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THE SHOCK AND VIBRATION DIGEST. VOLUME 4. NUMBER 7,(U)
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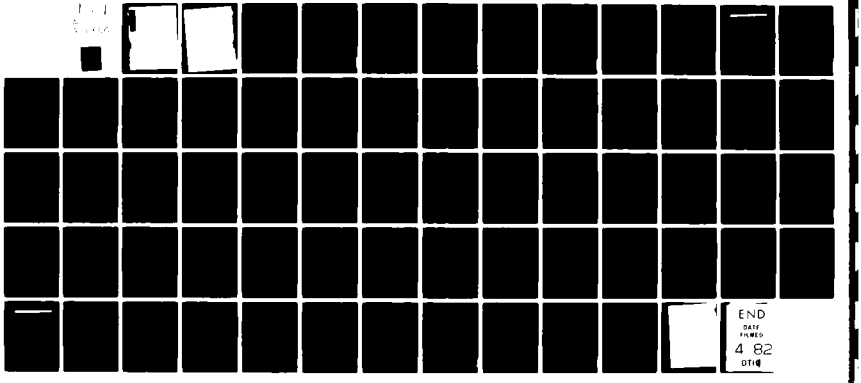

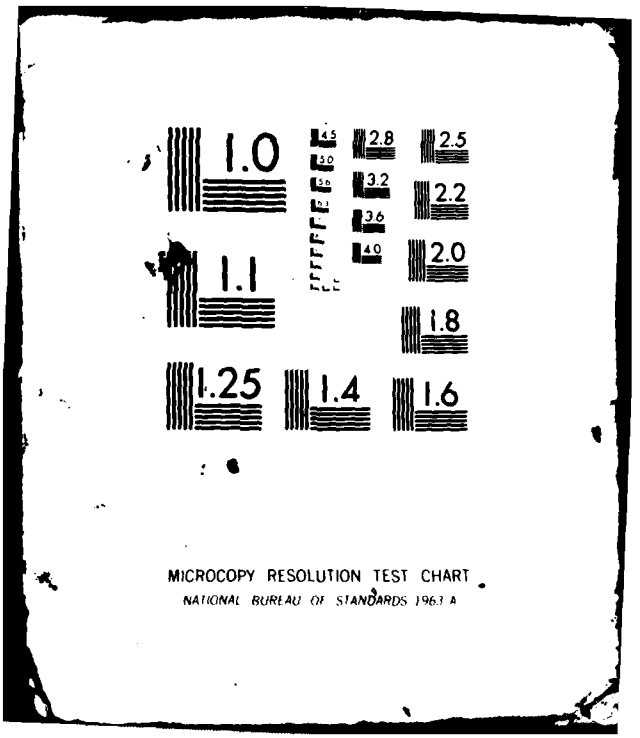
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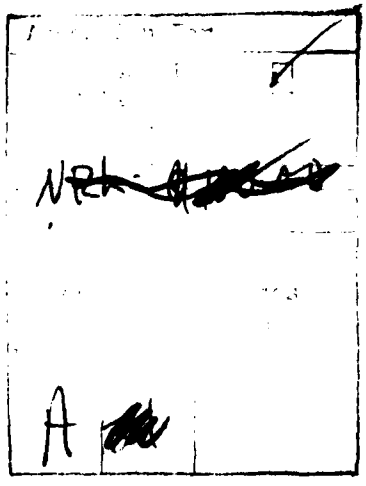
43RD SHOCK AND VIBRATION SYMPOSIUM

The deadline for those offering papers for presentation at the 43rd Shock and Vibration Symposium has been extended to 21 August 1972. Papers are solicited on problems related to the measurement, description, simulation and control of mechanical shock and vibration. Papers will be selected for presentation at the symposium on the basis of a summary. The summary cover sheet provided as the last page of this issue of the DIGEST should accompany the submitted summary. Completed manuscripts, due by the date of the Symposium, will be considered for publication in the Shock and Vibration Bulletin.

The 43rd Shock and Vibration Symposium, to be held at Asilomar, California, 5-7 December, will be hosted by the U.S. Army (Fort Ord near Monterey).



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EDITORS RATTLE SPACE

RELEVANCY AND COMMUNICATIONS IN ENGINEERING

In the January 1971 issue of the SHOCK AND VIBRATION DIGEST, K. E. McKee wrote an editorial on "Relevancy in Engineering." He applied this term to the particular subject of the relevancy of many of the highly theoretical papers published in technical journals as they relate to the needs of the working engineer. It was pointed out that such articles are often of very little help in assisting engineers in the solution of everyday problems. He blames this problem on the colleges and professional societies in that the training provided by these institutions is often not relevant to prepare the young engineers to work in industry.

It appears to me that the relevancy issue in engineering is a much broader one than that indicated by Dr. McKee. This broader issue includes the entire field of communication. In order to obtain more practical articles, someone has to write them and in order to provide the engineer with an education better suited to his career, someone has to prepare the required material and communicate it to the engineering student. A proposed expansion of the technical curriculums in our colleges and universities was discussed in another editorial by myself in the April 1971 issue of the SHOCK AND VIBRATION DIGEST.

Unfortunately, engineers are taught by engineers and engineers will have to do the writing. I say "unfortunately" because engineers in general are rather poor communicators and their introverted nature makes it difficult for them to express themselves in writing. There are exceptions, of course, but not a sufficient number of them to get the job done.

For example, in a recent vote taken by the Institute of Electrical and Electronics Engineers to determine if the IEEE should get involved in nontechnical issues such as engineers' salaries and employment practices, only one-third of the membership voted. This means that 82,900 engineers did not care to communicate their views on a subject that might be vital to their professional survival. Many other examples could be cited to indicate that engineers do not care to get involved or are unable or unwilling to communicate either with each other or the general public. This lack of communication is responsible in part for the technical decline in this country for the past few years and the subsequent economic problem that many engineers are facing today.

The question is of course what has caused this lack of interest to communicate with others and what can be done about it. Is it the educational process in engineering that produces individuals who cannot or do not wish to communicate or is it that mostly introverted individuals are attracted to engineering in the first place? I believe that the answer is partially due to both factors. Since the problem of individual development prior to the college level is too complex to consider here, the emphasis must be placed on trying to educate the engineer in the universities and technical schools so that he enters his professional life not only with a relevant technical education but also with relevant knowledge as to how to evaluate the social impact of his technical decisions. He must also have been trained to: (1) appreciate his social responsibility; (2) have the ability to communicate with technical and nontechnical individuals; and (3) have the desire to become involved so that he can contribute to the technical, political, and social environment of which he is a part.

G. Harold Klein

SYMPOSIUM ON VIBRATION PROBLEMS IN INDUSTRY

An international symposium which will concentrate on the practical aspects of vibration problems and their solution is planned for April 10-12, 1973 at Keswick, English Lakes Region, England. The symposium will provide an opportunity for designers and operators to describe their experiences in the presence of experts in the relevant fields of vibration analysis and testing. It is anticipated that considerable mutual benefit will be derived from the interchange of data and ideas from associated regimes of vibrational behavior. While contributions describing original laboratory work will be accepted, special priority will be given to papers which deal with practical instances of problems which have arisen in design or operation.

At each session a recognized expert will present an introductory paper and this will be followed by short papers submitted by delegates. The following fields will be covered and are not confined to the examples given.

1. Flow-induced vibration within an enclosure.
   Example: Tube bank heat exchangers in cross flow.
   Reactor fuel elements in annular flow.

2. Flow-induced vibration in the atmosphere.
   Example: Stability of structures in winds.
   Behavior of aircraft components.
   Stability of high speed vehicles.

3. Flow-induced vibration in liquids.
   Example: Stability of gate valves.
   Oscillation of marine structures.

4. Acoustic vibration.
   Example: Damage to nuclear reactor pressure vessel insulation.
   Damage to pressurized gas circuit components.

Delegates are invited to submit short papers on aspects of vibration mechanics conforming to the headings given. Papers are also invited on techniques and facilities for solving problems together with case histories of successful and unsuccessful approaches. Some time will be set aside for the presentation of up-to-the-minute papers describing work in hand or results obtained from very recent investigations. Papers should not exceed eight pages in length (sheets will be supplied) and should be in English. Abstracts should be 300 to 400 words long and may be in English, French or German. It is intended that all the papers will be published in bound form in advance of the Symposium. Details for intending authors or delegates are available from: Dr. J. R. Wakefield, United Kingdom Atomic Energy Authority, Reactor Development Laboratory, Windscale and Calder Works, Sellafield, Seascale, Cumberland, England.

MEASUREMENT ORIENTED ENGINEERS

A cooperative program at Arizona State University to encourage the development of measurement oriented engineers in all disciplines is announced. The Laboratory for Measurement Systems Engineering at the University and the faculties of Mechanical, Electrical, Civil, Industrial, Chemical Engineering, and Engineering Mechanics and Materials will participate. Under this program all students pursuing studies toward an MS in Engineering may take their option in Measurement Systems Engineering. This program is especially suitable for practicing engineers in industry who wish to return for an MS in an experimentally oriented program. The basis of the studies is a unified approach to the engineering of measuring systems developed at Arizona State University which has been successfully applied for over a decade. A brochure describing the program is available from P. K. Stein, Professor of Engineering, Laboratory for Measurement Systems Engineering, Arizona State University, Tempe, Ariz. 85281.

A short course is being offered on the "Unified Approach to the Engineering of Measuring Systems" January 29 to February 3 in Phoenix, Arizona. The course is directed toward engineers with BS degrees or equivalent, who are

in theoretical, practicing, or administrative positions in industry, government, or educational institutions. The program emphasizes the essential unity between experimental and theoretical approaches, and some of the management problems which arise from organizing such a combination. The program has been offered 81 times throughout the US and Canada since 1962. It is a practical, sensible and sound approach to the problem of getting meaningful data on systems. For further information on the course, contact P. K. Stein, 5602 East Monte Rosa, Phoenix, Ariz. 85018.

STANDARD FOR RESILIENT MOUNTINGS

A new standard has been compiled confronting the problems associated with the proper application of resilient mountings. The standard (American National Standard S2.8-1972) is entitled "Guide for Describing the Characteristics of Resilient Mountings" and is available from the American National Standards Institute. The standard was prepared by a writing group composed of both users and manufacturers who worked under the jurisdiction of the US Standards Institute Sectional Committee S2, Mechanical Shock and Vibration.

The standard presents suggestions as to subject matter and format for describing resilient mountings, so that there will be a clear understanding by both the user and the manufacturer. Since the intention of the standard is to be regarded as a guide rather than a rigid specification. It is beyond the scope of the standard to present dimensional or configuration characteristics of resilient mountings. Rather, it is intended to outline, in standardized form, what data should be presented to enable the experienced designer to apply resilient mounting correctly. Also, the standard defines terminology in a further effort to ease the problem of communication between the user and manufacturer.

FREE FIXTURE DESIGN CRITERIA CHART OFFERED

A chart listing reasonable design criteria for fixtures used in vibration and shock testing is offered free by Tustin Institute of Technology. The new chart presents numerical limits for lowest resonant frequencies, for allowable lateral motion and for allowable differences between vibration intensities at test item attachment points. These limits are less restrictive for large and heavy test items. For the chart contact Tustin Institute of Technology, 22 E. Los Olivos Street, Santa Barbara, Calif. 93105.

SYSTEM IDENTIFICATION OF VIBRATING STRUCTURES -- MATHEMATICAL MODELS FROM TEST DATA

A symposium on the determination of models of dynamic systems on the basis of test data will be held at the ASME National Meeting, New York, November 1972. The symposium is sponsored by the Shock and Vibration Committee of the Applied Mechanics Division of the ASME. A full schedule of invited papers is slated for presentation. Most of the papers will deal with the computational determination of the parameters in the equations of motion of dynamic systems on the basis of available test data on the response of the system. Several papers will review the identification techniques available, including those used in related areas. Other papers will treat specific applications, such as rotating machinery, civil engineering structures, aircraft structures, high-speed ground transportation vehicles, machine tools, and automobiles. The papers are to be published in an ASME Symposium Monograph.

Further information on the Symposium can be obtained from Ray Cohen, Department of Mechanical Engineering, Purdue University, W. Lafayette, Ind. 47907; or Walter Pilkey, Department of Aerospace Engineering, University of Virginia, Charlottesville, Va. 22901.

STRUCTURES, STRUCTURAL DYNAMICS AND MATERIALS CONFERENCE

10-12 April 1972
San Antonio, Tex.

This annual conference, which brought together specialists in structures, structural dynamics and materials, provided a technical forum for the presentation of new developments and design solutions pertinent to advanced transportation systems. The conference was organized within the framework of four major categories of transportation: space and interplanetary, aircraft, ground and marine. Also included were sessions associated with new developments and common problems in key disciplines in the aerospace field. This year the AIAA Technical Committees on Structures, Structural Dynamics and Materials, and the Structures and Materials Committee of the ASME Aviation and Space Division were joined by the Society of Automotive Engineers in sponsoring this meeting.

Sessions on dynamics dealt with ground transportation, space/interplanetary structures, aircraft structures, and structural dynamics technology. A volume of the papers entitled A Collection of Technical Papers on Structural Dynamics as Related to Advanced Transportation Systems is available from the AIAA.

