

Rylander, R.; Sorensen, S.; Berglund, K.; and Brodin, C. (Stockholm Univ., Stockholm, Sweden)

J. Acoust. Soc. Am. 51(2), 790-798 (Feb. 1972), 21 refs

Key Words: experimental results, human factors engineering, noise tolerance, sonic boom

The results of a study of boom exposure effect on structures are reported. Sonic booms of various intensities are produced by flying military aircraft over a test area. Test persons are directly exposed under the flight path, the effect being measured with the aid of a visual performance test and a tracking test. In addition, the subjective reactions of the test persons and military recruits, present at other sites under the sonic boom carpet, are evaluated.

72-864

SONIC BOOM EXPOSURE EFFECTS II.3: STARTLE RESPONSES

Thackray, R. I. (Psychology Lab., Civil Aeronaut. Inst., Box 25082, Oklahoma City, Okla.)

J. Sound and Vib. 20(4), 519-526 (Feb. 22, 1972), 35 refs

Key Words: human factors engineering, noise tolerance, sonic booms

Somatic reactions or responses to impulsive acoustic stimuli will cause startle responses which consist of the startle reflex, the orienting response, or some combination of these two. They may cause secondary effects in terms of influence on performance. Sonic booms, being impulsive stimuli, are often considered to evoke only startle reflexes. However, it seems quite likely that at least under certain conditions, the "startle" resulting from sonic booms could be more appropriately considered a surprise or orienting response. As the startle reflex and the orienting response have a number of characteristics in common, they are often confused. Since the effects of performance of these types of responses could be quite different, it is of particular importance to distinguish between them.

72-865

HUMAN RESPONSE TO SONIC BOOM IN THE LABORATORY AND THE COMMUNITY

Von Gierky, H.E. and Nixon, C.W. (Aerosp. Medical Res. Lab., Wright-Patterson AFB, Ohio 45433)

J. Acoust. Soc. Am. 51(2), 766-782 (Feb. 1972), 30 refs

Key Words: human tolerance, sonic boom

Present-day estimates regarding the acceptability of sonic booms by man are derived from various observations, overflight programs, and experimental field and laboratory studies conducted both within and outside the United States. The loudness and annoyance of individual booms and their dependence on the boom overpressure and pressure-time function, in addition to the complex reaction of individuals, groups, and communities exposed to sonic booms of varied magnitude and frequency are discussed. The few experiments available prove that even sonic booms of the maximum intensity presently feasible do not produce direct medical injury. Based on the integrated body of results of recent physiological, phychoacoustic, behavioral, and sociological studies in various countries, estimates of the effects and acceptability of regular frequent supersonic commercial overland flight schedules are presented and discussed in terms of aircraft noise pollution in general, and of potential certification of aircraft with respect to noise and sonic boom. Findings support the current policy that commercial supersonic transport aircraft will not be permitted to fly over the United States unless and until the noise factors are brought within acceptable limits.

ISOLATION

(Also see Nos. 849, 880)

72-866

EVOLUTION OF AN AIR SUSPENSION SYSTEM FOR TRUCKS

Locke, W.S. (Motor Truck Div., International Harvester Co.)

Soc. Automotive Engrs., Preprint #720105, 16 pp

Key Words: suspension systems (vehicles), trucks

A new truck air suspension system which provides excellent roll stability and articulation capability without compromising the exceptionally soft ride characteristics of air suspension is described. The new suspension fits vehicle models ranging between 23,000-54,000 lb gvw,

and a saddle arrangement attaches the rear axle housing to the trailing arm. Aluminum forgings are used in an effort to achieve minimum weight in every suspension part and all chassis components.

72-867

GMC ASTRO AIRE REAR SUSPENSION
Schmidt, R. F. (GMC Truck and Coach Div., General Motors Co.)
Soc. Automotive Engrs., Preprint #720106, 5 pp

Key Words: suspension systems (vehicles), trucks

An over-the-highway 34,000 lb tandem rear axle air suspension system for heavy duty truck/tractor applications is described. Various design approaches for truck air suspensions during the past two decades, are reviewed to trace the evolution of the present design philosophy which provides roll resistance comparable to steel leaf spring suspension systems.

METAL WORKING AND FORMING

72-868

IDENTIFICATION OF MACHINE TOOL RECEPTANCES BY RANDOM FORCE EXCITATION
Hanna, N.H. and Kwiatkowski, A.W. (Mech. Engr. Dept., Univ. Birmingham)
Intl. J. Mach. Tool Design Res. 11, 309-325 (1971), 7 refs

Key Words: machine tools, random excitation, testing techniques

An experimental procedure for determining receptances of machine tool structures in which a magnetic vibrator applies a random force between the table and the spindle is described. Results obtained from testing two machine tools by this method, and by the conventional sinusoidal force method, are presented and discussed. The conclusion reached is that the method is reliable and adequately accurate. Advantages to be obtained from using the technique are suggested.

72-869

MEASURING METHODS IN RESEARCH ON THE DYNAMIC CHARACTERISTICS OF MACHINE TOOLS, BASED ON THE PRINCIPLE OF DOUBLE MODULATION
Polacek, M.; Vanek, J.; and Nemec, I. (Vyzkumny Ustav Obrabečich Stroju a Obrabeni, Prague, Czechoslovakia)
Intl. J. Mach. Tool Design Res. 11, 273-282 (1971), 3 refs

Key Words: chatter, machine tools, measurement techniques, modulation principles

Electrochemical transducers of a modulation type are suitable for obtaining the product of two time variables based on the "double modulation" method. The paper describes applications of the method for obtaining the real part of the frequency characteristic of the mechanical structure and for measurement of the spindle rotation accuracy.

OFF-ROAD VEHICLES

(Also see No. 884)

72-870

POWER TRAIN-VEHICLE MODELING TO SIMULATE SHIFTING TRANSIENTS OF OFF-HIGHWAY VEHICLES
Koch, L.G. (Caterpillar Tractor Co.)
Soc. Automotive Engrs., Preprint #720044, 15 pp, 8 refs

Key Words: mathematical models, off-highway vehicles, power-train, simulation, transient response

Analytic modeling and analog computer simulation techniques are presented for determining power train transient responses excited by clutch-actuated gear shifts. A method for describing the dynamics of a transmission arrangement having several clutches and interconnected planetary gear sets is considered in detail. Simulation model testing is directed toward optimizing system design parameters and evaluating power train component capability and vehicle shift-feel. Data reduction techniques applied to model responses of torque and speed will yield appropriate spectrums representative of a simulated work cycle. The spectrum data are used to predict hours of life for gears, bearings, and driveshafts, according to cumulative fatigue damage theory.

72-871

VIBRATION EFFECTS ON RECOGNITION OF IMMINENT OVERTURN
Stephens, L. E. (Purdue Univ.) (1971)
67 pp

Key Words: tractors, vibration excitation

The influence of random vertical vibration on the ability of tractor operators to detect an imminent roll overturn is evaluated. An analog computer is used to model the equation of motion of a tractor operating a side slope on rough terrain. The output from the computer controls the movement of a ride simulator on which subjects are seated. Subjects are instructed to stop the simulator by depressing a steering wheel horn ring when they are convinced that to delay any longer would result in a roll overturn. Their steering ability and reaction times are evaluated. Vibration levels of 0.0, 0.25, and 0.5 g rms are used. The overturn accident rate increases by one-third when the acceleration increases from 0.0 to 0.25 g, but shows only a slight additional increase at 0.5 g. Subjects who are told the success or failure of each trial have a lower overturn rate than those who have to evaluate their own results. The former group shows no increase due to acceleration. Steering ability is influenced by acceleration level, but reaction time is not affected.
UM 72-8034

72-872

DYNAMIC RESPONSE OF A PRIME MOVER TO RANDOM INPUTS
Wolken, L. P. (Univ. Illinois at Urbana-Champaign) (1971)
232 pp

Key Words: dynamic response, ground vehicles, mathematical models, tractors

The mathematical model derived is usable for a parametric study of various vehicle design concepts. The representation of the terrain input as a random input provides a more realistic analysis of the vehicle motion. It is concluded that random vibration simulation results in a more realistic analysis than deterministic vibration simulation, but at a greater expense on the digital computer. The two vehicles simulated are an International 340 utility tractor and a John Deere 6600 combine with a four-row corn header.
UM 72-7112

RAIL

(Also see No. 800)

72-873

SONIC BOOM EXPOSURE EFFECTS II.4: ANNOYANCE REACTIONS
Borsky, P. N. (Noise Res. Unit, Sch. Public Health and Admin. Medicine, Columbia Univ., Franklin Square, N. Y.)
J. Sound and Vib. 20(4), 527-530 (Feb. 22, 1972), 8 refs

Key Words: human factors engineering, noise tolerance, sonic boom

Annoyance due to sonic boom exposure is but one link in a chain of interacting variables starting with an unwanted stimulus, which may or may not result in an annoyance response. The annoyance effect of sonic boom must be related to this general context in order to maintain a proper perspective. The degree of physical exposure and intervening psycho-social variables determine the occurrence of the annoyance response. All these variables must be measured or controlled in experimental studies in order to arrive at an appropriate judgement concerning annoyance effects due to sonic boom exposures.

72-874

TRUCK BOLSTER DYNAMIC LOADINGS MEASURED UNDER HARMONIC ROLL CONDITIONS
Monselle, D. (Assn. Am. Railroads, Chicago, Ill.)
ASME Paper No. 71-WA/RT-6

Key Words: harmonic response, railroad trains

This paper illustrates the truck-bolster dynamic loadings measured under the extreme harmonic roll condition on a specially prepared test truck. Methods of instrumentation developed to measure such loadings are described.

REACTORS

72-875

A SEISMIC DESIGN IN THE TSURUGA NUCLEAR POWER PLANT -- PART II: DESIGN OF THE REACTOR BUILDING, REACTOR CONTAINMENT, AND REACTOR PRESSURE VESSEL
Akino, K.; Kato, M.; and Tamura, S. (Japan Atomic Power Co., Tokyo, Japan)
Nippon Genshiryoku Gakkaishi 13 (2), 85-90 (Feb. 1971)

Key Words: nuclear power plants, seismic design

A summary of the seismic calculations covering the main components is presented. (In Japanese) NSA-8453

RECIPROCATING MACHINE

72-876

REDUCTION OF NOISE EMISSIONS FROM DIESEL ENGINE SURFACES
Russell, M.F. (C.A.V. Ltd., England)
Soc. Automotive Engrs., Preprint #720135, 11 pp, 4 refs

Key Words: engine noise, noise reduction, vehicles

Noise reduction techniques which have evolved for commonly used surface structures for diesel engines are described. Four in-line diesel engines are treated by these techniques, and noise reductions of 5-8 dBA are obtained. In all cases, the same manufacturing plant is to machine the modified crankcase/cylinder block casting; the valve gear cover and sump are modified versions of those already fitted to the engine.

ROAD

(Also see Nos. 777, 783, 801, 809, 810, 811, 817, 820, 821, 866, 867)

72-877

APPLICATION OF THE SHOCK RESPONSE SPECTRUM TO SOME AUTOMOTIVE CRASHWORTHINESS PROBLEMS
Davis, S. (Fairchild Republic Div., Fairchild Industries)
Soc. Automotive Engrs., Preprint #720071, 11 pp, 14 refs

Key Words: collision research, motor vehicles, shock response spectra

The shock response spectrum is defined and applied to several areas of automotive design and crash test evaluation. An examination of the shock response spectra for several deceleration pulse shapes for vehicle front structure design indicates that there is no "best" input pulse applicable to all occupant/restraint systems. However, in the 8-12 Hz frequency range of current occupant/restraint systems, the square wave does appear to offer significant reduction in peak deceleration response for the fully-restrained occupant. The shock response spectrum method is also used to compare a velocity-sensitive vs constant-force front structure, deceleration data from different vehicles, and accelerometer data having different frequency limits.

72-878

MOTOR VEHICLE NOISE -- IDENTIFICATION AND ANALYSIS OF SITUATIONS CONTRIBUTING TO ANNOYANCE
Galloway, W.J. and Jones, G. (Bolt Beranek and Newman Inc.)
Soc. Automotive Engrs., Preprint #720276, 15 pp, 10 refs

Key Words: human factors engineering, noise tolerance, traffic noise

Twelve vehicle type/noise source/operating mode situations causing various degrees of annoyance are identified as part of a survey involving 1200 respondents. Each situation is assigned to one of three categories of annoyance sensitivity depending upon the attitudinal factors related to the source. Each category has a linear relationship between noise intensity and annoyance. Noise measurements indicate that the respondents, in general, properly identify the types and magnitudes of noise sources found at their sites.

72-879

DYNAMIC TESTING AND COMPUTER ANALYSIS OF AUTOMOTIVE FRAMES
Hay, J.K. and Blew, M.J. (Structural Dynamics Res. Corp.)
Soc. Automotive Engrs., Preprint #720046, 24 pp, 10 refs

Key Words: automobile frames, computer programs, dynamic testing, finite element technique, truck frames

A method for quick and accurate static and dynamic analysis of automotive frame designs through use of a structural analysis computer program supplemented by empirical test data is discussed. A special beam finite element used in the computer program permits more

comprehensive and detailed structural description. Specific subprograms and testing techniques are described briefly. Also presented is a correlation between computer-predicted and actual experimental results for static deflection, and natural frequencies and mode shapes of a representative automotive frame.

72-880

DEVELOPMENT OF DRIVE AXLE AIR SUSPENSION FOR HIGHWAY TRACTORS
Henry, L.O. (Neway Div., Lear Siegler, Inc.)
Soc. Automotive Engrs., Preprint #720107, 7 pp

Key Words: suspension systems (vehicles), tractors, trailers

Recently, several concepts of drive axle air suspensions have been developed within the industry to various stages. This paper presents concept parameters, product development, and suspension development of the Neway Drive Axle Air Suspension (ARD). Performance ride and handling factors, compatibility, and structural integrity are the established guidelines.

72-881

OCCUPANT PROTECTION IN REAR-END COLLISIONS
Melvin, J.W. and McElhaney, J.H. (Highway Safety Res. Inst., Univ. Mich., Ann Arbor, Mich.)
Soc. Automotive Engrs., Preprint #720033, 9 pp, 9 refs

Key Words: collision research, safety restraint systems

The problem of occupant protection in severe rear-end collisions from the standpoint of high performance seat structures and head restraints is discussed. Consideration is given to both fixed and deployable head restraints. Two-dimensional computer simulations of occupant kinematics in a variety of rear-end collisions are utilized to provide initial performance criteria for head restraint design configurations. The results of various prototype performances and general criteria for high-performance head restraint systems are discussed.

72-882

MOTOR VEHICLE NOISE GENERATION AND POTENTIAL ABATEMENT
Paullin, R.L. and Safeer, H.B. (Office of Noise Abatement, Office of the Secretary of Transp.)
Soc. Automotive Engrs., Preprint #720273, 8 pp, 12 refs

Key Words: motor vehicles, noise reduction, traffic noise

The Department of Transportation initiated a study on the magnitude of the transportation noise problem and its potential abatement. The first comprehensive review and analysis of transportation noise in the United States resulted. Four computer simulation models are used to establish noise levels which might be expected for different transportation modes as a function of the traffic characteristics peculiar to that mode. The study also deals with the responsibility and ability of public and private groups to provide the necessary implementation programs to achieve noise abatement. The need for government standards and regulations is reviewed, and also, the need for additional research and development of successful means for reducing noise.

72-883

INVESTIGATION OF VEHICLE SIDE-IMPACT STIFFNESS -- COMPARISON OF STATIC AND DYNAMIC TESTS
Rau, H. (Inst. Auto. Engr., Tech. Univ., Berlin, West Germany)
Soc. Automotive Engrs., Preprint #720224, 24 pp, 4 refs

Key Words: automobiles, collision research, impact tests

Vehicle side-impact stiffness is investigated and static and dynamic tests are compared to evolve guidelines for a final test procedure that is practicable, reproducible, and as close as possible to real accidents. Additionally, the investigation emphasizes testing of side parts significant to the objectives of the test: door only, door and sill, or door, sill and roof. New cars and heavily rusted vehicles are used.

72-884

A STUDY OF VEHICLE VIBRATION SPECTRA AS RELATED TO SEATING DYNAMICS
Stikeleather, L.F.; Hall, G.O.; and Radke, A.O. (Bostrom Div., UOP)
Soc. Automotive Engrs., Preprint #720001, 34 pp, 40 refs

Key Words: automobiles, human factors engineering, vibration tolerance

Some new vehicle ride vibration data is presented. The Janeway recommended limit, Pradko/Lee absorbed power, and Mil-Std-1472A (proposed ISO tolerance criteria) provide formats for the data presentation. A brief literature review of the subjective tolerance question is included. The importance of seating systems which attenuate vehicle vibration is demonstrated.

72-885

EXPERIMENTAL SAFETY VEHICLE CRASHWORTHINESS DESIGN
Wingenback, W.J. and Schwarz, R. (Advanced Systems Lab., AMF Inc.)
Soc. Automotive Engrs., Preprint #720070, 15 pp

Key Words: collision research, experimental vehicles

In developing the AMF Experimental Study Vehicle, two of the major problems encountered involved limitation of passenger compartment intrusion during side impacts, and dissipation of vehicle kinetic energy during high-velocity front and rear impacts. A design solution to the first of these problems, which has as its basic element an aluminum honeycomb sandwich door panel, is described. Several evolutionary models were built and tested under both static and dynamic loading, including full-scale vehicle crashes. Actual behavior agreed well with analytically predicted behavior, enabling the side-structure system to meet ESV design goals. The solution developed for the second problem utilizes variable stroke hydraulic buffers to absorb the required energy. Bumper systems incorporating such buffers were tested successfully in various impact configurations at velocities of up to 50 mps. Both analysis and test results lead to the conclusion that the ESV crashworthiness goals can be met or exceeded with such systems.