S. Rubin
The Aerosp. Corp.
Los Angeles, Calif.

JULY

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

ADVANCED TOPICS IN NUMERICAL ANALYSIS
Place: Univ. Calif. (LA)
Dates: July 31-Aug. 4
Objective: A number of topics will be presented which are important in the use of numerical analysis but which are relatively new and not normally in the readily available texts.
Contact: P.O. Box 24902, Continuing Ed. Engr. Sci. Univ. Extension, UCLA, Los Angeles, Calif. 90024

AUGUST

COMPUTER PROGRAMS FOR STRUCTURAL ANALYSIS
Place: Univ. S. Calif.
Dates: Aug. 7-11
Objective: The theory used in development of the computer programs will be given by lecturers currently involved in the formulation of new computer analysis in the structural mechanics field. The finite element and finite difference methods will be discussed in detail. The capability and availability of the general purpose structural analysis program NASTRAN will be discussed.
Contact: Noncredit Programs Adm. 353, Univ. S. Calif., Los Angeles, Calif. 90007

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. Summer. 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

PYROTECHNICS AND EXPLOSIVES
Place: Philadelphia, Pa.
Dates: Aug. 21-25
Objective: The course will be welcomed both by newcomers to the field as well as by experienced men who wish to brush up on latest developments. Coverage emphasizes recent effort, student problems, new techniques, and applications.
Contact: Mr. Gunther Cohn, Registrar, The Franklin Inst. Res. Labs., Philadelphia, Pa. 19103

NOISE AND VIBRATION CONTROL IN BUILDINGS
Place: Vancouver, B.C., Canada
Dates: Aug. 29-31
Objective: Emphasis will be placed on practical acoustics and architectural and engineering noise control. The printed lecture notes providing extensive tables of valuable noise and noise control data, and a documentation of the entire course will be given.
Contact: Miss G. A. Cianci or Mrs. C.S. Kelly, Bolt Beranek and Newman, Inc., 50 Moulton St., Dept. C, Cambridge, Mass. 02138

SEPTEMBER

HUMAN ACOUSTICS
Place: Cleveland, Ohio
Dates: Sept. 11-14
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

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

SIMILARITY METHODS AND MODELS IN ENGINEERING
Place: Univ. Tenn.
Dates: Sept. 11-15
Objective: The course will show how similarity methods can be used (1) to obtain quantitative data for prototype design with the aid of small models, (2) to obtain experimental data for verification of a theory, (3) to explore fundamental behavior of a little understood analysis, and (4) to evaluate the limitations of an expensive system that might already be in existence.
Contact: Univ. Tenn., Dept. Conf. Inst., 1345 Circle Park, Knoxville, Tenn. 37916

MECHANICAL VIBRATION
Place: Univ. Tenn.
Dates: Sept. 11-15
Objective: Forced and free vibrations of a simple one degree-of-freedom system will be studied. Topics and areas that may be covered can include: vibration analysis of multidegree-of-freedom systems, vibrations of continuous systems, techniques of vibration isolation and reduction, analysis of nonlinear systems and vibrations resulting from shock loads.
Contact: Univ. Tenn., Dept. Conf. Inst., 1345 Circle Park, Knoxville, Tenn. 37916

NOISE IN MANUFACTURING PLANTS
Plate: Vancouver, B.C., Canada
Dates: Sept. 6-8
Objective: A simple, informative introduction to acoustics is offered followed by a fairly detailed discussion of a number of representative examples of noise control using basic concepts, straightforward methods, and available materials.
Contact: Miss G. A. Cianci or Mrs. C.S. Kelly, Bolt Beranek and Newman, Inc., 50 Moulton St., Dept. C, Cambridge, Mass. 02138

VIBRATION OF STRUCTURES CURRENT ASPECTS OF DAMPING AND CONTROL
Place: Pa. State Univ.
Dates: Sept. 17-22
Objective: This seminar is for the benefit of engineers and scientists working in industry and government. It will provide the participant with a fully up-to-date account of results and techniques for understanding and controlling structural vibration. The basic principles and methods of vibration control will be emphasized. The participant should become able to apply new knowledge to his immediate problems, to organize better his approach to other problems of the present day, and, through increased understanding of the field and familiarity with the relevant literature, to be better equipped to tackle the problems of the future.
Contact: Pa. State Univ., Conf. Ctr. -- Continuing Ed. 410 J. Orvis Keller Bldg., Univ. Park, Pa. 16802

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 Nos. 1040, 1096, 1184)

72-1036

RESONANCES IN NONSTATIONARY NONLINEAR MULTIDEGREE-OF-FREEDOM SYSTEMS

Agrawal, B.N. and Evaniwanowskii, R.M. (COMSAT Labs., Clarksburg, Md.)

AIAA/ASME/SAE 13th Structures, Structural Dynamics and Materials Conf., San Antonio, Tex., (Apr. 10-12, 1972) AIAA Paper No. 72-401, 11 pp, 6 refs

Key Words: multidegree-of-freedom systems, natural frequency, nonlinear systems

An asymptotic method for determining resonant responses of nonstationary nonlinear systems is presented. The resonance conditions, resonance coefficients, and higher order resonances are discussed. The first asymptotic approximation nonstationary solution is obtained for general resonances. A gyroscopic system is analyzed for combination differential resonances $\mu = \omega_2 - 2\omega_1$ and $\mu = \omega_2 - \omega_1$. Using the general solution, the nonstationary and stationary responses and stability conditions are obtained. The numerical results indicate that the change in the rate of variation of the frequency of excitation may shift the nonstationary response from one stable mode to another.

72-1037

APPLICATION OF THE SPECTRUM INVERSION TECHNIQUE TO THE VIBRATION ANALYSIS OF A BUILT-UP PLATE

Morrow, B.W.
Univ. Miami, PhD Thesis (1971) 82 pp

Key Words: mode shapes, natural frequencies, plates

The spectrum inversion technique for the vibration analysis of structures is a method adapted by Plass from a mathematical technique developed by Bazley and Fox. The technique permits simultaneous variations on deflection and moment and the shape and moment distribution of the vibrating system are represented as an eigenvector and the natural frequency is the corresponding eigenvalue. This method is used to obtain upper and lower bounds on natural frequencies of vibration and estimates of the corresponding deflection patterns for a particular configuration. This structure is composed of a gridlike core, formed by mutually intersecting beamlike web members, and two thin cover sheets bonded to the core. Numerical solution of the operator-eigenvalue problem appropriate for this structure, yields bonds on the first three natural frequencies and approximations to the corresponding mode shapes. These theoretical results are compared with experimental values obtained for the same structure by Austin and Plass. Reasonably good agreement was found between the theoretical and experimental results. U.M. 72-12887

72-1038

STATISTICAL LOADS ANALYSIS TECHNIQUE FOR SHOCK AND HIGH-FREQUENCY EXCITED ELASTODYNAMIC CONFIGURATIONS

Saczalski, K.J. and Park, K.C. (Clarkson Col. Tech., Potsdam, New York)

U.S. Naval Res. Lab., Shock Vib. Bull. 42 (5), 101-107 (Jan. 1972) 19 refs

Key Words: elastodynamic response, high frequency excitation, shock excitation, statistical analysis

A recently developed technique for describing deterministic and nondeterministic response characteristics of shock and high-frequency excited elastodynamic systems is extended, in a statistical sense, to determine reactive loads, and resulting stresses, at desired locations on structural elements within the system. The coupled transcendental elastodynamic equations include the elastic wave effects of continuous mass distributed structural elements in addition to the inertial effects of arbitrarily shaped rigid bodies. Depending upon the type of excitation imposed on the system, the calculated loads and stresses may be compared to known experimental and analytical failure criteria to establish limits of structural reliability.

INTEGRAL TRANSFORMS

72-1039
ON THE USE OF FOURIER TRANSFORMS OF MECHANICAL SHOCK DATA
Gaberson, H.A. and Pal, D. (Naval Civil Engr. Lab., Port Hueneme, Calif.)
U.S. Naval Res. Lab., Shock Vib. Bull. 42(5), 87-96 (Jan. 1972) 9 refs

Key Words: Fourier transforms, shock waves

Some uses and analyses of Fourier transforms of mechanical shock motions are presented. A simplified proof that the magnitude of the acceleration transform is the residual velocity shock spectrum is given in a form that readily introduces the "running" Fourier transform. A method is presented for analyzing high narrow peaks on actual Fourier transforms to determine the actual excursion associated with the peak frequency. The effects of truncating the record of a slowly decaying transient is also considered. The paper closes with a discussion of the merits of the various transforms.

NUMERICAL ANALYSIS

72-1040
ON A DIRECT-ITERATIVE EIGENSOLUTION TECHNIQUE
Dong, S.B. and Wolf, J.A., Jr. (Sch. Engr. and Appl. Sci., Univ. Calif., Los Angeles, Calif.)
Intl. J. Numer. Methods Engr. 4(2), 155-161 (Mar.-Apr. 1972) 19 refs

Key Words: mode shapes, natural frequencies

Two variations of an iterative scheme are presented for the solution to algebraic eigensystems. These algorithms are used in conjunction with the method of reduced generalized coordinates so that n number of frequencies and mode shapes are obtained simultaneously. The bases of the scheme are the well-known results of Stodola-Vianello and Gram-Schmidt. Advantages of the present schemes are realized both in computational effort and in computer storage. Examples are presented to illustrate the convergence characteristics.

72-1041
A NUMERICAL CALCULATION OF A BILATERAL LIMIT FOR DESIRED VECTORIAL AND TENSORIAL FIELD QUANTITIES OF THE ELASTIC EIGENVIBRATION STATE
Stumpf, H. (Institut für Technische Mechanik, Technische Hochschule, 51 Aachen, Templergraben 55 (BRD))
Z. Angew. Math. Mech. 52(1), 37-44 (Jan. 1972) 8 refs

Key Words: eigenvalue problems

An investigation and a numerical illustration is given of a method that allows the limitation of arbitrary field quantities in two- or three-dimensional linear-elastic bodies in the state of eigenvibrations. The energy of the Green state coordinated to the field quantity is not presupposed to be infinite.

OPTIMIZATION TECHNIQUES
(Also see No. 1118)

72-1042
LIMITING PERFORMANCE OF GROUND TRANSPORTATION VEHICLES SUBJECT TO TRANSIENT LOADING
Pilkey, W.D. and Wang, B.P. (Univ. Va., Charlottesville, Va.)
AIAA/ASME/SAE 13th Structures, Structural Dynamics and Materials Conf., San Antonio, Tex., (Apr. 10-12, 1972) AIAA Paper No. 72-340, p. 1-5, 6 refs

Key Words: collision research, ground vehicles, linear programing

The problem of limiting performance of vehicles in protecting passengers or freight under crash conditions or the isolation of passengers from rough terrain is considered. Linear programing is employed and rather than analyzing specific isolator configurations, the absolute optimum performance is computed regardless of configuration. The limiting performance characteristics are useful as guides to the effectiveness of existing systems. Also, these characteristics allow the system designer to ascertain on the basis of response specifications alone the feasibility of a proposed design; in addition, he can measure and monitor his progress during the design process. Numerical results are included.

STABILITY ANALYSIS

72-1043

STABILITY OF MOTION OF FORCE-FREE SPINNING SATELLITES WITH FLEXIBLE APPENDAGES

Meirovitch, L. and Calico, R.A. (Va. Polytech. Inst. and St. Univ., Blacksburg, Va.)

J. Spacecraft Rockets 9(4), 237-245 (Apr. 1972) 13 refs

Key Words: dynamic stability, Lyapunov's method, rotating bodies

Two approaches to the stability analysis of torque-free spinning bodies consisting of a main rigid body and a number of distributed elastic parts are presented. The stability analysis is based on the Lyapunov direct method and automatically takes into consideration the existence of motion integrals. The first approach to the stability problem is based on modal analysis, whereas the second one makes use of integral coordinates. The case of a torque-free satellite represented by a rigid hub with six flexible appendages is solved. Closed-form stability criteria derived by the second approach compare favorably with numerical results obtained by modal analysis.

72-1044

DYNAMIC STABILITY ANALYSIS BY THE CONJUGATE GRADIENT METHOD

Rubinstein, M.F. and Roberts, T.A. (Sch. Engr. and Appl. Sci., Univ. Calif., Los Angeles, Calif.)

J. Franklin Inst. 293(3), 173-189 (Mar. 1972) 9 refs

Key Words: dynamic stability, finite element technique, gradient methods

A method is presented to determine the regions of dynamic instability of a structural system. The finite element method is employed in problem formulation, and the conjugate gradient method is used to compute the boundaries of dynamic instability by minimizing appropriate Rayleigh quotients. The solution of the governing equation is reduced to a problem of finding the frequencies which bound the region of dynamic instability. An algorithm is presented for computing the boundary frequencies for the first mode of dynamic instability. Higher modes of dynamic instability are computed from a modified algorithm based on revised Rayleigh quotients which sweep out the modes previously calculated. An example, in which the dynamic stability of a plate is established, illustrates the method.

VARIATIONAL METHODS

72-1045

NUMERICAL SOLUTION OF DYNAMICAL SYSTEMS BY DIRECT APPLICATION OF HAMILTON'S PRINCIPLE

Vance, J.M. and Sitchin, A. (Dept. Mech. Engr., Univ. Fla., Gainesville, Fla.)

Intl. J. Numer. Meth. Engr. 4(2), 207-216 (Mar./Apr. 1972) 5 refs

Key Words: dynamic systems, numerical techniques

A method is described which allows a direct derivation of a set of first-order finite difference equations to numerically compute the motion of any conservative or nonconservative dynamic system with a finite number of degrees of freedom. The derivation of the method is based on an application of Lagrangian multipliers to a functional form of Hamilton's principle. The method eliminates the differentiation with respect to time associated with Lagrange's equations, and reduces the work required to obtain the most desirable form for numerical integration from the standpoint of computational efficiency and accuracy. For systems with many degrees of freedom, the required matrix inversions produce first derivatives of the coordinates, instead of second derivatives, thus eliminating a potential source of error in numerical integration. Two examples are given to illustrate the method.

FINITE ELEMENT MODELING

(Also see Nos. 1150, 1191, 1192)

72-1046

VIBRATION OF CIRCULAR AND ANNULAR PLATES USING FINITE ELEMENTS

Kirkhope, J. and Wilson, G.J. (Carlton Univ., Ottawa, Canada)

Intl. J. Numer. Meth. Engr. 4(2), 181-193 (Mar./Apr. 1972) 9 refs

Key Words: circular plates, finite element technique, flexural vibration, rings

The finite element method is applied to the free transverse vibration of circular and annular plates of varying thickness. An annular element is derived which incorporates the number of diametral modes in the deflection function. This results in an element having only four degrees of freedom, these being the deflections and slopes at the inner and outer radii of the element

at an antinode of the particular vibration mode. Thickness variation in the radial direction is readily introduced, and stiffness and inertia matrixes are presented for elements with linear and parabolic variations in thickness. The method is checked with several numerical examples. Calculations of free vibration of circular and annular plates of constant, linear and parabolic thickness variation are compared with available exact solutions.

72-1047
CONVERGENCE OF EIGENVALUE SOLUTIONS IN CONFORMING PLATE BENDING FINITE ELEMENTS

Lynn, P.P. and Dhillon, B.S. (Dept. Civil and Environ. Engr., Univ. Colorado, Boulder, Colo.)

Intl. J. Numer. Meth. Engr. 4(2), 217-234 (Mar./Apr. 1972) 13 refs

Key Words: eigenvalue problems, finite element technique, plates

The convergence proof of plate eigenvalue solutions from conforming displacement finite elements is presented. The analysis is based on converting a thick plate free vibration problem into a corresponding isoperimetric variational problem. A conforming thick plate element is used to illustrate the mathematical development. On the basis of the derived asymptotic rate of convergence of the approximate eigenvalues, the authors propose a practical method of improving the numerical solutions. Extension of the mathematical proof to cover classical thin plate finite elements is briefly discussed.

MODELING
(Also see Nos. 1085, 1119, 1161, 1199)

72-1048
VIRTUAL MASS OF SUMBERGED STRUCTURES

Chandrasekaran, A.R.; Saini, S.S.; and Malhotra, M.M. (Univ. Roorkee, Sch. Res. and Train. in Earthquake Engr., Roorkee, India)

ASCE J. Hydraul. Div. 98(HY5), 887-896 (May 1972) 9 refs

Key Words: hydrodynamic response, submerged structures

A structure submerged in water exhibits different dynamic behavior resulting from the interaction of the surrounding water than when it vibrates in air. The submerged structure is subjected to additional hydrodynamic pressures and its dynamic characteristics alter when it vibrates in water. Virtual mass concept is increasingly being used in design to account for the influence of surrounding water and this is used indirectly to represent the hydrodynamic pressure. A simple experimental technique for the determination of virtual mass for partially and fully submerged structures is presented herein. The virtual mass depends on the geometry and its dynamic properties in air. Because of the surrounding water, the natural period of vibration of a structure elongates and the damping increases. As a result of the added mass of the surrounding water, the stresses and strains in the structure under dynamic conditions are increased but some relief is provided by the increased damping.

72-1049
ANALYSIS OF TRANSIENT LINEAR WAVE PROPAGATION IN SHELLS BY THE FINITE DIFFERENCE METHOD

Geers, T.L. and Sobel, L.H.
Lockheed Missiles and Space Co., Palo Alto, Calif., NASA-CR-1885, (Dec. 1971) 191 pp

Key Words: cylindrical shells, finite difference technique, hole-containing media, transient excitation

The applicability of the finite difference method to propagation problems in shells, and the response of a cylindrical shell with cutouts to both longitudinal and radial transient excitations are investigated. It is found that the only inherent limitation of the finite difference method is its inability to reproduce response discontinuities accurately. The short wave length limitations of thin shell theory that create significant convergence difficulties may often be overcome through proper selection of finite difference mesh dimensions and temporal or spatial smoothing of the excitation. Cutouts produce moderate changes in early and intermediate time response of a cylindrical shell to axisymmetric pulse loads applied at one end. The cutouts may facilitate the undesirable late-time transfer of load-injected extensional energy into nonaxisymmetric flexural response.
N72-15873

72-1050

SOUND RADIATION FROM PLATES WITH DENSITY AND STIFFNESS DISCONTINUITIES
Howe, M.S. and Heckl, M. (Dept. Math., Imperial Col. Sci. and Tech., London, S.W.7., England)
J. Sound and Vib. 21(2), 193-203 (Mar. 22, 1972) 4 refs

Key Words: plates, sound radiation

Sound radiation from infinite, plane plates caused by the interaction of bending waves with density and stiffness fluctuations in the material of the plate is discussed. Because of the great variety of configurations encountered in practice the sound radiation theory is worked out in the case in which the variations in density and/or bending stiffness may be regarded as random functions of position on the plate. This should give valuable insight into the order of magnitude of acoustic losses to be encountered in engineering practice. Cases where the plate may be regarded as loaded with randomly sited point masses, and randomly sited parallel line masses, are considered in detail. Experiments conducted with a large steel plate in air show a large measure of agreement with the theory.

72-1051

EQUIVALENT SPRING-MASS SYSTEM: A PHYSICAL INTERPRETATION
Wada, B.K.; Bamford, R.; and Garba, J.A. (Jet. Propulsion Lab., Pasadena, Calif.)
U. S. Naval Res. Lab., Shock Vib. Bull. 42(5), 215-225 (Jan. 1972) 3 refs

Key Words: computer programs, eigenvalue problems, finite element techniques, mass-spring systems

Large finite element computer programs and/or comprehensive modal tests are used to obtain the eigenvalues and eigenvectors of structures that have many degrees of freedom. The large quantity of data often masks the physical implications of the results, and these implications are invaluable for proper data usage. A technique is described that generates an equivalent spring-mass model for each eigenvector of the structure when the generalized mass and stiffness matrixes are available. The physical significance of the equivalent spring-mass system and its application in modal testing, identification of eigenvectors, extraction of a lower-order model, comparison of similar models, selection of significant eigenvectors, and usage with limited computer programs are discussed.

72-1052

HSRI THREE-DIMENSIONAL CRASH VICTIM SIMULATOR: ANALYSIS VERIFICATION, AND USERS' MANUAL AND PICTORIAL SECTION
Highway Safety Res. Inst., Ann Arbor, Mich. (June 1971) 285 pp

Key Words: collision research, mathematical models, occupant response

The report deals with the development and use of mathematical models for the simulation of automotive occupant kinematics in the event of a collision. This model was developed as a tool to study advanced concepts and designs of seat restraint systems from the viewpoint of occupant protection. After a discussion of the state of the art of mathematical modeling of the crash victim, an analytical description of the HSRI three-dimensional crash victim simulator is presented. A detailed users' manual is included. PB-208242

COMPUTER PROGRAMS

(Also see No. 1166)

72-1053

A NORMAL MODE COMPUTER PROGRAM FOR CALCULATING SOUND PROPAGATION IN SHALLOW WATER WITH AN ARBITRARY VELOCITY PROFILE
Newman, A.V. and Ingenito, F. (Shallow Water Surveillance Branch, Acoustics Div.)
Naval Res. Lab., NRL-MR-2381, Washington, D.C. (Jan. 1972) 70 pp, 9 refs

Key Words: computer programs, finite difference technique, underwater sound

A computer program written in FORTRAN 3400/3600/3800 is described which solves the Z dependent part of the Helmholtz equation for a two-fluid shallow water model by means of a finite difference technique. Sound speed profiles for the model are entered as discrete sets of points. The first fluid is subdivided into N incremental layers to permit the use of the finite difference equations. A linear interpolation is performed between the profile depths and the depths at which the incremental layers are defined to give sound speeds for the latter. The boundary conditions for continuity of acoustic pressure and the vertical particle velocity are matched at the interface between the two fluids. The pressure amplitude must be zero to within a designated epsilon at the interface between air and the first fluid. Trial solutions are made until the desired solution is bracketed and then

a false position technique proceeds to find the acceptable solution. The effect on each normal mode amplitude in the first fluid resulting from an assumed small absorption in the second fluid is found by calculating the ratio of the mode attenuation coefficient in the first fluid to the volume attenuation in the second fluid. The computer program provides, as an option, the calculation of group velocities.
AD-737629

72-1054

PERFORM: A COMPUTER PROGRAM TO DETERMINE THE LIMITING PERFORMANCE OF PHYSICAL SYSTEMS SUBJECT TO TRANSIENT INPUTS
Pilkey, W.D. and Wang, B.P. (Dept. Aerosp. Engr. and Engr. Phys., Univ. Va., Charlottesville, Va.)
U. S. Naval Res. Lab., Shock Vib. Bull. 42(5), 185-190 (Jan. 1972) 8 refs

Key Words: dynamic systems, PERFORM (computer program), shock isolators, transient response

PERFORM is a user-oriented computational capability for the evaluation of the limiting performance of multidegree-of-freedom dynamic systems. Appropriate systems are those for which certain maximum response variables, e.g., peak accelerations, stresses, or displacements, are to be minimized while other maximum response variables are bounded. The user provides system equations of motion in which those portions, e.g., isolators, of a system to be evaluated have been replaced by functions of time. Sets of constraints, objective functions and possible transient inputs are also user prescribed. PERFORM then automatically computes the limiting performance characteristics. These characteristics can be employed in the evaluation phase of systems design by informing the systems engineer whether or not his preliminary design scheme is feasible and by guiding him in appropriate modifications as the design proceeds and in the selection of optimal hardware.

DIGITAL SIMULATION

(Also see Nos. 1051, 1190)

72-1055

COMPUTER SIMULATION OF SHIP STRUCTURAL LOADS DUE TO WAVES
Kaplan, P. (Oceanics, Inc., Plainview, N.Y.)
AIAA/ASME/SAE 13th Structures, Structural Dynamics and Materials Conf., San Antonio, Tex. (Apr. 10-12, 1972) AIAA Paper No. 72-342, 17 pp, 17 refs

Key Words: mathematical models, ships, simulation, slamming, water waves

Analytical models and techniques for computer simulation are presented for the slowly varying direct wave-induced loads and higher frequency vibratory loads associated with various types of slamming. Frequency response techniques for linear wave-induced loads are applied to regular waves and extended to random waves via spectral analysis. Comparisons with model test data show good agreement over a wide range of headings, speeds, hull forms, etc. Time history outputs for bending moments caused by nonlinear slamming are obtained, and methods of representing both types of loading as time histories are presented. Output data at rates much faster than real time allow rapid analysis of such loads via computer simulation.

PARAMETER IDENTIFICATION

72-1056

DERIVATION OF MASS AND STIFFNESS MATRIXES FROM DYNAMIC TEST DATA
Thoren, A.R. (Teledyne Brown Engr. Co., Huntsville, Ala.)
AIAA/ASME/SAE 13th Structures, Structural Dynamics and Materials Conf., San Antonio, Tex. (Apr. 10-12, 1972) AIAA Paper No. 72-346, 5 pp, 5 refs

Key Words: dynamic testing, mass matrixes, matrix methods, stiffness matrixes, test data

A technique is described by which orthonormal modal vectors are computed from dynamic test response data. The modal vectors are then used to compute mass, stiffness, and damping matrixes for a discrete model of the distributed elastic system. Matrixes thus computed from subsystems tests may be readily incorporated into larger system models. The method has been applied to a test of the Saturn V S-II stage LOX tank-engine support system. The dynamic responses of the discrete model are shown to correlate well with test data through the frequency range tested.

DESIGN TECHNIQUES

SURVEYS

(Also see Nos. 1061, 1077)

72-1057

AUTOMATED DESIGN OPTIMIZATION OF SUPERSONIC AIRPLANE WING STRUCTURES UNDER DYNAMIC CONSTRAINTS

Fox, R.L.; Miura, H.; and Rao, S.S. (Case Western Reserve Univ., Cleveland, Ohio)

AIAA/ASME/SAE 13th Structures, Structural Dynamics and Materials Conf., San Antonio, Tex. (Apr. 10-12, 1972) AIAA Paper No. 72-333, 16 pp, 24 refs

Key Words: aircraft wings, mathematical models, optimum design

The problems of the preliminary and first level detail design of supersonic aircraft wings are stated as mathematical programs and solved using automated optimum design techniques. The problem is approached in two phases: the first is a simplified equivalent plate model in which the envelope, plan form and structural parameters are varied to produce a design, the second is a finite element model with fixed configuration in which the material distribution is varied. Constraints include flutter, aeroelastically computed stresses and deflections, natural frequency and a variety of geometric limitations. The Phase I objective is a combination of weight and drag while Phase II is a weight minimization.

ENVIRONMENTS

ACOUSTIC

(Also see Nos. 1097, 1105, 1142, 1159, 1160, 1162)

72-1058

EFFECTS OF RISE TIME AND REPETITION RATE ON THE LOUDNESS OF ACOUSTIC TRANSIENTS

Carter, N.L. (Commonwealth Acoustic Labs., 5 Hickson Rd., Millers Point, New Wales 2000, Australia)

J. Sound and Vib. 21(2), 227-239 (Mar. 22, 1972) 37 refs

Key Words: acoustic excitation

The effect on loudness of variations in rise time and repetition rate of acoustic transients 1 msec in duration was studied. One possible interpretation of the results is that loudness increases in discrete steps as rise time is reduced continuously. This possibility is considered in relation to data on the loudness critical band and the formation of the critical band at threshold. Five "loudness" calculation methods developed for steady state noise were applied to the Fourier transforms of the transients and compared with the calculated loudness of white noise judged equally loud. The five calculation methods were the Zwicker method, Stevens Mark VI method, Kryter's PNdB method, dBA and dBC. Of these dBA predicts loudness most effectively in the face of variations in rise time and repetition rate of the transients.