ROTORS

(Also see Nos. 805, 850, 851, 852)

72-886

DYNAMIC STABILITY OF FLEXIBLE ROTOR-BEARING SYSTEMS
De Choudhury, P. (Univ. Va.) (1971)
258 pp

Key Words: dynamic stability, journal bearings, rotors

The stability of rotor-bearing systems is investigated assuming small linear and angular displacements. The linear, second-order equations of motion are derived. The homogeneous equations of motion are solved to obtain the system characteristic equation and the coefficients of the characteristic equation are then used to obtain the onset of instability by Routh stability criteria for different parametric conditions. The gyroscopic effects on the stability of a rotor are also determined. The equations of motion for a general flexible rotor in two bearings supported on damped elastic supports is derived using flexibility influence coefficients. These equations of motion take into account the effects of external and internal damping, and aerodynamic coupling at each mass station.
UM 72-7216

72-887

A GENERALIZED MATRIX SOLUTION FOR ELLIPTIC WHIRL OF ELASTIC ROTORS
Doyle, R.E. (Univ. Wisc.) (1971)
130 pp

Key Words: lumped parameter method, periodic response, rotors

The foundation and basic structure of a new highly generalized lumped parameter (Prohl-type) method for predicting the steady-state transverse dynamical behavior of actual multispan rotor bearing support systems is presented. By employing 17 x 17 real matrixes, the problem of finding critical speeds, three-dimensional mode shapes, damped unbalance response, and phase relations is readily handled in cases involving forward or backward synchronous or nonsynchronous elliptic whirl. Each fluid film-bearing support system is assumed to be anisotropic and is described in terms of 27 parameters, 16 of which are direct and cross-coupling film coefficients for treating both translatory and conical journal whirl. The mass, stiffness, and damping properties of each support are included, as are the effects of thrust, torque, shear deflection,

and gyroscopic moments on the rotor. The new analysis should serve as a powerful analytical design tool.
UM 72-408

72-888

VIBRATION AND OSCILLATION OF AVIATION ENGINE ROTORS
Levit, M.E. and Roizman, V.P.
Air Force Systems Command, Foreign Tech. Div., Wright-Patterson AFB, Ohio
FTD-MT-24-6-71 (June 1971), 239 pp
(Transl. of "Vibratsiya i Uravnoveshivaniye Rotorov Aviadvigatelei" Moscow, Iz-vo Mashinostroyeniye, 1970)

Key Words: aircraft engines, balancing, rotors

Contemporary methods of balancing rotors of aircraft engines are surveyed and the factors which influence the level of vibrations of engines are listed. One of the basic reasons for vibrations is the imbalance of elastically deformable rotors during operation at revolutions per minute close to critical. Simplified methods of balancing are given, producing a considerable effect when using equipment existing in plants. Much attention is given to the complex method of the research of the dynamics of aircraft engines such as the stage preceding the selection of the means of rotor balancing. The results of research on vibrations of full-scale gas-turbine aircraft engines and of their compressions and turbines are illuminated. A fundamental solution of the questions connected with automation of the processes of balancing and development of new means of balancing is given and apparatus and equipment are described. Basic problems in the area of the further development of the theory and practical methods of balancing of rotary systems of aircraft engines are formulated.
AD-728121

72-889

THE DYNAMIC CHARACTERISTICS OF A TURBOROTOR SIMULATOR SUPPORTED ON GAS-LUBRICATED FOIL BEARINGS -- PART I: RESPONSE TO ROTATING IMBALANCE AND UNIDIRECTIONAL EXCITATION
Licht, L.
Ampex Corp., Redwood City, Calif.
NASA-CR-124620 (1970), 40 pp

Key Words: gas bearings, rotors

A 16 in. rotor, weighing approx 21 lb was supported by the air-lubricated foil bearings. In physical size and in mass distribution, the rotor closely matched that of an experimental Brayton cycle turboalternator unit. The rotor was stable in both vertical horizontal attitudes at speeds up to 50,000 rpm. A detailed description of the experimental apparatus and of the foil bearing design are given. The paper contains data on response of the rotor to rotating imbalance, symmetric and asymmetric, and to excitation by means of a vibrator (shake table). It is concluded that the gas-lubricated foil bearing suspension is free from fractional frequency whirl and suffers no loss of load capacity when excited at frequency equal to half the rotational speed. In contrast to rigid gas bearings, the foil bearing imposes no stringent requirements with respect to dimensional tolerances, cleanliness, or limitations of journal motion with the narrow confines of bearing clearance.
N72-12410

72-890

THE DYNAMIC CHARACTERISTICS OF A TURBOROTOR SIMULATOR SUPPORTED ON GAS-LUBRICATED FOIL BEARINGS -- PART 2: OPERATION WITH HEATING AND THERMAL GRADIENTS
Licht L.
Ampex Corp., Redwood City, Calif.
NASA-CR-124621 (1970)
24 pp

Key Words: dynamic stability, gas bearings, rotors

A high speed rotor, supported by gas-lubricated foil bearings, is free from self-excited whirl and displays no loss of load capacity when vibrated at a frequency equal to the rotational speed. It is demonstrated that in addition to tolerance of geometrical imperfections, misalignment and foreign particles, the foil bearing performs well at elevated temperatures and accommodates appreciable temperature gradients. The foil bearing is endowed with superior wipe-wear characteristics and the flexibility of the foil accounts not only for the stability of the foil bearing, but also for its accommodation of, and compensation for, distortion, contamination, and contact.
N72-12411

72-891

THE APPLICATION OF LINEAR PROGRAMING TECHNIQUES TO BALANCING FLEXIBLE ROTORS
Little, R.M. (Univ. Va.) (1971)
172 pp

Key Words: balancing, linear programing techniques, rotors

The feasibility of a new flexible rotor balancing method is demonstrated. The balancing problem is formulated such that the "effective" unbalance of the rotor is identified. That is, discrete unbalance components which produce the same observed response as the actual rotor unbalance are identified, and subsequently removed. In addition to satisfying the specified observations, the unbalance is identified such that it is potentially harmful to response at a certain speed and axial location. This effective unbalance identification problem is formulated as a linear program. The potentially harmful response corresponds to the linear programing objective function, while the observations become constraints. A theoretical model of the rotating shaft system makes it possible to formulate an objective function corresponding to response which cannot actually be observed. The advantages afforded by such a formulation are not available with any of the flexible rotor balancing techniques presently employed. An additional advantage of linear programing techniques is found in the fact that it is possible to impose limits on the size of the calculated balance weights. The theoretical studies conducted indicate that the linear programing technique is a highly effective method of flexible rotor balancing. Suggestions pertaining to the application of the method to balancing actual rotors are presented, and recommendations are offered concerning future development of certain aspects of the approach.
UM 72-7269

SATELLITE

72-892

A STUDY OF THE FLEXIBLE BODY DYNAMICS OF THE RAE-A SATELLITE
Avco Corp., Systems Div., New York, N.Y.
NASA-CR-124642 (Mar. 1971), 84 pp

Key Words: antennas, computer programs, simulation, spacecraft

Spacecraft flight data are compared with simulated data computed by the RAE and IMP dynamcis simulator computer programs. There is insufficient data available to provide definitive data on antenna boom position to the Radio Astronomy experiment. Enough data exist to indicate the trend of antenna boom stiffness and temperature gradient. It is possible to obtain a good fit of simulated data to measured spacecraft attitude data when the antenna booms are extended to 480 ft.
N72-12884

SELF-EXCITED

72-893

GALLOPING OSCILLATIONS OF PRISMATIC STRUCTURES
Novak, M. (Univ. West. Ontario, London, Canada)
J. Engineering Mech. Div., ASCE, 98 (EM1), 27-46 (Feb. 1972), 13 refs

Key Words: aerodynamic excitation, prismatic bodies

Galloping oscillations can arise above a certain onset wind velocity with lateral force coefficient $A_1 > 0$ (unstable cross sections) and also at $A_1 \leq 0$ (stable cross sections). In the latter case, an initial disturbance is also necessary to trigger the vibrations. This triggering disturbance must be larger than the unstable amplitude, proportional to structural damping, and in some cases must be able to decrease with increasing wind velocity. The onset velocities are higher with $A_1 \leq 0$ and are directly proportional to structural damping in all cases. Turbulence can drastically change the aeroelastic stability of prismatic bodies. With rectangular cross sections of 2/1 the tendency to galloping instability from zero position decreases with increasing turbulence intensity and can vanish at intensities of 8 percent or so. On the contrary, prisms of 1/2, stable in the smooth flow, can become unstable in the turbulent flow and their tendency to galloping oscillations increases with turbulence intensity.

72-894

FLUTTER RESEARCH IN THE UNITED KINGDOM 1969-1971
Woodcock, D.L. and Lawrence, A.J. (Royal Aircraft Establishment, Farnborough, England)
RAE-TM-813 (Sept. 1971), 25 pp

Key Words: aerodynamic characteristics, aircraft, flutter

Research projects on the subject of flutter in fixed wing aircraft are discussed. Emphasis is placed on aeroelasticity and research involving unsteady aerodynamics and vibrations. The use of hinge moment derivatives by a forced response technique is described. A numerical analysis of the aerodynamics of bodies in supersonic flow is presented.
N72-11892

SHIP

72-895

VIBRATION IN THE AFTERBODY OF SHIPS
Pettersen, J.W.E.; Sigwaldsen, O.; and Vedeler, B. (Det norske Veritas, Oslo, Norway)
North East Coast Inst. Engrs. and Shipbuilders 87(5), 117-138 (May 1971), 29 refs

Key Words: human factors engineering, ship vibrations, structural response

Vibration experienced in the afterbody of ships has often caused annoyance to crew members and has been of sufficient severity to cause damage to machinery components and ship structural parts. The following main topics are discussed: (1) evaluation of propeller and I.C. engine excitation; (2) calculation of dynamic response of structural members; and (3) assessment of vibration environmental conditions from a habitability viewpoint. The importance of obtaining reliable methods for prediction of ship dynamic behavior at the design stage is emphasized.