72-1059

THE LOGARITHMIC DEPENDENCE OF SURFACE GENERATED AMBIENT SEA NOISE SPECTRUM LEVEL ON WIND SPEED

Crouch, W.W. and Burt, P.J. (Naval Underwater Sys. Ctr., New London Lab., New London, Conn.)

J. Acoust. Soc. Amer. 51(3), 1066-1072 (Mar. 1972) 5 refs

Key Words: mathematical models, underwater sound

A mathematical description of ambient sea noise is presented that takes into account the two dominant sources: surface agitation and distant shipping. The contribution from surface agitation is shown to be linearly dependent upon the logarithm of wind speed for depths between 400 and 2500 fathoms at several sites near Bermuda. When this is taken into account, the ambient noise data that include both sources can be analyzed to determine the individual levels of the sources. Also, the standard deviations of the two sources can be determined from the standard deviations of the measured levels.

72-1060

PRELIMINARY RESULTS ON TWO-SEGMENT NOISE ABATEMENT STUDIES

Denery, D.G.; Bourquin, K.; and Drinkwater, F.J., III

Natl. Aeronaut. and Space Admin., Ames Res. Ctr., Moffett Field, Calif., NASA-TM-X-62098 (Sept. 1971) 27 pp

Key Words: aircraft noise, noise reduction

The two-segment noise abatement approach procedure has been evaluated in an operational cockpit environment using operational equipment. The upper segment glide slope was determined

by a three-dimensional area navigation system and the lower segment glide slope was provided by the ILS glide slope beam. The flight director steering computer was modified to provide the pilot with continuous command information during the entire approach. A 30-day flight test program was conducted at Stockton Metropolitan Airport, Stockton, California. Twenty-eight pilots representing the airlines, professional pilot associations, NASA, and the FAA participated in the flight evaluation. A total of 190 two-segment approaches consisting of a 6 deg upper glide slope and a 400 ft ILS intercept altitude were flown. Noise data and aircraft position data were measured on the ground during the approach studies. Although the data presented in this report are preliminary, the two-segment approach appears to be an operationally feasible way of reducing airport community noise.
N72-13985

72-1061

LEGAL NOISE LIMITS DEMAND IMPROVED ENGINES AND SUBSYSTEMS
Flanagan, W. (Tech. ed. Automotive Engr.)
Automot. Engr. 80 (5), 36-41 (May 1972)

Key Words: motor vehicles, noise reduction

Legislation on overall vehicle noise means that components and subsystems will have to be closely scrutinized and often quieted drastically. A summary of current problems and some recommended noise reduction practices.

72-1062

HIGH FREQUENCY WAVES IN THIN BODIES OF REVOLUTION
Rulf, B. and Ezer, J.G. (Dept. Math. Sci., Tel Aviv Univ., Tel Aviv, Israel)
J. Sound and Vib. 21 (1), 1-10 (Mar. 8, 1972)
7 refs

Key Words: bodies of revolution, high frequency excitation, sound waves, wave propagation

High frequency propagation of acoustic and elastic waves in nonuniform waveguides of cylindrical symmetry is studied. Asymptotic approximations for the propagating modes are found. Both ordinary and uniform asymptotic expansions of several typical problems are shown.

72-1063

WALL FLOW NOISE IN A SUBSONIC DIFFUSER
Timpke, E.F. and Binder, R.C. (Calif. State Col., Long Beach, Calif.)
U. S. Naval Res. Lab., Shock Vib. Bull. 42 (3), 209-216 (Jan. 1972) 8 refs

Key Words: experimental results, noise, piping, piping resonators

Wall flow noise in a variable angle two-dimensional subsonic diffuser is investigated. Measurements are made of the sound pressure level, power spectral density, and the cross-correlation function. Wall noise measurements are made at various locations in the diffuser for flow through a parallel wall channel, flow approaching separation, and separated flow. The sound pressure level increases as the diffuser angle increases, and reaches a maximum at flow separation. The sound pressure level is as much as 28 db higher at the separation point as compared to the sound pressure level for flow between parallel walls. The magnitude of the root mean square wall pressure fluctuations in turbulent flow is 0.0053 times the free stream dynamic pressure. This value compares fairly well with other values reported in the literature. The convection velocity is 0.83 times the free stream velocity for flow in parallel walls and decreases to 0.73 times the free stream velocity beyond separation. An analytical distribution function is developed to describe the spectral noise characteristics of the large-scale turbulent eddies as the flow field changes.

72-1064

INTERFERENCE OF WIDEBAND SOUND IN SHALLOW WATER
Weston, D.E. and Stevens, K.J. (Admiralty Res. Lab., Teddington, Middlesex, England)
J. Sound and Vib. 21 (1), 57-64 (Mar. 8, 1972)
9 refs

Key Words: underwater sound

Propagation experiments are described covering ranges of several kilometers and frequencies between 0.1 and 1.2 kHz. The interference pattern for a source towed past a hydrophone demonstrates a focusing effect predicted theoretically. The interference pattern for a fixed source shows tidal changes of a magnitude agreeing with theory. From the results of both experiments the number of modes effective is found to vary as (frequency) x (range)$^{-1/2}$, which has important implications. The mean frequency spacing of the interference peaks and the time dispersion of pulses are reciprocally related, and for isovelocity water both are almost independent of range and frequency.

72-1065

DEVELOPMENT OF A FLUIDIC HIGH-INTENSITY SOUND GENERATOR

Wolfe, H. F. (Air Force Flight Dynamics Lab., Wright-Patterson AFB, Ohio)

U. S. Naval Res. Lab., Shock Vib. Bull. 42 (3), 167-178 (Jan. 1972) 8 refs

Key Words: experimental results, noise generation, spacecraft

An experimental investigation conducted to determine the performance characteristics of a prototype fluidic high-intensity sound generator is described. Acoustic and steady state flow tests of a two-stage annular slot configuration are performed to establish the primary performance parameters. The acoustic performance for a sine sweep input indicates a relatively flat output between 600 and 1800 Hz. The steady state results indicate that the load on the receiver alters considerably the nozzle pressure profiles and amplifier characteristics. A method of evaluating changes in geometry from steady state measurements is presented. The configuration tested indicates that a greater modulation of the supply nozzle jet is needed to improve the performance. The possibility of modulating the sound output to almost any arbitrary input waveform without the limitations imposed by mechanical parts represents a significant advantage in high-intensity sound generation.

72-1066

ENVIRONMENTAL POLLUTION, NOISE POLLUTION: NOISE EFFECTS ON HUMAN PERFORMANCE (VOLUME 1)

Defense Documentation Ctr., Alexandria, Va., DDC-TAS-71-31-1-Vol-1 (Aug. 1971) 102 pp

Key Words: human factors engineering, noise tolerance, reviews

This is one of two volumes on environmental and noise pollution presenting a series of annotated bibliographies. Noise effects on humans such as motor reactions, hearing, speech, sleep, perception, nervous system, visual signals and fatigue are presented. Corporate author-monitoring agency, subject, title, and report number indexes are included.
AD-729850

RANDOM

72-1067

A GENERAL METHOD WITH SHAPING FILTERS TO STUDY RANDOM VIBRATION STATISTICS OF LIFTING ROTORS WITH FEEDBACK CONTROLS

Gaonkar, G. H. (Faculty of Math. Stud., Div. Sci. and Tech., So. Ill. Univ., Edwardsville, Ill.)

J. Sound and Vib. 21 (2), 213-225 (Mar. 22, 1972) 30 refs

Key Words: random vibration, rotors, statistical analysis

Random vibration statistics of linear or perturbed linear dynamic systems with variable parameters, in particular of lifting rotors with feedback controls are studied. By introducing shaping filters to random inputs, the response variance matrix is solved directly from another set of linear equations. Therefore, with the stipulation of stationary Gaussian random inputs, the computational scheme of response threshold crossing statistics under steady state conditions is essentially no more involved than generating the state vector to step inputs.

72-1068

SIMULATION OF RANDOM ENVELOPE PROCESSES

Yang, J.-N. (Jet Propulsion Lab., Pasadena, Calif.)

J. Sound and Vib. 21 (1), 73-85 (Mar. 8, 1972) 25 refs

Key Words: fast Fourier transforms, random response, simulation

Efficient and practical methods of simulating stationary and nonstationary random envelope processes are presented. The stationary envelope processes are simulated by using the fast Fourier transform while the nonstationary envelope processes are simulated as the square root of the sum of a series of cosine functions and a series of sine functions with random phase angles. Typical applications of the envelope simulation are the simulations of peaks and troughs which play an important role in the analyses of the first excursion probability, fatigue and crack propagation. In particular, applications to the crack propagation under random loadings are demonstrated in detail.

SEISMIC

(Also see Nos. 1153, 1197)

72-1069

A STUDY OF STOCHASTIC MODELS FOR PREDICTING MAXIMUM EARTHQUAKE STRUCTURAL RESPONSE

Gungor, I.

Univ. Ill., Champaign, Ill., PhD Thesis (1971) 153 pp

Key Words: multidegree-of-freedom systems, prediction, seismic response, simulation, single degree-of-freedom systems

The applicability of approximate distributions for extremes of random functions to predict the maximum earthquake response of structures corresponding to a given probability of exceedance is investigated. Multidegree-of-freedom elastic systems and single degree-of-freedom elastoplastic systems are considered. The range of applicability of the proposed approach is investigated through a simulation study. The results are found to be satisfactory in the range of practical interest for parameters which are commonly used in earthquake engineering.
U.S. 72-12186

SHOCK

(Also see Nos. 1039, 1092, 1093, 1106, 1128, 1158)

72-1070

THE EFFECT OF THE FIN-OPENING SHOCK ENVIRONMENT ON GUIDED MODULAR DISPENSER WEAPONS

Denton, K.D. and Herzing, K.A. (Honeywell Inc., Government and Aeronaut. Prod. Div., Hopkins, Minn.)

U. S. Naval Res. Lab., Shock Vib. Bull. 42(3), 159-165 (Jan. 1972) 2 refs

Key Words: aircraft equipment response, shock response, weapon systems

Recent laboratory studies of a first-generation aircraft modular dispenser weapon show that modularity, while increasing the efficiency and effectiveness of the inventory, may result in subjecting weapon components to significant self-generated system operational environments for which the component was not originally designed. For example, the shock environment produced by tail-fin opening of a weapon in free flight was found to be a significant factor that should be considered when designing and developing future modular weapon systems employing folded fins. The results of the fin-opening shock study are presented. The fin-opening shock environment levels are shown to be higher than those allowed by conventional MIL-STD requirements. A procedure for developing a shock spectrum test criterion for modular fuze and guidance electronic components is also included.

72-1071

A NUMERICAL STUDY OF THE DYNAMIC RESPONSE OF A CYLINDRICAL CAVITY SUBJECTED TO GROUND WAVE DISTURBANCE

Jackson, T.M.

Univ. Ill., Champaign, Ill., PhD Thesis (1971) 125 pp

Key Words: cavity-containing media, elastic media, interaction: structure-medium, protective shelters, underground structures

The analysis and design of underground protective structures require an understanding of the coupled dynamic behavior of those structures when subjected to blast induced ground motions. A general numerical solution procedure is developed in this study that provides a simplified approach for this three-dimensional wave propagation and dynamic interaction problem. The method is limited to elastic media. Illustrative problems are solved for an unlined cavity of vertical cylindrical shape. A parameter study is not made although the problem results are presented in nondimensionalized form and, therefore, are readily extended to other parameter values of interest. Since analytical or numerical solutions by other methods for this problem are not available, results from illustrative problems are compared to corresponding free field and plane strain solutions. The numerical procedure is applied to a model of coupled orthogonal planes. The numerical results provide a description of the interaction behavior between the ground wave and the cavity. Time histories for acceleration and velocity are shown for representative points on the cavity and maximum ranges of acceleration, velocity, and displacement are tabulated. The motions of the three-dimensional problem are compared to a corresponding free field solution to provide amplification factors which further describe the interaction behavior.
U.M. 72-12227

72-1072
LOWER BOUNDS FOR THE PRESSURE JUMPS OF THE SHOCK WAVES OF A SUPERSONIC TRANSPORT OF GIVEN LENGTH
Jones, L. B. (Univ. Bradford)
Aeronaut. Quart. 23 (1), 67-76 (Feb. 1972) 14 refs

Key Words: shock wave propagation

In an earlier paper the lower bounds for the pressure jumps across the bow shock waves of a supersonic transport were derived, it being assumed that all the shocks had coalesced into either the bow or rear shocks, but not that the shocks were at such a great distance (asymptotic) that they had the same strength. In this paper the results of the earlier work are developed so that the lower bounds for the pressure jumps across shock waves propagating through a homogeneous atmosphere are determined by considering bow and rear shock waves simultaneously.

72-1073
DRAG MEASUREMENTS ON CYLINDERS IN EVENT DIAL PACK
Mellsen, S. B. (Defense Res. Estab., Suffield, Ralston, Alberta, Canada)
U. S. Naval Res. Lab., Shock Vib. Bull. 42 (4), 157-173 (Jan. 1972) 12 refs

Key Words: circular cylinders, shock waves

Drag measurements on circular cylinders in the blast wave from a 500 ton TNT burst are obtained with the free flight method. Cylinders 3-1/2 to 12 in. diam are tested at peak incident overpressures of 5.9 to 20.5 psi. Drag pressure, drag pressure impulses and drag coefficient are evaluated and tabulated. Transitions through critical Reynolds and Mach number regimes are both observed and described.