72-896

FLEXIBLY-MOUNTED SUPERSTRUCTURES
Marine Engineer and Naval Architect 94(1148), 455-457 (Nov. 1971)

Key Words: noise reduction, ship structures, vibration isolators

The entire after-deckhouse of a large coaster, Skeppsbron, with bridge and funnel, weighing 69 tons was resiliently mounted. Measurements of noise levels throughout the ship are recorded in the paper.

SPACECRAFT

(Also see No. 831)

72-897

VIBRATION ANALYSIS OF A 1/15-SCALE DYNAMIC MODEL OF A SPACE SHUTTLE CONFIGURATION
Thornton, E.A. (Old Dominion Univ., Norfolk, Va.)
NASA-CR-111984 (1971), 146 pp

Key Words: beams, computer programs, finite element techniques, NASTRAN (computer program), natural frequencies, space shuttle

The natural frequencies and mode shapes of a 1/15-scale space shuttle dynamics model are analytically determined. The model, a parallel beam type structure with delta wings, is dynamically representative of the stiffness and mass properties of an early space shuttle design. Important characteristics of the model are elastic interfaces with adjustable spring rates. Normal mode computations are made using the finite element modeling technique as implemented in the NASTRAN (NASA Structural Analysis) computer program. The feasibility of neglecting elastic deformations in the lower modes is investigated using a rigid body model.
N72-12871

STRUCTURAL

(Also see Nos. 773, 780, 789, 896)

72-898

DYNAMIC BEHAVIOR AND STABILITY OF SOLIDS AND STRUCTURES
Herrmann, G.
Stanford Univ., Dept. Appl. Mech., Palo Alto, Calif.
AFOSR-TR-71-1963 (March 1971), 9 pp

Key Words: dynamic stability, interaction: structure-fluid, structural elements

The following aspects of the dynamic behavior and stability of solids and structures are studied: moving loads acting on structural systems; dynamics of composite materials; dynamics and stability of rotating structures; applications of microstructure mechanics; and, dynamic interactions of structures and fluids.
AD-734288

72-899

REINFORCED CONCRETE SEISMIC DESIGN
Hollings, J.P. (Beca, Carter, Hollings and Ferner, Wellington, New Zealand)
New Zealand Engr. 26(12), 371-378 (Dec. 15, 1971), 5 refs

Key Words: reinforced concrete, seismic design

Reinforced concrete, as customarily designed and detailed, and in contrast to structural steel, is essentially a brittle material. The avoidance of brittleness is a prime aim of earthquake resistant design. With care in design and detailing, reinforced concrete structures can be converted

from an inherently brittle character to an adequately ductile one for good performance in earthquakes. This paper reviews a rational design procedure for achieving ductility in reinforced concrete structures.

72-900

BOUNDS FOR IMPULSIVELY LOADED PLASTIC STRUCTURES
Martin, J.B. and Ronter, A.R.S. (Brown Univ., Providence, R.I.)
J. Engineering Mech. Div., ASCE 98(EM1), 107-119 (Feb. 1972), 15 refs

Key Words: boundary value problems, dynamic response, plastic properties

Methods of bounding the displacements of chosen points in impulsively loaded structures previously established for a variety of models of plastic behavior are discussed. In the present paper these methods are reformulated by making use of recent developments in bounding theorems in plasticity. This reformulation permits the method to be extended to problems in which the deformations for the structure are moderately large. An example of the application of the method is presented, and the bound predictions are compared with experimental results.

72-901

SHOCK TRANSMISSION IN COUPLED BEAMS AND RIB STIFFENED STRUCTURES
Pope, L.D.; Manning, J.E.; and Scharton, T.D.
Bolt Beranek and Newman, Inc., Cambridge, Mass.
NASA-CR-121042 (Nov. 1971), 134 pp

Key Words: beams, coupled systems, shock wave transmission, stiffened cylinders

Shock transmission in a simple coupled beam structure and in a ring-stringer stiffened cylinder is investigated experimentally and analytically using wave transmission and statistical energy analysis concepts. The use of the response spectrum to characterize the excitation provided to a simple beam by a force pulse is studied. Analysis of the transmission of a dilatation wave in a periodically stiffened plate indicates that the stiffeners are fairly transparent to the wave, but some of the dilatational energy is scattered into bending at each support.
N72-12915

72-902

RESONANT RESPONSE OF OFFSHORE STRUCTURES
Selna, L. and Cho, D.
(Sch. Engr. and Appl. Sci., Univ. Calif., Los Angeles, Calif.)
J. Waterways, Harbors and Coastal Engr. Div., ASCE 98(WW1), 15-24 (Feb. 1972) 24 refs

Key Words: hydrodynamic excitation, mathematical models, offshore structures

A nonlinear deterministic mathematic model is used to investigate the resonant response of a tall offshore structure under the action of periodic deep water waves. The added mass which is attributed to the acceleration of a body in the fluid is taken into consideration. The fundamental period of vibration of a structure is lengthened because of the effect of the added mass. An incremental numerical technique is employed to obtain the solution. The results show that even when damping caused by drag is considered, the response of the structure at resonance is greatly amplified.

72-903

EFFECT OF SONIC BOOM ON STRUCTURES -- THIRD REPORT: MEASUREMENT OF EIGENFREQUENCIES OF BUILDING STRUCTURES WHICH ARE SENSITIVE TO THE BOOM
(Transl. from French by Scientific Translations Center, Santa Barbara, Calif.)
De Tricaud, P.
(Centre Sci et Tech. du Batiment, Paris, France)
NASA-TT-F-14057 (Nov. 1971), 35 pp

Key Words: acoustic response, ceilings, natural frequencies, sonic boom

The first eigenfrequency, damping and dispersions measured for various types of full-sized building partitions and ceilings are reported. Studied panels are made of plaster, plaster tile, plaster brick and various sandwich constructions. Measurements are compared with theoretical predictions. Various panel fixation methods are evaluated.
N72-11944

72-904

SONIC BOOM EXPOSURE EFFECTS II.1: STRUCTURES AND TERRAIN
Weber, G. (Technische Universität Hannover, Curt-Risch-Institut für Schwingungs- und Messtechnik, Hannover, West Germany)
J. Sound and Vib. 20 (4), 505-509 (Feb. 22, 1972), 15 refs

Key Words: sonic boom, structural response

Extensive data on sonic boom data damage accumulated from many investigations which have taken place over the past 10 yr are reviewed. Available data show some features which are relatively easy to define. Conclusive statements concerning sonic boom exposures and the occurrence of damage on structures are attempted in this paper. In many areas, where it is not so easy to obtain adequate data, suggestions are made concerning suitable research. The three general sets of parameters which determine the effect of sonic booms on structures and terrain are: (1) the generation; (2) the propagation of shock waves; and (3) the characteristics of the structures. The first two of these parameters are better known than the third. If the specific aircraft design, flight and weather conditions are known, the free field pressure wave characteristic can be predicted. The effect of sonic booms on topographical features and ground motion effects on structures are evaluated and structural parameters are discussed.

TRANSMISSIONS

(Also see No. 826)

TURBOMACHINERY

72-905

EXHAUST GAS SILENCING AND SILENCER MATERIAL REQUIREMENTS WITH AND WITHOUT TURBOCHARGER ON THE VEHICLE ENGINE
Martin, H. (J. Eberspächer, Esslingen, Germany)
Automobiltechnische 2t 73 (12), 449-451 (Dec. 1971), 5 refs

Key Words: cargo vehicles, noise reduction

The nature of noise silencing by exhaust gas turbine and the degree of silencing in relation to the total exhaust noise intensity are discussed. The material requirements in the silencer itself are thereby essentially smaller, as represented by Diesel engines for commercial vehicles.

72-906

SHOCK AND VIBRATION TESTS OF A SNAP-8 NaK PUMP
Stromquist, A.J.; Nelson, R.B.; and Hibben, L. (Aerojet General Corp., Azusa, Calif.)
NASA-TM-X-67945 (Oct. 1971), 18 pp

Key Words: environmental response, power plants, shock excitation, spacecraft

The pump used for reactor cooling in the SNAP-8 space power system is subjected to the expected vehicle launch vibration, and shock loading in accordance with the SNAP-8 environmental specification. Subsequent disassembly reveals damage to the thrust bearing pins, which should be redesigned and strengthened. The unit remains operational, however, when run in a test loop after reassembly.
N72-12601

USEFUL APPLICATION

(Also see No. 818)

72-907

HIGH-FREQUENCY HYDRAULIC VIBRATORS
Smith, J.D. (Univ. Engr. Dept., Trumpington Street, Cambridge, Mass.)
J. Mech. Engr. Sci. 13 (6), 380-383 (Dec. 1971), 2 refs

Key Words: hydraulic systems, vibrators (machinery)

Hydraulic vibrators which are powerful, cheap and compact are described and theory for their performance prediction is given. They are of use where high forces are required on structures of high dynamic stiffness at frequencies up to 1 kHz.