72-1074
THE IMPULSE IMPARTED TO TARGETS BY THE DETONATION OF LAND MINES
Westline, P.S. (Southwest Res. Inst., San Antonio, Tex.)
U. S. Naval Res. Lab., Shock Vib. Bull. 42 (2), 97-107 (Jan. 1972) 8 refs

Key Words: explosions, impulse intensity, mines, tanks (combat vehicles)

Numerous testing programs have been conducted to determine how land mines damage vehicles or armor plates; however, very few analytical studies have been conducted because the load imparted to a structure from a land mine explosion has never been determined. The few analytical calculations which have been made assumed that the target was loaded by an air blast. In this paper, the writer shows that the impulse imparted to the target is not entirely an air blast phenomenon. The impulse is caused principally by the momentum in the soil particles surrounding the buried explosive. A technique is developed for predicting the impulse imparted to targets such as wheels and armor plates. Several illustrative calculations are compared with experimental test results to establish the validity of this procedure for estimating the impulse imparted to a target from a land mine explosion.

GENERAL WEAPON
(Also see Nos. 1074, 1148)

72-1075
MEASUREMENT OF IMPULSE FROM SCALED BURIED EXPLOSIVES
Morris, B.L. (U.S. Army Mobility Equip. Res. and Dev. Ctr., Fort Belvoir, Va.)
U. S. Naval Res. Lab., Shock Vib. Bull. 42 (2), 123-127 (Jan. 1972) 3 refs

Key Words: impulse intensity, mines

A dimensional analysis performed to determine the physical scaling parameters governing the response of wheels to blast loading is described. Hopkinson scaling is used to determine the proper charge size and location for one-quarter scale blast tests. The total energy imparted to the test wheels by the detonation is determined, and the scaled specific impulse is calculated. The test and calculation procedures are described.

TRANSPORTATION
(Also see Nos. 1052, 1172)

72-1076
THE MECHANICS OF FORECASTING THE COMMUNITY NOISE IMPACT OF A TRANSPORTATION SYSTEM
Gebman, J.R.
The Rand Corp., Santa Monica, Calif. P-4735 (Nov. 1971) 19 pp, 19 refs

Key Words: environmental effects, prediction, traffic noise

Noise impact assessment methodology being developed by The Rand Corporation to assist policy makers in evaluating the potential environmental impact of future transportation alternatives is reviewed and assessed.

72-1077
A SURVEY OF TRAFFIC INDUCED VIBRATIONS
Whiffin, A.C. and Leonard, D.R.
Road Res. Lab., RRL Report LR-418, Crowthorne, Berkshire, England (1971) 54 pp, 50 refs

Key Words: human factors engineering, structural response, traffic induced vibration

The effect of traffic induced vibrations on people and structures is surveyed and compared with the effects of vibrations from other sources. Information derived from field measurements is included together with existing scales for assessing intensity of vibrations. The problems of vibration transmission and isolation, building response and disturbance of equipment within buildings are also considered. The need for more practical information on building response and damage is evident. Traffic induced vibrations are noticeable on some bridges. Methods of dynamic analysis are required which will enable designers to allow for the dynamic stresses generated by vehicles and to take into account the reaction of pedestrians. The trend towards more slender designs and hence more "lively" bridges is accentuating the need for this information. The most satisfactory way to minimize the effect of traffic induced vibrations is to remove the problem at its source by maintaining road surfaces to a good standard.

PHENOMENOLOGY

COMPOSITE

(Also see Nos. 1107, 1158)

72-1078
ON THEORIES FOR THE DYNAMIC RESPONSE OF LAMINATED PLATES
Sun, C.T. and Whitney, J.M. (Purdue Univ., Lafayette, Ind.)
AIAA/ASME/SAE 13th Structures, Structural Dynamics and Materials Conf., San Antonio, Tex. (Apr. 10-12, 1971) AIAA Paper No. 72-398, 8 pp, 9 refs

Key Words: dynamic response, laminates, plates

The effect of the heterogenous shear deformation over the thickness of the laminated plate on the dynamical behavior of laminated plates is investigated. Three sets of governing equations are derived according to different assumptions on the local transverse shear deformation and interface conditions. The equations are compared by investigating several numerical examples of harmonic wave propagations. A special formulation for laminates with midplane symmetry is also presented and discussed.

DAMPING

(Also see Nos. 1073, 1112, 1118, 1120, 1137, 1183)

72-1079
MEASUREMENT OF THE DAMPING PROPERTIES OF SILICONE-BASED ELASTOMERS OVER WIDE TEMPERATURE RANGES
Coote, C.T. (Inst. Sound & Vib. Res., Univ. Southampton, Southampton SO9 5NH, England)
J. Sound and Vib. 21(2), 133-147 (Mar. 22, 1972) 19 refs

Key Words: elastomers, material damping

The measurement of some dynamic shear properties of silicone-based elastomers over wide temperature ranges is described. The work arose out of a need to find a suitable material for use in artificial damping treatments applied to aircraft panels to reduce the response to acoustic excitation. The material selected operates satisfactorily over the wide temperature range encountered in the aircraft environment. Apparatus developed is used to measure the real part of the shear modulus and loss factor over the temperature range -60 to +150°C. Tests are conducted over a frequency range of 200-1000 Hz at various strain levels up to 1 percent. Tests on the most promising material are extended to determine the dynamic shear properties at subambient temperatures. Investigations are also made to determine the sensitivity of the dynamic shear properties to changes in material filler content and strain applied. An error analysis is performed to ensure no magnification of experimental error in calculating results from the measured data. The most satisfactory performance is obtained from a fluorinated silicone rubber having a shear modulus of 1700 psi (1.2×10^6 kg/m^2) to 60 psi (4.22×10^4 kg/m^2) and a loss factor of 0.7-0.2 over the temperature range -60 to +150°C.

72-1080

EXPERIMENTAL EVALUATION OF THE AERODYNAMIC DAMPING OF SKIN PANELS AT LOW-SUPERSONIC MACH NUMBERS

Muhlstein, L., Jr. (NASA Ames Res. Ctr., Moffett Field, Calif.)

AIAA/ASME/SAE 13th Structures, Structural Dynamics and Materials Conf., San Antonio, Tex. (Apr. 10-12, 1972) AIAA Paper No. 72-402, 7 pp, 12 refs

Key Words: aerodynamic damping, rectangular panels

The aerodynamic damping of the first three vibration modes of a rectangular panel exposed to attached turbulent flow measured over the Mach number range of 1.10 - 1.40 is reported. Data show that aerodynamic damping is a strong function of Mach number, dynamic pressure, mode shape, and boundary layer thickness. At low-supersonic Mach numbers, aerodynamic damping is found to be 20-100 times as large as structural damping. Calculations of panel response to boundary layer noise at low-supersonic Mach numbers that neglect aerodynamic damping can therefore result in significant overdesign.

72-1081

LOW-FREQUENCY DAMPING MECHANISMS IN MECHANO-ACOUSTICAL NETWORKS

Seshadri, T.V. and Lowery, R.L. (Fruehauf Res. and Develop., Detroit, Mich.)

J. Sound and Vib. 21(1), 65-72 (Mar. 8, 1972) 4 refs

Key Words: acoustic response, lumped parameter method, mathematical models, panels, sonic boom, windows

The response of a panel or window to sonic boom and to other transient loads can often be found by deriving an equivalent lumped parameter model for the structure. The greatest response of such a mechano-acoustical system depends strongly upon the damping mechanisms of the components. This paper is concerned with finding realistic values for the lower bounds of the damping mechanisms in various mechano-acoustical systems. The results indicate that although part of the damping consists of radiation losses at openings, and radiation and viscous losses at narrow interconnecting hallways, the structural damping of the panel is of primary concern.

FLUID

(Also see Nos. 1048, 1064, 1065, 1126, 1193)

72-1082

THE FIRST 20 YEARS OF ACOUSTIC SIGNAL PROCESSING

Anderson, V.C. (Univ. Calif., San Diego, Marine Physical Lab., Scripps Inst. Oceanography, San Diego, Calif.)

J. Acoust. Soc. Amer. 51(3), 1062-1065 (Mar. 1972) 1 ref

Key Words: underwater sound

The decade of the 1950s marks the beginning of acoustic signal processing as a subfield of underwater acoustics. The forerunner, signal recognition, gradually evolved into a unified class of spatial and temporal processing techniques and theory which came to stand on its own. The doctrines that emerged in that decade, such as spectrum analysis, correlation, and multiple beamforming have continued to grow in sophistication, until we now find methods such as the fast Fourier transform, sequential detection, and adaptive beamforming handed down to us from the 1960s. The milestones of signal processing over the past 20 years present a striking record of progress in that field.

72-1083

ON THE MEDIUM FROM THE POINT OF VIEW OF UNDERWATER ACOUSTICS

Berman, A. and Guthrie, A.N. (Naval Res. Lab., Washington, D.C.)

J. Acoust. Soc. Amer. 51(3), 994-1009 (Mar. 1972) 39 refs

Key Words: underwater sound

A brief survey of the state of knowledge in ocean acoustics circa 1948 is given and the advances made during the past two decades are reviewed. Twenty years ago the thermostructure of the ocean was known in moderate detail, while the character of the boundaries could be specified less precisely. A principal deficiency was in the ability to handle a mathematical model of the ocean which would give a prediction of the acoustic field in detail. While much remains unknown today, considerable knowledge has been gained in the past 20 years, concerning the geographic and seasonal variation of the medium. Reasonably good specifications of the ocean boundaries are now available. The acoustic absorption coefficient in the ocean is known imperfectly, and the ability to specify the thermomicrostructure is poor. Nonetheless, the intensive efforts of many investigators over the

last 20 years have yielded a computational capability which now allows a general specification of propagation in relatively great detail.

72-1084

TWENTY YEARS IN UNDERWATER ACOUSTICS: GENERATION AND RECEPTION
Hueter, T. F. (Honeywell Inc., Marine Syst. Ctr., Seattle, Wash.)
J. Acoust. Soc. Amer. 51 (3), 1025-1040 (Mar. 1972) 20 refs

Key Words: measuring instruments, transducers, underwater sound

Development in the art of transducer design and array configuration has been spurred on mainly by two motivating forces: (1) extensive research in underwater propagation established the advantages of increasingly lower frequencies for long-range-detection and localization of targets and noise sources; (2) the advent of new piezoelectric and structural materials and of solid-state electronic devices led to substantial improvements in transducer performance with regard to sensitivity, power output, and depth of submersion. Theory has kept abreast with these developments, particularly in handling large arrays with their mutual impedance problems, in pointing to digital multibeamforming techniques, and in revealing the significance of waveform design to detection performance. A few new concepts were born and have won acceptance during this period. These include: the generation of sound by hydroacoustic means, the employment of compliant metal tubes for acoustic focusing and reflection, the exploitation of structural flexing modes for sound radiation, and the use of free-flooded cavity structures as deep submergence sources. As we continue to adapt our sources and receivers to the ocean's transfer functions, noise patterns, and targets -- false and true -- there will be an increasing need for fundamental research into the acoustic properties of materials and for field test of experimental acoustic detection systems.

72-1085

A REVIEW OF REVERBERATION, SCATTERING, AND ECHO STRUCTURE
Horton, C.W., Sr. (Appl. Res. Labs. and Dept. Physics and Geological Sci., The Univ. Tex., Austin, Texas)
J. Acoust. Soc. Amer. 51 (3), 1049-1061 (Mar. 1972) 58 refs

Key Words: underwater sound

A tremendous amount of work in the area of reverberation and scattering has been performed over the last 20 years. An effort is made to summarize with graphs and charts the amount and nature of this work. Comparisons are made between the results of measurements at sea, measurements with models, and theoretical calculations. Since theoretical solutions of scattering from randomly rough surfaces involve numerous approximations, these different solutions are classified with the aid of tree diagrams so that one can chart a path through the various approximations. Most of the unclassified work on echo structure has been devoted to intensive analyses for targets of relatively simple geometric shape. For example, the sphere and the cylinder (with and without internal structure) still present interesting problems.

72-1086

REVIEW OF UNDERWATER ACOUSTICS RESEARCH; NOISE
Wenz, G.M. (Naval Undersea Res. and Develop. Ctr., San Diego, Calif.)
J. Acoust. Soc. Amer. 51 (3), 1010-1024 (Mar. 1972) 45 refs

Key Words: underwater sound

The purposes, problems, and progress of radiated noise, self-noise, and ambient noise research are reviewed. Purposes are related primarily to national defense, but applications to fishery and to the utilization of other natural resources are also noted. Basic problems, most of which were recognized 20 years or more ago, involve ascertainment of properties of the noise, identification of noise sources and mechanisms of noise generation, and the discovery and definition of noise dependencies on environmental factors. Many radiated and self-noise sources and mechanisms have been identified. Major problems are those of noise measurement, noise reduction, and prevention. In the field of ambient noise, most measurements have been of sound-pressure level. Some of the noise sources and environmental factors have been identified, and a capability for qualitative and gross prediction has been achieved. Recommended are further investigations of the variation of ambient noise with receiver depth, directionality of the noise field, statistics of both noise level and instantaneous noise values, additional work at frequencies below 10 Hz, and additional geographic coverage, making full use of current knowledge to fashion models for experimental guidance. Challenging problems exist in procedures and instrumentation for noise studies.