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Secondary Journals

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BOOKS

AN INTRODUCTION TO MECHANICAL VIBRATIONS

Robert F. Steidel, Jr.
John Wiley and Sons, Inc.
New York, N.Y. (1971)

This textbook develops the basic topics of mechanical vibrations in a straightforward manner. Emphasis is placed on problem solving. The book accomplishes three major objectives. These are: (1) basic concepts mechanical vibration are stressed; (2) ample problems and examples are supplied; and (3) applied topics such as energy dissipation, initial conditions and transient vibration are discussed.

The book is well suited for an elementary text. It contains sufficient material for a comprehensive one semester course. The author has organized the text and accompanying examples in a fashion similar to many standard textbooks on this subject now available.

The book contains 10 chapters and a brief appendix listing 12 useful Laplace transforms. Among the topics discussed that are not necessarily found in other introductory tests are: filar pendulums, phase plane, harmonic analysis, convolution, random vibration, coupled modes, influence coefficients and transfer matrixes. Special attention has been given to damping mechanisms of interest to the engineer. Matrix notation is used and some brief discussions of numerical solutions are provided.

An introductory text such as this is likely to accompany the student into advanced studies and engineering practice. It should contain a comprehensive bibliography plus sufficient tabular and graphical aids for general problem solving. This book is lacking in these areas, but would appear attractive for at least two types of users One is the practicing engineer requiring an elementary book in mechanical vibrations for background information; the other is the instructor in engineering mechanics selecting an introductory text for a first course in mechanical vibration.

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TRANSPORTATION NOISES -- A SYMPOSIUM ON ACCEPTABILITY CRITERIA

Edited by James D. Chalupnik
University of Washington Press,
Seattle and London (1970)

This book contains the proceedings of a symposium entitled "Evaluating the Noises of Transportation" held at the University of Washington on March 26-28, 1969 and sponsored by the Office of Noise Abatement, Department of Transportation. One of the stated goals of the symposium was to reach agreement among the various experts in the field on a unified noise scale rating that could be used for evaluating all transportation noise sources. Although this was not achieved, the proceedings do provide excellent insight into the problems associated with the measurement of noise. These are discussed throughout the book. The proceedings are presented in five sessions consisting of the following:

- Transportation Noises
- Scales for Expressing Noise
- Laboratory Methods for Evaluating Human Response to Noise
- Methods for Evaluating Community Response to Noise
- Relation between Laboratory Results and Community Response

The proceedings begin with descriptions of the acoustical characteristics of various aircraft and surface vehicles. Spectral characteristics

of aircraft noise, including sonic boom, are presented while surface vehicle noise is described in terms of a weighted frequency scale (A-scale). The various scales for evaluating noise which have been used by special interest groups to rank noise of a particular type of transportation vehicle are described, emphasizing the relative merits of each. Laboratory methods or schemes are described which attempt to represent the same physical effect or magnitude of the noise.

The responses of individuals and the community to environmental stimulii resulting from transportation noise are described. Correlation of the responses in terms of these scales (i.e., measured sound) is presented. Criteria for determining acceptability of noise are described in terms of three general effects. These relate to the creation of hearing damage, the interference with speech communication and the psychological magnitude scale, e.g., loudness, noisiness and annoyance. One concluded from the proceedings that not all of the criteria are predicted best by any one noise scale, i.e., weighting of the frequency spectrum.

The papers presented contain valuable sources of current information pertaining to the subjective evaluation of noise (with emphasis on transportation noise). The book should be of great value to legislators in government, to industry, and to universities, where it can be used as a supplemental text for courses in noise pollution.

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HYPERBOLIC EQUATIONS AND WAVES
Battelle Seattle 1968 Recontres
Edited by Marcel Froissart
Springer Verlag, Berlin-Heidelberg, Germany
(1970)

This collection of papers is assembled primarily for the benefit of the participants of the Recontres and perhaps those who had an interest in attending but were unable to do so. Recontres, as pointed out by the Editor, "may very well look like a hodgepodge of quite unrelated ideas." The Editor has attempted to present sufficient material for the expert to obtain a more synthetic view of the subject. In so doing, most of the contents are reprints of previously published papers. The reviewer has not read the book in detail, but inspected it and discovered the following structure.

The major part of this book has to do with some of the work of Lighthill. The first paper, entitled "Wave Mathematics", is a brief introductory guide to the significance of the following seven reprinted papers: "Group Velocity"; "On Waves Generated in Dispersive Systems to Traveling Forcing Effects, with Applications to Dynamics of Rotating Fluids"; "Contributions to Theory of Waves in Nonlinear Dispersive Systems"; "Some Special Cases Treated by the Whitham Theory", by M. J. Lighthill; "Variational Methods in Applications to Water Waves", by G. B. Whitham; "Wave Trains in Inhomogeneous Moving Media", by F. P. Bretherton and C. I. R. Garrett; and "Phase Jumps", by M.S. Howe. J. Leray presents three short papers, each about one page, referring to his publications on the subjects of hyperbolic equations and the Cauchy problem. Five of Leray's publications are reprinted.

Some of the original papers contained in this book include: "The Theory of Lacunas", a discussion, analysis, and generalization of a paper by I. G. Petrovsky, by L. Garding; "Stability of Fluid Motions and Variational Principles", a derivation from a variational principle of the Einstein equations for a perfect fluid obeying an equation of state, by A. H. Taub; "A Difference Method for Plane Problems in Dynamic Viscoelasticity", by J. Bejda; "A Survey of Hyperbolic Systems of Conservation Laws in Two Dependent Variables", by J. A. Smoller; "Maximum Norm Stability for Parabolic Difference Schemes in Half-Space", and "Stability and Well-Posedness for Difference Schemes in Partial Differential Equations for Time Dependent Problems in Half-Space", by S. J. Osher; and "On the General Theory of Mixed Problems", by L. Hersh.

Except for the sequence of papers by Lighthill, there is an obvious lack of continuity in the contents of this book. The book is an unusual collection of articles pertaining to the fields of mathematical physics, applied mathematics, and pure mathematics. A comprehensive, synthetic view of the subject, hyperbolic equations and waves, is not presented in this book. The Editor

appropriately writes, "Such a view is impossible to put in words, and has to be extracted from the diversity of the points of view, of the approaches, of the analytic descriptions." This book does contain such diversity.

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PAPERS AND REPORTS

MODAL REPRESENTATIONS FOR THE HIGH FREQUENCY RESPONSE OF ELASTIC PLATES

Randles, P.W. and Miklowitz, J.
Intl. J. Solids Struc. 7(8), 1031-1055 (Aug. 1971)

Refer to Abstract No. 71-1421

The authors have used modal solution to obtain the high frequency response of an infinite plate under impulsive line load. It is essential, for this purpose, to have a clear understanding of the frequency spectrum of the system. Fortunately, a reasonably good understanding of the spectrum, except at large wave number, has been made possible through the work of Mindlin, among others.

Apparently, the high frequency response of the plate cannot be easily recovered from the modal solution. One of the difficulties results from the integrability, or lack of it, of the response variable around singular points. This difficulty can be overcome by using a transformation as proposed by the authors. The attention then need be focused only on a small domain of the transformed space. The knowledge of singularities in this domain has been used to manipulate and rearrange integrals over the branches. The authors have compared their solution with known exact solution of the Lamb's problem.

It is not clear at this moment whether the paper has any practical use at all. However, the technique proposed by the authors could be used for analyzing the high frequency response of rods and shells.

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DATA REDUCTION FROM NONLINEAR RESPONSE CURVES

Novak, M.
J. Engr. Mech. Div., Proc. ASCE 97(EM4), 1187-1204 (Aug. 1971)

Refer to Abstract No. 71-1298

The author presents an extensive and useful discussion of methods for finding nonlinear stiffness and damping for quasi-single degree-of-freedom systems from the response curves as a function with different amounts of excitation. The results depend on a number of assumptions which are clearly stated but must be carefully taken into account. The analysis is based upon the well known Krylov-Bogolivboff method of averages. The results should be valid, as the author points out, for those cases in which the equivalent damping is not too large and for which the nonlinear restoring force does not give a motion which deviates too far from a sinusoidal one. In particular, this approach will not work for a response curve exhibiting the jump phenomenon or stop motion.

In general, the nonlinear restoring force is found by averaging the response curve to determine the backbone or free vibration frequency as a function of amplitude. Nonlinear damping is found from that response corresponding to a 90 deg phase-shift. Since the response is damping controlled under these circumstances, the damping may be found directly. A method based on bandwidth is also presented.

The results ostensibly depend on frequency squared or rotating mass excitations; it would take little effort to adapt them to some other case. The author puts great stress on particular forms of nonlinearity but the amount of error introduced really depends on the amount of the nonlinearity and not on its functional form. The methods appear to have been developed primarily

for the analysis of the influence of the foundation on Civil Engineering structures. One assumes this is the reason for considering eccentric weight excitation and relatively low frequencies. The methods suggested look quite suitable for this class of problem and should be brought to the attention of all engineers concerned with obtaining field data for dynamic design of large structures such as turbogenerator sets, bridges and buildings. The chapter on nonlinear vibrations in Harris and Crede's Shock and Vibration Handbook is a useful introduction to the pertinent theory.