72-1087
PROPAGATION
Williams, A.O., Jr. (Brown Univ., Providence, R.I.)
J. Acoust. Soc. Amer. 51(3), 1041-1048 (Mar. 1972)

Key Words: underwater sound

Progress in the understanding of underwater sound propagation covering the last 20 years is reviewed. Few new topics have appeared, but far more complex problems can now be handled -- in considerable part, thanks to computers. Emphasis has shifted to lower frequencies, longer ranges, and wave-theoretical methods. We are still limited by extreme variability of the medium and its boundaries, and by a gap of understanding between mechanical-chemical and acoustical properties. Efforts to narrow this gap should continue, as should the search for "invariants" of problems and for statistical theories to match averaged data.

INELASTIC
(Also see No. 1128)

VISCOELASTIC
(Also see Nos. 1128, 1134, 1137)

72-1088
PROPAGATION OF TRANSIENT PULSES FROM A SPHERICAL CAVITY IN A VISCOELASTIC MEDIUM
Aboudi, J. (Dept. Engr. Sci., Tel Aviv Univ., Ramat-Aviv, Israel)
Intl. J. Numer. Meth. Engr. 4(2), 289-299 (Mar./Apr. 1972) 16 refs

Key Words: cavity-containing media, Fourier transformation, transient response, viscoelastic media

The problem of an impulsively applied pressure acting on the surface of a spherical cavity in a linear viscoelastic medium is solved by an approximate inversion of the Fourier transform. The method can be applied to general models of viscoelasticity described by the Boltzmann superposition principle, with relaxation or creep functions given analytically or numerically in the time or the frequency domain.

72-1089
ON THE ASYMPTOTIC STABILITY OF SOLUTIONS OF A LINEAR VISCOELASTIC BEAM
Genin, J. and Maybee, J.S. (Purdue Univ., Lafayette, Ind.)
J. Franklin Inst. 293(3), 191-197 (Mar. 1972) 7 refs

Key Words: beams, vibration response, viscoelastic properties

The vibrations of a beam which satisfies the linear viscoelastic stress-strain law for a Kelvin material are studied. General descriptions of the initial conditions are considered and broad descriptions of the boundary conditions for both elastic and viscoelastic behavior are obtained using an energy technique. These descriptions are generalized by including the effects of all possible kinematical boundary conditions. Results are presented in the form of uniqueness, boundedness and stability theorems.

EXPERIMENTATION

DATA REDUCTION
(Also see Nos. 1039, 1082)

EQUIPMENT

72-1090
STABILITY OF AN AUTOMATIC NOTCH CONTROL SYSTEM IN SPACECRAFT TESTING
Agrawal, B.N. (COMSAT Labs., Clarksburg, Md.)
U. S. Naval Res. Lab., Shock Vib. Bull. 42(3), 83-88 (Jan. 1972) 2 refs

Key Words: control systems, dynamic response, launching response, mathematical models, simulation, spacecraft

An automatic notch control system is simulated analytically. The response of the structure is obtained by numerical integration and, at each step of integration, the amplitude of base excitation is modified by the control equation. Such a simulation can be used to predict the stability of the notch control system and to adjust the compression ratio to its optimum value for the sinusoidal vibration testing.

72-1091

VIBRATION FIXTURING -- NEW CELLULAR DESIGN, SATURN AND ORBITAL WORKSHOP PROGRAMS

Stafford, R.L. (McDonnell Douglas Astronaut. Co., Huntington Beach, Calif.)

U. S. Naval Res. Lab., Shock Vib. Bull. 42(3), 205-208 (Jan. 1972) 4 refs

Key Words: spacecraft, testing techniques, vibration tests

During the test programs for the Saturn S-IVB/V, IB and Orbital Workshop, most of the vibration items were tested by mounting them on sections of vehicle structure representing actual vehicle installation. Some vehicle sections were as large as 5-1/2 by 10 ft. Fixtures for mounting and holding these structures during vibration which had the capability of transmitting vibration up to 2000 Hz to the extreme edges of the structure and, subsequently, to the test items, presented special design problems. Most large vibration fixtures used for these programs were of welded tubular construction. The welded tubular concept proved successful, complex, heavy, and costly. Therefore, a new cellular structure fixture design concept was used for some items on the Orbital Workshop. The cellular structure concept discussed herein has a higher stiffness-to-weight ratio and is less costly than previous tubular designs.

EXPERIMENT DESIGN

(Also see No. 1099)

INSTRUMENTATION

72-1092

LASER INTERFEROMETRY IN SHOCK WAVE RESEARCH

Barker, L.M. (Sandia Labs., Albuquerque, N. Mex.)

Exp. Mech. 12(5), 209-215 (May 1972) 29 refs

Key Words: interferometers, lasers, measurement techniques, shock wave propagation

The various laser-interferometer instrumentation techniques which have been applied to the study of plane stress wave propagation in solids are reviewed and discussed. The capabilities and limitations of present systems are described.

72-1093

ACTIVE NOTCH FILTERS FOR EXTENDING FREQUENCY RESPONSE OF ACCELEROMETERS

McConnell, K.G. (Iowa State Univ., Ames, Iowa)

Exp. Mech. 12(5), 223-228 (May 1972) 6 refs

Key Words: accelerometers, measuring instruments, transducers

The useable frequency range of lightly damped accelerometers is limited to 0.2 of their mounted natural frequency for amplitude distortions of less than 5 percent, while phase distortion is not a major problem until near resonance. There have been situations where the measured motion contains unforeseen high frequency components which are distorted because of the accelerometer transfer function. There are several ways to overcome amplitude distortion of the higher-than-anticipated frequency components: (1) change instrumentation to an accelerometer which has a higher natural frequency; (2) establish data analysis techniques which will account for the amplitude distortion; or (3) set up a notch filter circuit which has a transfer function that is the reciprocal of the accelerometer transfer function. This paper presents several such circuits and discusses what happens when the transfer functions are mismatched as to natural frequency of the accelerometer vs the center frequency of the filter and accelerometer damping vs filter damping. The results show that the useful frequency range of the accelerometer can be extended to near resonance if: (1) the accelerometer-mounted natural frequency and the filter center frequency are matched within +2 percent; and (2) the damping ratios are matched within a factor of two.

72-1094

A GENERAL STATEMENT ON THE STABILITY OF A SHIFTED CENTER DURING DETERMINISTICALLY INDUCED VIBRATIONS

Merz, E. (68 Mannheim 42, Pommernstr, 45 (BRD))

Z. Angew. Math. u. Mech. 52(1), 45-54 (Jan. 1972) 6 refs

Key Words: measuring instruments, vibration measurement

All studies dealing with zero-shift of measuring instruments and electric pointer type movements on the basis of deterministically induced vibrations have led to the same proof of stability. In the present study evidence is given that this proof of stability is generally valid for such problems and moreover for similarly constructed general equations of motion. As a result the comprehensive test of stability is considerably reduced. (In German)

72-1095
A DATA AMPLIFIER GAIN-CODE RECORDING SYSTEM
Olbert, J.R. and Hammond, T.H. (Hughes Aircraft Co., Culver City, Calif.)
U. S. Naval Res. Lab., Shock Vib. Bull. 42(3), 79-82 (Jan. 1972)

Key Words: data recorders, recording instruments, vibration measurement

To eliminate the need of an instrumentation operator manually logging amplifier gain settings, a system was designed which would continuously record all amplifier gain information on the same magnetic tape as the actual vibration data. This gain information is multiplexed with an IRIG-B time code signal and recorded on a single tape track. To accomplish this task, both time and frequency multiplexing schemes are used.

PROCEDURES
(Also see No. 1101)

SIMULATORS
(Also see No. 1101)

72-1096
EFFECT OF CORRELATION IN HIGH-INTENSITY NOISE TESTING AS INDICATED BY THE RESPONSE OF AN INFINITE STRIP
Morrow, C.T. (Advanced Tech. Ctr., Inc., Dallas, Tex.)
U. S. Naval Res. Lab., Shock Vib. Bull. 42(2), 235-245 (Jan. 1971)

Key Words: noise, testing techniques

A narrow strip (bar or ribbon) is taken as a theoretical test case for the realism of high-intensity noise testing in much the same way that a simple mechanical resonator is commonly taken as a theoretical test case for most conventional shock and vibration testing. It is shown that in an effort to design a realistic test, one must consider the point-to-point correlation of the applied field in addition to the sound pressure level, even when the damping of the strip is large enough to prevent significant return reflections from the ends. Three types of correlation are investigated in particular -- complete correlation at the coincidence angle for the given frequency, and independent excitations at the different antinodal regions. With minor reinterpretation, the formulas remain applicable when, in addition, an exponential decay of correlation with distance in either direction along the strip is introduced.

TECHNIQUES

72-1097
METHOD OF MEASUREMENT AND ANALYSIS OF NOISE OF AN AIRCRAFT IN FLIGHT
Auzolle, S. and Hay, J.
Scientific Translation Serv., Santa Barbara, Calif., NASA-TT-F-14058 (Dec. 1971)(Engl. Transl. of "Methodes de Mesure et d'Analyse du Bruit des Auions en Vol" Paris. Soc. Natl. d'Etude et de Construc. de Moteurs d'Aviation, 1971, 27 pp. Presented at the 10th Intern. Aeron. Congr. of AFITA, Paris, 1-3 Jun. 1971) 39 refs

Key Words: aircraft noise, measuring instruments, noise measurement

An aircraft noise measuring installation developed by several French organizations for full-scale measurement of aircraft noise in flight is described. The system uses an extensive measurement chain network equipped with microphones, cinetheodolites, and magnetic tape recorders. A computer analysis of annoyance level, directivity, and statistical properties of the noise is presented.
N72-13987

72-1098
METHODS OF CRASHWORTHINESS TESTING FOR AIRCRAFT DESIGN
Bloedel, A.W. (Cessna Aircraft Co.)
SAE Preprint No. 720323, 9 pp, 4 refs

Key Words: aircraft, collision research, testing techniques

The first steps to crashworthiness testing are to design and fabricate instrumentation, design and construct a crash test site for barrier crash testing, and design and fabricate impact sleds for product improvement. Associated with the design phase are many hours of report and paper research pertaining to aircraft crash testing and automobile crash testing. Four basic design concepts apply to crashworthiness of aircraft: production of a structure that will stay intact during a crash; restraint of the occupant during the crash; protection of flailing limbs from injury; and restraint of loose equipment in the cabin. Destruction type tests on full-scale vehicles

assure structural integrity of the capsule and provide acceleration pulse shapes of primary structure as collapse occurs in the forward section of the fuselage.

72-1099

VIBRATION ANALYSIS AND TEST OF THE EARTH RESOURCES TECHNOLOGY SATELLITE

Cokonis, T.J. and Sardella, G. (Gen. Elec. Co., Space Div., Philadelphia, Pa.)

U. S. Naval Res. Lab., Shock Vib. Bull. 42(2), 203-211 (Jan. 1972) 9 refs

Key Words: launching response, spacecraft, vibration response

A unique approach used for the launch vibration analysis of the Earth Resources Technology Satellite (ERTS) is presented and analytical results are compared with experimental measurements. The ERTS is basically a modification of the Nimbus vehicle with solar array paddles unchanged. The complex paddle system could best be represented by measured data obtained from previous Nimbus modal testing. The successful extraction and subsequent recoupling on ERTS of the solar array paddle modes from the original Nimbus experimental mode shapes is given. The analytical model is described along with its verification by an abbreviated modal test. Good correlation between test and analysis is shown by frequency and mode shape comparisons. Some areas of discrepancy uncovered in the analytical model are modified to improve the analytical representation of the spacecraft.

72-1100

SIMULTANEOUS DETERMINATION OF THE ISOPACHIC AND ISOCHROMATIC FRINGE PATTERNS FOR DYNAMIC LOADINGS BY HOLOGRAPHIC PHOTOELASTICITY

Holloway, D.C.

Univ. Ill., Urbana-Champaign, PhD Thesis (1971) 78 pp

Key Words: dynamic excitation, holographic techniques

Two different holographic systems capable of providing separate but simultaneous isochromatic and isopachic fringe patterns for dynamic loadings are described. The development and assemply of a Q-switched ruby laser suitable for use as a light source in these systems is reported. One system involves the use of a quartz light rotator, and a double light pass through the specimen to separate the fringe patterns. The other system uses a partially aluminized specimen and a reflecting surface technique to isolate them. The theory is experimentally confirmed with static loadings and numerous examples of dynamic events are shown.
U.M. 72-12215

72-1101

TECHNIQUES FOR IMPULSE AND SHOCK TUBE TESTING OF SIMULATED REENTRY VEHICLES

Jamison, N.K. (McDonnell Douglas Astronaut. Co., Huntington Beach, Calif.)

U. S. Naval Res. Lab., Shock Vib. Bull. 42(3), 187-203 (Jan. 1972) 12 refs

Key Words: impact tests, reentry vehicles, shock testing, testing techniques

The test techniques and procedures used in instrumenting and testing 12 simulated reentry vehicles to impulse and blast loadings are described. These tests are designed to supply data for structural hardening analyses and do not simulate any specific nuclear effects loading. The vehicles are of the same gross weight, but contain different heat shield and substructure materials. The vehicles are subjected to both short duration impulse tests using contact sheet explosive and long duration blast tests using an explosively driven shock tube. The overall objectives are to determine experimentally the structural behavior and failure of each vehicle, rank the vehicle configurations as to their capability in resisting dynamic loading, and obtain strain data at selected locations for correlations with and verification of structural response computer codes. Test techniques are developed for instrumenting, supporting, retrieving, and loading the vehicles in a manner that simulates as nearly as possible free flight environmental conditions. Large quantities of good quality structural response (strain) data are obtained that compare favorably with structural response computer codes.

COMPONENTS

BEAMS, STRINGS, RODS

(Also see No. 1089)

72-1102

DYNAMIC PROPERTIES OF SELECTED WIRE ROPES SUBJECTED TO AN AXIAL LOAD
Chung, B.S. (The Cath. Univ. Amer. (1971))
126 pp

Key Words: cables (ropes), dynamic response

The dynamic behavior of wire rope is formulated by considering both the tension and stiffness. Experimentally determined natural frequencies of the wire rope in both air and water show good agreement with the theory for a uniform beam under axial tension. The added mass coefficients of the wire rope are determined and compared with the existing theory for a circular cylinder. The viscous damping characteristics of the wire rope are measured both in air and water under transverse vibration, and in air under longitudinal vibration. The elastic modulus of the wire rope is measured by static and dynamic methods. The difference between these two values is less than 4 percent. The longitudinal pulse-wave velocities for the wire rope under tension are measured. An empirical formula for the pulse-wave velocity is suggested.
U.M. 71-29239

72-1103

LARGE FLEXURAL OSCILLATIONS OF THIN BEAMS
Critchfield, M.O.
Univ. Ill., Urbana-Champaign, Ill.
PhD Thesis (1971) 80 pp

Key Words: beams, lumped parameter method, oscillation

A discretization technique based on a lumped parameter concept is utilized to investigate the large inextensional oscillations of thin viscoelastic beams. Discrete models are devised for simply supported and cantilever beams. Other boundary conditions associated with inextensional behavior may be similarly considered. Lagrange equations of motion are derived in a general way for the large free oscillation response of these models having an arbitrary number of degrees of freedom (links). These equations are numerically integrated for the undamped simply supported case in terms of initial conditions corresponding to the linear fundamental mode at the equilibrium position. In general, it is found that the resulting large oscillatory response is not periodic. The basic governing equations for free oscillations are then utilized to obtain the corresponding equations for a second problem, the dynamic stability of a cantilever beam subjected to an inclined follower force. Governing equations for other loading conditions may likewise be found. It is shown that corresponding to a given load and inclination angle, a unique equilibrium configuration exists. The stability of this configuration is investigated by utilizing an analysis based on a perturbation method. Curves are presented which illustrate the critical force to cause flutter as a function of the inclination angle and system damping.
U.M. 72-12127

72-1104

DRIVEN NONLINEAR OSCILLATIONS OF A STRING
Eller, A.I. (Naval Postgrad. Sch., Monterey, Calif.)
J. Acoust. Soc. Amer. 51 (3), 960-966 (Mar. 1972) 6 refs

Key Words: nonlinear response, strings

Nonlinear vibrations of a string may become unstable when the string is driven with sufficient amplitude near resonance. This paper describes the experimental conditions under which transverse oscillation of a horizontal string, driven in the vertical plane, become unstable. It is found that the planar oscillations become unstable in two ways. One instability involves a spontaneous growth or decrease in the amplitude of the driven vertical motion. The other involves the spontaneous appearance of a transverse horizontal component of vibration perpendicular to the driving force, thus leading to a whirling or nonplanar motion of the string. The response of the nonplanar mode of oscillation is described and it is found, for example, that for certain conditions the driven vertical component of oscillation decreases in amplitude when the driving level is increased.

72-1105

ACOUSTICALLY INDUCED VIBRATIONS OF SLENDER RODS IN A CYLINDRICAL DUCT
Hine, M. J.
Univ. Southampton (England), PhD Thesis (Jan. 1971) 185 pp

Key Words: acoustic excitation, flexural vibration, fluid induced excitation, rods

The nature of acoustically induced transverse vibrations or slender rods contained within a fluid-filled cylindrical duct is investigated for both single rods and rod clusters. The effect of low Mach number fluid flow on acoustically induced rod response is also studied.
N72-16559

72-1106

CIRCULAR CANTILEVER BEAM ELASTIC RESPONSE TO AN EXPLOSION
Kim, Y.S. and Ukrainetz, P.R. (Dept. Mech. Engr., Univ. Saskatchewan, Saskatoon, Canada)
U. S. Naval Res. Lab., Shock Vib. Bull. 42 (2), 109-121 (Jan. 1972) 8 refs

Key Words: air blast, cantilever beams, circular beams, dynamic response

The response of a circular cantilever beam subjected to a plane transverse air blast is obtained. From this response, the drag coefficients of the circular cylinder under the unsteady flow conditions of an air blast wave are determined using the domain conversion method. A conversion of the response is made from the time domain into the frequency domain and then from the frequency domain back to the time domain.

72-1107

VIBRATIONS OF LAMINATED BEAMS
Krajcinovic, D. (Argonne Natl. Lab., Argonne, Ill.)
AIAA/ASME/SAE 13th Structures, Structural Dynamics and Materials Conf., San Antonio, Tex. (Apr. 10-12, 1972) AIAA Paper No. 72-399, 9 pp, 10 refs

Key Words: beams, equations of motion, laminates

Variational equations of motion are derived for a three-layered laminated (sandwich) beam. Deformations are assumed to be small, elastic, and a no-slip condition at the laminae interfaces is postulated. However, the Bernoulli hypothesis of planar cross sections is assumed as being valid not for the entire cross section but for each laminae independently. Shear stresses in faces and normal stresses in core are accounted for. Theory incorporates both axial and bending motion. Rotatory and warping inertia are neglected and a simple approximate formula is derived for the lowest natural frequency.

72-1108

DYNAMICS OF SPINNING BODIES CONTAINING ELASTIC RODS
Kulla, P. (Messerschmitt-Bölkow-Blohm G.m.b.H., Ottobrunn b. München, Germany)
J. Spacecraft Rockets 9 (4), 246-253 (Apr. 1972) 7 refs

Key Words: dynamic stability, rotating structures, rotors

The linearized partial and ordinary differential equations of spinning bodies containing elastic rods are formulated: the rods are along the spin axis and perpendicular to it. Rigid symmetric rotors parallel to the spin axis are included. After transformation to the frequency domain, the impedance of the rods is derived from the partial differential equations and then used to describe the dynamics of the combined system in terms of six degrees of freedom of the central body. No truncation error is induced as in normal mode analysis. The system becomes unstable when the lowest natural frequency approaches zero. So the stability limit is independent of internal damping. For rods along the spin axis and for cable type rods perpendicular to the spin axis closed-form solutions are available. It is shown that the system becomes less stable if the translational motion of the center mass is suppressed.

72-1109

ELASTIC WAVES PRODUCED BY LONGITUDINAL IMPACT ON A SYSTEM WITH SYMMETRICALLY BRANCHED RODS
Lee, J.D.
Brown Univ., Providence, R.I., AROD-5606-14-E (May 1971) 27 pp

Key Words: rods, wave propagation

The problem of the propagation of a longitudinal elastic wave which is traveling along a thin uniform rod at the end of which a branched, symmetrically arranged system of rods is joined is treated analytically. The symmetry condition greatly simplifies the analysis and enables the problem to be treated as a two-dimensional one. The theory used for the propagation of longitudinal waves along the rods is the simple one-dimensional one while flexural wave propagation is treated by the Timoshenko theory. The numerical results obtained with this analysis are

found to agree well with experimental observations.
AD-729822

72-1110

TRANSIENT RESPONSE IN A ROD IN TERMS OF POWER SERIES EXPANSIONS
McNiven, H.D. and Mengi, Y. (Dept. Civil Engr., Univ. Calif., Berkeley, Calif.)
J. Sound and Vib. 21(1), 11-18 (Mar. 8, 1972) 4 refs

Key Words: rods, series solution, transient response

The transient response of a semi-infinite, isotropically elastic rod to a uniform pressure on its end is found in terms of power series expansions. The series are expansions in time about each of the three wave fronts represented in the Mindlin-McNiven approximate theory. The coefficients of the first four terms in each series are established by having the solutions satisfy the boundary and initial conditions. Numerical analysis is used to find the response at the end of the rod. It is shown how the first few terms of the series can be used to predict what the response would be if a large number of terms were used.

72-1111

RADIATION RESISTANCE OF A BAFFLED BEAM
Wallace, C.E. (Arizona State Univ., Tempe, Ariz.)
J. Acoust. Soc. Amer. 51(3), 936-945 (Mar. 1972) 14 refs

Key Words: acoustic response, beams

The radiation resistance of a beam is theoretically determined from the total acoustic power radiated into the farfield. The beam is supported in an infinite baffle, with both hinged and clamped supports considered. Asymptotic solutions are derived for frequencies well below the critical frequency. Curves, covering the entire frequency range between the low- and high-frequency asymptotic solutions, are obtained through numerical integration for the first 10 modes of beams with various width-to-length ratios. For frequencies well below the critical frequency, the ratio of the radiation resistance of a beam clamped at each end to that of a beam hinged at each end is 0.851 for the first mode, 0.711 for the second mode, and asymptotically approaches 2 as the mode number tends to infinity. For both hinged and clamped supports, the radiation resistance of all modes increases with the beam width-to-length ratio.

72-1112

THE DYNAMIC PROPERTIES OF GLASS AND CARBON FIBER REINFORCED PLASTIC BEAMS
Wright, G.C. (Inst. Sound and Vib. Res., Univ. Southampton, Southampton SO9 5NH, England)
J. Sound and Vib. 21(2), 205-212 (Mar. 22, 1972) 13 refs

Key Words: beams, dynamic response, resonant beam method, testing techniques

The dynamic moduli and loss factors of a number of fiber resin combinations are found by a resonant beam method. The measured dynamic moduli values differ from those predicted by linear theories in several aspects and explanations of these departures are given. The results are compared with those of other workers in the field.

BEARINGS

(Also see No. 1174)

72-1113

FACTORS WHICH AFFECT THE TRANSIENT BEHAVIOR OF PRELOADED BALL BEARING ASSEMBLIES
Carmichael, G.D.T. and Davies, P.B. (Central Electricity Generating Board, Berkeley Nuclear Labs., Berkeley, Gloucestershire, England)
Trans. Amer. Soc. Lubricating Engr. 15(1), 1-7 (Jan. 1972) 7 refs

Key Words: ball bearings, elastohydrodynamics, experimental results, transient response

An experimental rig developed to measure the variation of the preload and friction torque in a pair of angular contact ball bearings is described. The results illustrate the effects of spindle speed, oil flow rate, type of oil, housing design and housing cooling. The variation of friction torque is discussed in the light of elastohydrodynamic theory.

72-1114

THE VIBRATION AND FRETTING CORROSION OF INSTRUMENT BALL BEARINGS
Hite, G.C.; Mabie, H.H.; Elss, N.S.; and Hurst, C.J. (Flight Test Engr., Wright-Patterson AFB, Ohio)
Trans. Amer. Soc. Lubricating Engr. 15(1), 25-36 (Jan. 1972) 6 refs

Key Words: ball bearings, fretting corrosion

The effect of frequency and amplitude of axial vibration and of bearing axial play in producing fretting damage in unlubricated ball bearings at constant temperature and humidity is studied. The impact forces occurring within the bearings because of these vibrations are also investigated. A simplified analog simulation model of the ball bearing and the vibration exciter system is described.

BLADES

(Also see Nos. 1067, 1156, 1182)

72-1115

SCALE EFFECTS IN THE BENDING VIBRATIONS OF HELICOPTER ROTOR BLADES

Young, M.I. (Dept. of Mech. and Aerosp. Engr., Univ. Delaware, Newark, Dela.)

J. Sound and Vib. 21(1), 127-132 (Mar. 8, 1972) 6 refs

Key Words: flexural vibrations, helicopters, rotary wings

Scale effects and dynamic similarity in the bending vibrations of helicopter rotor blades are examined by expressing the first three modes of bending vibration of a uniform, conventional rotor blade by a series of Legendre polynomials as suggested by Wilde and others. The natural frequency ratios for these three modes are then determined as functions of a dynamic similarity parameter over the entire range of designs and operating conditions from very flexible, rapidly rotating blades to highly rigid, slowly turning conditions.

ISOLATORS

72-1116

TRANSIENT RESPONSE OF PASSIVE PNEUMATIC ISOLATORS

Fox, G.L. and Steiner, E. (Barry Div. of Barry Wright Corp., Burbank, Calif.)

U. S. Naval Res. Lab., Shock Vib. Bull. 42(4), 85-91 (Jan. 1972) 4 refs

Key Words: passive isolation, pneumatic isolators, transient response

The dynamic characteristics of pneumatic isolators in their nonlinear region of operation has become of recent interest. Equations derived for the general nonlinear case where the volume change is greater than approx 10 percent are presented. The effects of orifice flow damping are included, and comparison between experimental and theoretical results are presented.

72-1117

ANALYSIS OF LEGGED LANDERS FOR THE SURVIVABLE SOFT LANDING OF INSTRUMENT PAYLOADS

Laurenson, R.M.; Melliere, R.A.; Douglas, M.; and McGehee, J.R. (McDonnell Douglas Astron. Co., E. St. Louis, Mo.)

AIAA/ASME/SAE 13th Structures, Structural Dynamics and Materials Conf., San Antonio, Tex. (Apr. 10-12, 1972) AIAA Paper No. 72-371, 10 pp, 7 refs

Key Words: landing impact, spacecraft

Two methods of analysis developed for legged planetary landers are described. The first of these, the Large Displacement Gear Analysis, is a design tool for statically determining the large displacement stroking behavior, energy absorption characteristics, and internal load distributions in a single gear. The second, the Landing Dynamics Analysis, predicts the spatial landing dynamics of a legged lander. Effects of structural flexibility, elastic-plastic gear load characteristics, and soil properties on the loads, motions, and stability of the lander may be determined. Validation of the analytical techniques is accomplished through comparison of predicted results and experimental data obtained during a model test program.