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TIMOSHENKO BEAM DYNAMICS
Anderson, G.M.
J. Appl. Mech. Trans. ASME 38(3), 591-594 (Sept. 1971)

Refer to Abstract No. 71-1422

Using Laplace transform method, the problem of the Timoshenko beam as formulated by Cowper (Ref. 10 cited in the paper) is solved when the boundary conditions and normal loads are time dependent. The analysis is restricted to the case when the beam is uniform both as regards geometrical and material properties. The cross section of the beam and the applied loads are assumed to be symmetric about the plane of deflection of the beam. It is shown that for finite beams, the integrands of the inversion integrals are single valued. The proof of this result is claimed to be new. The emphasis is on analytical details and no numerical data is provided.

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IMPULSIVELY LOADED CIRCULAR PLATES
Batra, R.C. and Dubey, R.N.
Intl. J. Solids Struc. 7(8), 965-978 (Aug. 1971)

Refer to Abstract No. 71-1480

A theoretical study is made for the deflection of circular plates of the elastic-plastic material taking into account the combined effect of bending moments and membrane forces. The dynamic load is supposed to be such that at some given time, an axisymmetric velocity field is instantaneously imparted to the entire plate, save at the edges where the velocity is zero and thereafter the plate is subjected only to the edge forces. The incremental theory and Mises yield criterion are used. The deformed shape of the plate and the central deflection are compared with the corresponding experimental findings.

The effect of both the membrane forces and the bending moments have been considered but the authors made too many assumptions to make the problem as simple as possible, which limits the practical applicability of the technique. As regards the use of the incremental theory in this paper, it is a fact that investigation of the bending of plates made of work-hardening material by means of the theory of plastic flow is extremely difficult if the customary form of the stress-strain relations is adopted. Indeed, from this relationship, the rate of change of the stress tensor cannot be obtained explicitly in terms of the rate change of the strain tensor, the strain invariants as is necessary in the study of the bending of plates. On the other hand, the application of the theory of plastic deformation for the analysis of circular plate problems made earlier by Russian investigators, in particular, Sokolovsky (Elastic-Plastic Bending of Circular and Annular Plates, Prikl. Mat. Mekh. 8, 141-166 (1944) and his group is worth mentioning in this context.

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VIBRATION RESPONSE AND WAVE PROPAGATION IN PERIODIC STRUCTURES
Mead, D.J.
J. of Engr. Indus., Trans. ASME 93(3), 783-792 (Aug. 1971)

Refer to Abstract No. 71-1420

In general this paper should interest those concerned with the analysis of structures subjected to dynamic loading. The paper investigates the vibration response of periodic structures from a wave propagation approach. The periodic structures considered exist in aerospace structures and in other reinforced plate structures and are readily identified by their identical unit

construction. This type of structure is approximated in the paper by a beam on a number of equally spaced elastic supports. The paper explores the important case where the wavelengths within the structure are of the same order as the distance between supports and hence a strong coupling of the response across one or more elastic supports is expected. These types of motion can be produced by convecting pressure fields acting on the structure, and are of considerable interest because of the structural damage they can cause.

In the analysis section of the paper, the author first presents a wave analysis of undamped periodic structure of infinite length. Then, a convected harmonic excitation field and structural damping are included in the analysis, and the forced wave motion of the finite periodic structure is obtained. The level of the damping is not restricted in this analysis. The finite periodic structure response is shown to be the sum of the forced wave response of an infinite periodic beam and a complementary solution which involves four unforced waves. These four waves satisfy the boundary conditions of the finite beam when they act together with the forced wave.

For the numerical analysis, the transverse stiffness of the elastic supports to the beam structure is assumed to be infinite. For this limiting case only two unforced waves occur in the complementary solution. The author states that the analysis is simpler and easier to interpret when one avoids a transfer matrix formulation and for the particular structure solved, one must agree. For more complicated structures, i.e., structures with a number of periodically spaced point dampers per span or periodic curves structures, a transfer matrix formulation should be simpler and the physical insight gained by the authors formulation would be lost in algebraic manipulation.

Numerical evaluation of the response of a five-span beam to acoustic excitation are obtained and compared to a similar structure of infinite length. Two cases are considered, namely; the beam is excited by an acoustic plane wave traveling at a given convection velocity, and by a convected sound field consisting of a random plane sound wave with a constant spectral density. The author then comments on the applicability of the wave propagation approach to rib-skin structures and to structural optimization.

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AXIALLY SYMMETRIC WAVES IN TRANSVERSELY ISOTROPIC RODS
Mengi, Y. and McNiven, H. D.
J. Acoust. Soc. Am. 50 (1), 248-257 (July 1971)

Refer to Abstract No. 71-1323

ANALYSIS OF THE TRANSIENT EXCITATION OF A TRANSVERSELY ISOTROPIC ROD
Mengi, Y. and McNiven, H. D.
J. Acoust. Soc. Am. 50 (1), 258-265 (July 1971)

Refer to Abstract No. 71-1324

FORCED VIBRATIONS OF FINITE, TRANSVERSELY ISOTROPIC RODS
Mengi, Y. and McNiven, H. D.
J. Sound and Vib. 17(3), 335-348 (Aug. 8, 1971)

Refer to Abstract No. 71-1474

TRANSIENT WAVE PROPAGATION IN A SEMI-INFINITE, TRANSVERSELY ISOTROPIC ROD
McNiven, H. D. and Mengi, Y.
J. Sound and Vib. 17 (1), 41-49 (July 8, 1971)

Refer to Abstract No. 71-1322

This group of four papers presents a study of axially symmetric wave propagations in transversely isotropic rods. The first paper is a development of a three-mode approximation in which only the longitudinal, first radial and first axial shear modes are retained. The retention of these modes is argued by comparing the frequency spectra of the approximate theory with those previously obtained from the exact theory. Adjustment factors were included to make the approximate spectral line match more closely

the exact lines. Comparisons were made for both magnesium and an unspecified fiber reinforced material. The equations of motion are obtained by the Hu-Washizu variational principle and frequency equations are obtained for harmonic motion.

The second and third paper present applications of this theory to two problems. The transient solution of the second paper is obtained by applying the method of characteristics to a bar with a uniform time dependent load applied to one end. A fuller treatment is given in the authors' Ref. 7 (Mengi and McNiven, Intl. J. Solids and Struc. 6, 871-892). Solutions are given for a constant force. Radial strain, axial strain, and axial generalized force at one diameter from the loaded end are presented for the two materials previously mentioned.

The forced vibrations are studied in the third paper. The free vibration mode shapes are obtained and superimposed to solve the forced vibration problem. Solutions are obtained for a uniform pressure distribution on one end which varies harmonically with time while the other end is free. Numerical results are presented for two cases; input frequency equal to a modal frequency and input frequency between modal frequencies.

The remaining paper investigates the transient waves in a semi-infinite rod using the three-dimensional theory of elasticity. An asymptotic solution valid for large distances from the end of the rod or the head of the pulse is obtained. No comparisons with the three-mode approximations are given.

These papers contain few examples but the general equations and solutions presented should be useful.

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PARAMETRIC RESONANCE OF A SINGLE DEGREE-OF-FREEDOM SYSTEM WITH DOUBLE BILINEAR HYSTERESIS
Asmis, K.G. and Tso, W.K.
Intl. J. Nonlinear Mech. 6 (4), 415-426 (Aug. 1971)

Refer to Abstract No. 71-1578

Several different mathematical models have been used to describe the hysteretic behavior of material damping in real engineering systems. The most widely used representation is the bilinear hysteretic model wherein the force-deflection characteristic of the system is replaced by a single parallelogram shaped relationship. In contrast, the "double bilinear" hysteretic restoring force is an example of a model formulated to produce a lower hysteretic loss than the bilinear model; its hysteresis loss is exactly half that of the usual bilinear model for the same amplitude of response.

In this paper, the authors utilize the "method of averaging" or the "technique of slowly varying amplitude and phase" to determine both first and second order approximations to the steady state parametric resonant response of a simple pendulum with a hinge exhibiting a double bilinear hysteretic moment-rotation characteristic. The determined steady state amplitude is verified by direct integration of the governing differential equation.

While a linear system with linear viscous damping gives unbounded response during parametric resonance, it is shown that such a system with damping modeled by the double bilinear hysteretic relationship generally yields a bounded response. Moreover, an explicit condition is given on the amplitude of the excitation in order that a bounded response be obtained.

The paper demonstrates that the double bilinear hysteretic system is less effective in limiting the growth of oscillation during parametric resonance than a similar system with bilinear hysteretic characteristics. In addition, the steady state parametric resonant response curves for the double bilinear hysteretic system are shown to lean strongly toward the lower frequency direction, resulting in a large "overhang" outside

the range of the normal parametrically resonant frequencies of the support excitation. Thus, unlike a bilinear hysteretic system, the double bilinear hysteretic system can be parametrically excited into large amplitude oscillations outside the normal parametric resonant range of excitation frequency, provided the initial disturbances are large.

Although the authors state that physical systems containing elements with double bilinear hysteretic characteristics are few, they suggest that this predicted existence of large amplitude oscillations outside the parametric resonant range could provide the experimental criterion for verifying the validity of using the double bilinear hysteretic model as a reasonable representation of material damping in practical engineering problems.

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THE FORCED MOTION OF A NONCONSERVATIVELY LOADED ELASTIC SYSTEM
Walter, W.W.
J. Sound and Vib. 18, 297-310 (1971)
Refer to Abstract No. 72-3

The paper considers the initial boundary value problem of a beam type one-dimensional continuous elastic system. The system is subjected to three types of loading: (1) it is a time-independent nonconservative load (the effect of this loading makes the problem no longer self-adjoint); (2) a prescribed time-dependent boundary conditions; and (3) lateral loading which is both spatial and time-dependent.

The author has skillfully blended the ideas derived from modal solution technique, the use of biorthogonality in nonself-adjoint operators and the use of William's method to provide a formal solution to the problem. The modal technique with the biorthogonality of modes enables the system to be decoupled so that the response of the system can be found by summing each modal contribution. The William's method resolves the complications introduced by the time-dependent prescribed boundary conditions. Such a technique is also referred to as the "Mindlin-Goodman Technique" (J. Appl. Mech. Trans. ASME, 377-380 (1950)).

Finally, an example is provided considering a cantilever with an end platform and loaded by a nonconservative axial load P with a fixed line of action and a time-dependent shear force acting at the free end. Numerical results are given to show the motions of the system and the mode shapes for particular sets of system parameters.

The paper is clearly written and has extended the modal technique commonly used for vibrations of conservative elastic systems to cover vibrational problems of nonconservative elastic systems.

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RESPONSE OF AN ACCELERATING VEHICLE TO RANDOM ROAD UNDULATION
Virchis, V.J. and Robson, J.D.
J. Sound and Vib. 18(3), 423-427 (Oct. 8, 1971)
Refer to Abstract No. 72-157

Consider a vehicle traveling across an undulating surface in such a way that each tire is always in contact with the surface (no bouncing of tires). If this surface is now modeled by a homogeneous stochastic process the imposed displacements of the points of contact of the tires will, as functions of time, in general be nonstationary stochastic processes. They will be stationary only in case of a steady state traveling vehicle.

The authors of this paper try to estimate the influence of the nonstationarity, assuming uniform acceleration, on the vehicle response within the framework of correlation theory. The vehicle is modeled by a single degree-of-freedom oscillator with data taken for a Hillman Imp. The correlation function of the surface undulation has been computed from surveyed data of a country road. As an indication of component stress the authors used relative displacement, the variance of which they calculated by a numerical integration technique using its integral representation in the time domain. Their results show that for their model the effect of acceleration (or deceleration) likely to be important in road vehicles on the variance of relative displacement is small (acceleration decreases and deceleration increases the variance slightly). Their results thus could indicate that a quasi-stationary treatment of such nonstationary problems would be sufficient.

But to justify such a general statement, which of course would be of great use for the investigation of complicated models of vehicles, further results (at least also variances of absolute displacement, velocity and acceleration) of not so simple models under variation of physical parameters would necessary.

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FREE VIBRATIONS OF FREELY SUPPORTED OVAL CYLINDERS
Culberson, L.D. and Boyd, D.E.
AIAA J. 9(8), 1474-1480 (Aug. 1971)
Refer to Abstract No. 71-1482

The authors present a theoretical method to determine the natural frequency and mode shapes for freely supported doubly symmetrical oval cylindrical shells. Two sets of equations of motion are derived by using Donnell's and Love's shell theories and comparison are made between the numerical results of the two formulations. Little difference is observed for a wide range of shell configurations. Good agreement is also obtained for comparison with the previously known results.

As the eccentricity parameter (ϵ) of oval cross sections increases, circumferential mode shapes vary significantly from those of circular cylinders ($\epsilon = 0$). Since the conventional manner of describing the circumferential modes by the number of crossing around the circumference is no longer adequate, the authors present a tracing of the calculated modes through a range of ϵ from zero to unity. Frequency spectrum vs circumferential wave number becomes highly irregular with the eccentricity increasing.

The presented approach may be useful for designers.

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Technical Notes

Mangiarotty, R.A.
AERODYNAMIC FLOW NOISE INTERFERENCE IN ACOUSTICALLY LINED DUCTS
J. Acoust. Soc. Am. 50(6), 1447-1448 (Dec. 1971) 4 ref

Schmerr, L.W., Jr. and Thau, S.A.
DYNAMIC STRESSES ALONG A RIGID-SMOOTH BOUNDARY OF A QUARTER-SPACE DUE TO INCIDENT RAYLEIGH WAVES
J. Appl. Mech., Trans. ASME 38(4), 1076-1078 (Dec. 1971) 9 refs

Tso, W.K. and Fung, D.P.K.
DYNAMIC INSTABILITY UNDER THE COMBINEDACTIONS OF NONCONSERVATIVE LOADING AND BASE MOTION
J. Appl. Mech. 38(4), 1074-1076 (Dec. 1971) 4 refs

Yang, J.C.S.
ELASTIC-PLASTIC WAVE CANCELLATION IN ENERGY-ABSORBING MATERIALS
AIAA J. 9(12), 2451-2453 (Dec. 1971) 1 ref

Yang, J.N.
STATISTICAL DISTRIBUTION OF SPACECRAFT MAXIMUM STRUCTURAL RESPONSE
J. Spacecraft and Rockets 9(1), 57-59 (Jan. 1972) 12 refs

A SOCIAL SURVEY INTO ANNOYANCE CAUSED BY THE INTERACTION OF AIRCRAFT NOISE AND TRAFFIC NOISE
J. Sound and Vib. 19(4), 473-476 (Dec. 22, 1971) 6 refs

CALENDAR

Meeting	Date 1972	Location	Contact
National Telemetering Conference, IEEE	MAY 1-5	Houston, Tex.	IEEE Hq.
27th Annual Technical Conference and Exhibit, ASQC	8-10	Washington, D.C.	R. W. Shearman, ASQC Hq.
Design Engineering Conference and Show, ASME	8-11	Chicago, Ill.	T. Ferdinand, ASME Hq.
Symposium on Noise and Vibration Control for Industrialist, SEE	10-12	Bath Univ. Tech., Bath, England	Secretariat, SEE Hq.
6th St. Louis Symposium on Composite Materials in Engineering Design, ONR, ARPA	11-12	St. Louis, Mo.	B. R. Noton, Engr. Design Lab., Wash. Univ., Box 1185, St. Louis, Mo. 63130
Mid-Year Meeting, SAE	15-19	Chicago, Ill.	A. J. Favata, SAE Hq.
Spring Joint Computer Conference, AFIPS	16-18	Atlantic City, N.J.	H. G. Asmus, AFIPS Hq.
Power Instrumentation Symposium, ISA	22-24	Dallas, Tex.	A. A. Syriotis, Bechtel Corp., Box 58587, Los Angeles, Calif. 90058
National Automobile Meeting, SAE	22-26	Detroit, Mich.	A. J. Favata, SAE Hq.
Spring Meeting and Exposition, SESA	23-26	Cleveland, Ohio	B. E. Rossi, SESA Hq.
National Air Transportation Meeting and International Forum for Air Cargo, SAE, AIAA, ASME	31-2	Washington, D. C.	A. J. Favata, SAE Hq.
Lubrication Symposium, ASME	JUNE 5-8	Boston, Mass.	A. B. Conlin Jr., ASME Hq.
13th Joint Automatic Control Conference, AIAA, AIChE, ASME, IEEE, ISA	16-18	Stanford Univ. Stanford, Calif.	D. B. DeBra, Stanford Univ., Stanford, Calif. 94305
Applied Mechanics Conference, ASME	26-28	Univ. Calif. La Jolla, Calif.	A. B. Conlin Jr., ASME Hq.
National Transportation Engineering Conference, ASCE	JULY 17-21	Milwaukee, Wis.	Meetings Manager, ASCE Hq.
National West Coast Meeting, SAE	AUG. 21-24	San Francisco, Calif.	A. J. Favata, SAE Hq.
6th International Conference on Nonlinear Oscillations, Acad. Sci. USSR, Czech. Acad. Sci., German Acad. Sci., Polish Acad. Sci.	29-4	Poznań, Poland	Polish Acad. Sci., Inst. Fundamental Tech. Res., Organizing Committee of the 6th Intl. Conf. Nonlinear Oscillations, Warsaw, Swietokrzyska 21, Room 334, Poland
Applied Mechanics Western Conference, ASME	29-31	Honolulu, Hawaii	A. B. Conlin Jr., ASME Hq.
National Combined Farm Construction and Industrial Machinery and Powerplant Meeting, SAE	SEPT. 11-14	Milwaukee, Wis.	A. J. Favata, SAE Hq.
National Aeronautic and Space Engineering and Manufacturing Meeting, SAE	OCT. 2-6	San Diego, Calif.	A. J. Favata, SAE Hq.
International Conference on Noise Control Engineering, INCE	4-6	Washington, D.C.	M. J. Crocker, R. W. Herrick Labs., School Mech. Engr., Purdue Univ., Lafayette, Ind. 47907
12 US Mechanisms Conference, ASME	8-11	San Francisco, Calif.	A. B. Conlin Jr., ASME Hq.
Industrial and General Applications Group Annual Meeting, IEEE	9-12	Philadelphia, Pa.	J. A. Herrmann, ITE Circuit Breaker Co., 1900 Hamilton St., Philadelphia, Pa. 19130
Symposium for Gearing and Transmissions, IFToMM, ASME, AGMA	11-12	San Francisco, Calif.	A.I. Tucker, Mail Zone C-3, Solar Div., Intl. Harvester Co., 2200 Pacific Hwy., San Diego, Calif. 92112
Annual and National Environmental Meeting, ASCE	16-20	Houston, Tex.	Meetings Manager, ASCE Hq.
Fall Meeting, SESA	17-20	Seattle, Wash.	B. E. Rossi, SESA Hq.

CALENDAR

Meeting	Date 1972	Location	Contact
16 Stapp Car Crash Conference, Wayne State Univ., Univ. Mich., SAE, Univ. Calif.	NOV. 8-10	Detroit, Mich.	A. J. Favata, SAE Hq.
Winter Annual Meeting, ASME	12-16	New York, N.Y.	A. B. Conlin Jr., ASME Hq.
Fall Joint Computer Conference, AFIPS	14-16	Las Vegas, Nev.	D. R. Cruzen, AFIPS Hq.
Fall Meeting, ASA	27-1	Miami Beach, Fla.	M. Kronegold, Inst. Marine Sci., Rickenbacker Causeway, Miami, Fla. 33149
75th Anniversary Meeting, ASTM	DEC. 3-5	New Orleans, La.	H. H. Hamilton, ASTM Hq.
43rd Shock and Vibration Symposium	5-7	Asilomar, Calif.	*Shock and Vibration Information Center*, Washington, D.C. 20390
	1973		
Automotive Engineering Congress and Exposition, SAE	JAN. 8-12	Detroit, Mich.	A. J. Favata, SAE Hq.
Dynamics Specialist Conference, AIAA	MAR. 19-20	Williamsburg, Va.	*Meetings Manager*, AIAA Hq.
14th Structures, Structural Dynamics and Materials Conference, AIAA, ASME, SAE	20-23	Williamsburg, Va.	Meetings Manager, AIAA Hq.
International Convention and Exhibit, IEEE	26-29	New York, N.Y.	J. M. Kinn, IEEE Hq.
Annual Structural Engineering Meeting, ASCE	APR. 9-13	San Francisco, Calif.	Meetings Manager, ASCE Hq.
Joint Railroad Technical Conference, IEEE, ASME	11-12	St. Louis, Mo.	IEEE Hq.
International Congress on Experimental Mechanics, SESA	MAY 13-18	Los Angeles, Calif.	B. E. Rossi, SESA Hq.
National Automobile Meeting, SAE	14-18	*Detroit, Mich.*	A. J. Favata, SAE Hq.
Spring Joint Computer Conference, AFIPS	15-17	Atlantic City, N.J.	H. G. Asmus, AFIPS Hq.
14th Joint Automatic Control Conference, AIAA, AIChE, ASME, IEEE	JUNE 20-22	Ohio State Univ. Columbus, Ohio	H. R. Weed, Dept. EE, Ohio State Univ., Columbus, Ohio 43210
76th Annual Meeting and Exposition, ASTM	24-25	Philadelphia, Pa.	H. H. Hamilton, ASTM Hq.

ACRONYM DEFINITIONS AND ADDRESSES OF SOCIETY HEADQUARTERS

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

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

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

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

ARPA: Advanced Research Projects Agency

ASA: Acoustical Society of America
335 E. 45 St., New York, N.Y. 10017

ASCE: American Society of Civil Engineers
345 E. 47 St., New York, N.Y. 10017

ASME: American Society of Mechanical Engineers
345 E. 47 St., New York, N.Y. 10017

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

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

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

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

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

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

INCE: Institute of Noise Control Engineering

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

ONR: Office of Naval Research
Code 400H4, Dept. Navy, Arlington, Va. 22217

SAE: Society of Automotive Engineers
2 Pennsylvania Plaza, New York, N.Y. 10001

SEE: Society of Environmental Engineers
68a Wigmore St., London W1H 9DL, England

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

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

URSI-USNC: International Union of Radio Science - US National Committee
c/o MIT Lincoln Lab., Lexington, Mass. 02173

GPO 935-947

PUBLICATIONS OF THE SHOCK AND VIBRATION INFORMATION CENTER

THE SHOCK AND VIBRATION BULLETIN

The Shock and Vibration Bulletins contain the proceedings of the annual shock and vibration symposia. They include papers presented; transcribed, edited discussions and panel sessions; and supplementary papers. Early issues of the Bulletin are out of print. Those since 1965, as well as a cumulative index of bulletins 1 through 35, may be requested from SVIC (remaining bulletins are currently being indexed). The Defense Documentation Center can supply any part of Bulletins 1 through 39 to qualified requestors. Bulletin 40, at $15.00, Bulletin 41 at $15.00 and Bulletin 42 at $40.00 may be ordered from the Shock and Vibration Information Center. Two cumulative Indexes of the Bulletins, one for Bulletins 1 – 35 and one for Bulletins 36 – 41 are available on request from the Shock and Vibration Information Center.

THE SHOCK AND VIBRATION MONOGRAPH SERIES

The monographs are summary state-of-the-art works, varying from less than 100 to 300 or more pages. SVM-1 is out of print. SVM-2 through SVM-8 are available at the prices listed from the Shock and Vibration Information Center, Naval Research Laboratory, Code 6020, Washington, D.C. 20390.

SVM-1 Random Noise and Vibration in Space Vehicles, by Richard H. Lyon; 66 pp, 31 figs., 4 chapters, 94 refs. 1967, price $1.50. Methods of predicting the response of a flight vehicle to the dynamic environment and levels to be encountered are reviewed. Simulation of these environments is described.

SVM-2 Theory and Practice of Cushion Design, by Gordon S. Mustin; 332 pp, 224 figs., 9 chapters, 311 annotated refs. 1968, price $2.75. Data on cushioning materials, their properties under all conditions, and helpful design information has been compiled from available literature. The emphasis is on materials and their properties, rather than devices which incorporate cushioning materials. The book should be useful to theoreticians, materials engineers, designers, specification writers, manufacturers and users.

SVM-3 Programming and Analysis for Digital Time Series Data, by Loren D. Enochson and Robert K. Otnes; 277 pp, 75 figs., 10 chapters, 48 refs. 1968, price $3.50. A comprehensive study of digital computer programming for, and analysis of, digital time series data is presented. These data may occur in such diverse fields as vibration acoustics, communications, control, oceanography, seismology, biomedical research and structural dynamics. While the treatment of the subject requires the use of advanced concepts, the introductory chapter bridges the gap. Examples are included at frequent points throughout the text to clarify concepts.

SVM-4 The Dynamics of Rotating Shafts, by Robert G. Loewy and V. J. Piarulli; price $[illegible]. Three main topics are treated: lateral motion, coupled lateral-torsional motion, and balancing. An unusual feature of this work is a bibliography of more than 540 references indexed both by subject and author.

SVM-5 Principles and Techniques of Shock Data Analysis, by R. F. Kelly and G. Richman; price $[illegible]. No clear-cut method exists to measure a singular shock, or to compare the relative severity of any two shocks unambiguously. The authors have brought together all of the techniques currently in use to observe, define, and analyze transient mechanical phenomena.

SVM-6 Optimum Shock and Vibration Isolation, by E. Sevin and W. Pilkey; price $7.50. Contempor[illegible] approaches to the problems of optimum shock and vi[illegible]lation design are discussed. Isolation systems su[illegible]ck, harmonic, and random environments are con[illegible]red. Emphasis is given to design methods whose applicability extends to large, real-world systems. An extensive annotated bibliography is included.

SVM-7 The Influence of Damping in Vibration Isolation, by J. E. Ruzicka and T. Derby; price $15.00. The influence of damping on the performance of passive vibration isolation systems subjected to harmonic vibration excitation is treated. To focus attention on isolator damping characteristics, consideration is limited to an idealized vibration isolation system in the form of a rigid mass connected to a rigid foundation by an isolator having linear stiffness characteristics and a wide range of linear and nonlinear damping characteristics. The isolation system performance characteristics considered include transmissibility, amplification factor, resonance properties, and vibration attenuation rates in the low and high frequency regions.

SVM-8 Selection and Performance of Vibration Tests, by A. J. Curtis, H. T. Abstein and N. Tinling; price $15.00. The rather widely scattered state of the art knowledge regarding the selection and performance of laboratory vibration tests has been compiled into one volume to serve as a guide and reference for the designer, the specifier and the practitioner. The monograph does not tell the reader which test to select nor does it provide a cookbook procedure with which a test may be performed. Rather, the principles and considerations which must be weighed in selecting a test and the requirements for satisfactory performance of that test are described. An extensive bibliography is included.

SVM-9 Equivalence Techniques for Vibration Testing, by W. C. Fackler; publication date September 197[illegible]. A current overview of progress in the development of vibration equivalence techniques is presented. An extensive list of annotated references, an annotated bibliography, and many ideas offered by the respondents to a letter survey of 186 authors and engineers in the field of vibration testing are included. The events associated with vibration testing and simulation are carefully organized, and it is clearly shown how the vibration equivalence techniques are used to define the relationship of these events. The index contains both author and subject entries to provide rapid access to the monograph contents.

OTHER PUBLICATIONS

The third edition of Index of Environmental Test Equipment in Government Establishments, (776 pp, Nov. 1967) is available to qualified requestors. This volume consists of three parts. Part I lists the establishments contributing data to the compilation, and those having corresponding equipments. Part II gives in tabular form detailed information about all environmental test equipment at each establishment. Part III lists the more important performance characteristics of commercially available test equipments such as centrifuges, shock testers, mechanical and electrodynamic vibrators.


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