72-1118

OPTIMIZATION OF A COMBINED RUZICKA AND SNOWDON VIBRATION ISOLATION SYSTEM

Zeidler, D.E. and Frohrib, D.A. (Medtronic, Inc., Minneapolis, Minn.)

U. S. Naval Res. Lab., Shock Vib. Bull. 42(4), 77-83 (Jan. 1972) 3 refs

Key Words: optimization, vibration isolators

An isolator combining the advantages of optimized Ruzicka and Snowdon models is presented. This isolator is demonstrated to have superior performance properties as evaluated by a criterion function of the form

$$I_t = DT_p + \log T_h,$$

where

- I_t = transmissibility index
- D = dimensionless weighting factor
- T_p = resonant or peak transmissibility
- T_h = transmissibility in the isolation range, above the highest resonance.

LINKAGES

72-1119

A GENERAL METHOD FOR KINETO-ELASTODYNAMIC ANALYSIS AND SYNTHESIS OF MECHANISMS
Erdman, A.G.
Rensselaer Polytechnic Inst., PhD Thesis (1971) 137 pp

Key Words: kineto-elastodynamic analysis, mechanisms, structural synthesis

Kineto-elastodynamics is the study of the motion of mechanisms consisting of elements which may deflect as a result of external loads or internal body forces. This thesis describes a general method of kineto-elastodynamic (KED) analysis and synthesis which may be applied to both planar and spatial mechanisms with elastic elements. Two levels of analysis are developed and applied to the study of an elastic four bar path generator linkage in order to determine the KED error in its prescribed performance caused by elastic deformations. These levels of analysis are based on the "instantaneous structure" concept in which a mechanism is "frozen" in numerous positions (which represent various configurations of the mechanism) and analyzed as a structure in each position. Link deformations are represented mathematically by a new stretch-rotation-deformation operation. The flexibility method of structural analysis is applied to the instantaneous structure to determine the KED deflections thus obtaining the error between actual and desired performance.
U.M. 72-10855

72-1120

DYNAMIC ANALYSIS OF THE RUNAWAY ESCAPEMENT MECHANISM
Hemp, G.W. (Dept. Engr., Sci. and Mech., Univ. Fla., Gainesville, Fla.)
U.S. Naval Res. Lab., Shock Vib. Bull. 42(4), 125-133 (Jan. 1972) 7 refs

Key Words: mathematical models, mechanisms, nonlinear damping, runaway escapement mechanism

A mathematical model developed for the nonlinear damping of the runaway escapement mechanism is described. A kinematics study develops expressions for the effective linkage ratios between the driving (starwheel) and driven (pallet assembly) members of the escapement for both entrance and exit engagements. The kinetics of the escapement action accounts for six phases of motion during one complete cycle of the pallet assembly and starwheel encounter. Accounting for the variability of the linkage ratios for the first time in an analytical treatment, the author derives an expression for the damping of the escapement. This expression is used to predict the behavior of a centrifugally driven mechanism for which experimental information is available. For steady state operation, the equation of motion for such units is solved in terms of elliptic integrals of the first kind.

MECHANICAL

72-1121

FACTORS AFFECTING THE TORSIONAL FREQUENCY RESPONSE OF MACHINE TOOL DRIVE SYSTEMS
Knight, W.A. (Dept. Mech. Engr., Univ. Birmingham)
Intl. J. Mach. Tool Des. Res. 12(1), 65-83 (Mar. 1972) 19 refs

Key Words: dynamic response, machine tools, torsional response

The factors which influence the dynamic torsional response of machine tool drive systems, including the gearbox ratios, rotational speed, preload and exciting force amplitude, are discussed. This is illustrated with cutting and forced vibration tests on a typical small horizontal milling machine drive. Frequency response measurements are carried out with electromagnetic exciters capable of exciting the drive system under rotating conditions. The dominant natural frequency of the drive results from the V-belts between the drive motor and gearbox and this resonance exhibits the characteristics of a nonlinear hardening system owing to the stiffness properties of the belts.

72-1122

FLEXURAL VIBRATIONS OF BELT TRANSMISSION SHAFTS
Kordysh, L.M. and Khomyakov, V.S.
Russ. Eng. J. 51(8), 27-31 (1971) (Engl. transl. of Vestnik Mashinostroeniya 51(8), 23-m 1971) 6 refs

Key Words: flexural vibration, shafts

How torsional vibrations of pulleys and errors in the manufacture of parts of a belt transmission can affect flexural vibrations of its shafts is shown, more specifically, the vibrations of the rear end of the spindle of a precision machine tool which supports the driven transmission pulley. Recommendations are made for reducing the effect of a transmission on flexural vibrations of a spindle.

MEMBRANES
(Also see No. 1133)

PANELS
(Also see Nos. 1080, 1177, 1179, 1180, 1181)

72-1123
CALCULATION OF PANEL FLUTTER BOUNDARIES
Gaspers, P.A., Jr. (NASA Ames Res. Ctr., Moffett Field, Calif.)
AIAA/ASME/SAE 13th Structures, Structural Dynamics and Materials Conf., San Antonio, Tex. (Apr. 10-12, 1972) AIAA Paper No. 72-403, 5 pp, 4 refs

Key Words: computer programs, flutter

Methods are described for the complete automation of flutter boundary calculations when the aerodynamic forces are derived from linear three-dimensional unsteady potential flow theory. The usual process of visual curve fairing in the μ-g plane is replaced by numerical procedures for ordering the eigenvalues in such a way that the nth eigenvalue is always associated with the same flutter boundary. The μ-g curves are interpolated via parametric cubic spline functions to produce the desired plots in the K-μ plane. The entire process is accomplished in a single computer run.

72-1124
A THEORETICAL AND EXPERIMENTAL STUDY OF MODE COUPLING DUE TO NONLINEARITY IN THE VIBRATION OF THIN PANELS
Morley, T.A. and Williams, C.J.H. (Univ. Birmingham, Edgbaston, Birmingham B15 2TT, England)
Symp. on Nonlinear Dynamics held at Loughborough Univ. Tech., England (Mar. 27-28, 1972) E.2.1-E.2.13, 11 refs

Key Words: equations of motion, nonlinear response, panels

Modes with closely equal natural frequencies are common in panel vibration. At large amplitudes in-plane membrane stresses couple these modes and produce phenomena unknown in the linear regime. The equations of motion governing the coupled motion of degenerate modes are derived and the coefficients of the nonlinear terms computed for several boundary conditions and modal configurations. The equations are shown to belong to a class of equations governing the nonlinear behavior of a wide range of structures possessing elastic symmetry. Examples are presented to show the effect of nonlinear coupling. Phenomena demonstrated, discussed and related to analogous behavior in other members of this class include: parametric instability of initially quiescent modes caused by fluctuating membrane stresses, the occurrence of a beating traveling wave effect due to the influence of coupling on the relative phase of the modes, and the existence of nonsteady forced oscillations. Nonlinearity is shown to be enhanced when the boundaries are constrained and when the vibrating surface cannot be developed such that "membrane stretching" is inevitable. The consequence is that the vibrational behavior is significantly affected when vibration amplitudes are comparable with the panel thickness.

72-1125
RADIATION RESISTANCE OF A RECTANGULAR PANEL
Wallace, C.E. (Arizona State Univ., Tempe, Ariz.)
J. Acoust. Soc. Amer. 51(3), 946-952 (Mar. 1972) 3 refs

Key Words: acoustic response, rectangular plates

The radiation resistance corresponding to the natural modes of a finite rectangular panel is theoretically determined from the total energy radiated to the farfield. The panel is assumed to be simply supported in an infinite baffle. Asymptotic solutions for the low frequency region are derived, and curves covering the entire frequency range for various mode shapes and aspect ratios are obtained through numerical integration. When the ratio of the acoustic wavenumber to the panel wavenumber is a constant much less than unity, the radiation resistance for all modes is a minimum if the intranodal area (the area between adjacent node lines) is square, and increases with the aspect ratio of the intranodal area.

PIPES

72-1126

LIQUID-STRUCTURE COUPLING IN CURVED PIPES -- PART II

Davidson, L.C. and Samsury, D.R. Machinery Dynamics Div., Naval Ship Res. and Dev. Ctr., Annapolis, Md.)

U. S. Naval Res. Lab., Shock Vib. Bull. 42(1), 123-136 (Jan. 1972) 7 refs

Key Words: coupled response, interaction: structure-fluid, piping

The coupled vibrational characteristics of a pipe assembly comprised of straight sections and uniform bends arranged in a nonplane configuration are analyzed. The results indicate a significant level of coupling between the plane compressional wave in the contained liquid and beam responses of the pipe. Experiments confirm the general level of coupling but indicate some difficulty in predicting the fine detail of frequency response.

PLATES AND SHELLS

(Also see Nos. 1037, 1046, 1047, 1049, 1050, 1078)

72-1127

FLEXURAL VIBRATING FREE-EDGE PLATES WITH STEPPED THICKNESS FOR GENERATING HIGH-DIRECTIONAL ULTRASONIC RADIATION

Barone, A. and Juarez, J.A.G. (Instituto di Acustica "O.M. Corbino" del Consiglio Nazionale delle Ricershe, Rome, Italy)

J. Acoust. Soc. Amer. 51(3), 953-959 (Mar. 1972) 4 refs

Key Words: measuring instruments, transducers

A transducer for the generation of high-directional ultrasonic radiation in fluids is studied. It consists of a plate of particular shape set in oscillation by an adequate vibrator. Since the directional pattern depends substantially on the phase with which the single elements of the plate vibrate, the radiating surface is shaped into steps covering areas vibrating with the same phase, the height of the steps being equal to a half-wavelength of the radiated sound, in order to obtain a coherent acoustic radiation. To facilitate the design of such plates, an approximate theory of their vibration is shown, and the experimental proofs, whose results confirm the full validity of the adopted method, are described.

72-1128

VISCOELASTOPLASTIC RESPONSE OF AXISYMMETRIC SHELLS UNDER IMPULSIVE LOADINGS

Chung, T.J. and Eidson, R.E. (Univ. Alabama, Huntsville, Ala.)

AIAA/ASME/SAE 13th Structures, Structural Dynamics and Materials Conf., San Antonio, Tex. (Apr. 10-12, 1972) AIAA Paper No. 72-400, 8 pp, 22 refs

Key Words: dynamic response, shells, viscoelastoplastic properties

The dynamic response of a viscoelastoplastic isotropic axisymmetric shell is analyzed by the finite element method, incremental theory of plasticity, and the direct numerical integration. A relaxation kernel in the form of exponential series and Von Mises yield criteria are utilized. Yielding of various points through the thickness of a shell is checked for appropriate treatment as to loading and unloading. Viscoelastoplastic stresses are first calculated to determine plastic tangent moduli and iterations carried out within an incremental load. To demonstrate the theory and procedures, a numerical example of the spherical cap under uniformly distributed impulsive loads is presented.

72-1129

OPTIMAL VIBRATIONAL MODES OF A DISK

DeSilva, B.M.E. (Dept. Math., Univ. Tech. Loughborough LE 11 3TU, England)

J. Sound and Vib. 21(1), 19-34 (Mar. 8, 1972) 18 refs

Key Words: disks, natural frequencies, optimization, turbine components

The problem considered is that of maximizing a linear combination of the natural frequencies of vibration of a turbine disk idealization of variable thickness. The problem is formulated as a general problem in optimal control theory with the addition of inequality constraints on the state variables. Significant progress has been made in solving the problem by using purely analytical techniques based on the maximum principle of Pontryagin. These transform the problem into a nonlinear programing problem which is solved numerically by using the Heaviside penalty function transformation in conjunction with Rosenbrock's hill-climbing techniques. Available computational experience indicates that these procedures provide powerful tools for handling complex structural optimization problems.

72-1130

ACCELERATION RESPONSE OF A BLAST-LOADED PLATE

Fagel, L.W. (Bell Tele. Lab., Inc., Whippany, N.J.)

U. S. Naval Res. Lab., Shock Vib. Bull. 42(2), 221-233 (Jan. 1972) 8 refs

Key Words: dynamic response, nuclear explosions, plates

A solution for a simply supported plate loaded by a step-function pressure is closely examined to determine contributions to acceleration from the plate's higher modes of vibration. Plate dimensions are assumed to be such that classical bending equations apply. It is established that the peak acceleration response can be as much as 2.6 times the peak response of a one degree-of-freedom analog. When damping is incorporated in the solution, the peak values are attenuated and much of the very high frequency response appears to dissipate rapidly. In practical situations where the damping ratio will be at least 1 percent, nine modes should adequately represent the plate's true response; however, computed accelerations may be nonconservative by up to 40 percent if only four modes are considered and by more than 100 percent if only one mode is used.

72-1131

AN APPROXIMATE THEORY FOR HIGH-FREQUENCY VIBRATIONS OF ELASTIC PLATES

Lee, P.C.Y. and Nikodem, Z. (Dept. Civil and Geol. Engr., Princeton Univ., Princeton, N.J.)

Intl. J. Solids Struct. 8(5), 581-612 (May 1972) 23 refs

Key Words: elastic theory, high frequency excitation, plates

Two-dimensional equations of successively higher orders of approximation for elastic, isotropic plates are deduced from the three-dimensional theory of elasticity by a series expansion in terms of simple thickness-modes for infinite plates. For each order of approximation from the zeroth up to the fourth, kinetic and strain energy densities, stress-strain relations and displacement equations of motion for both flexural and extensional vibrations are presented. Dispersion curves for real and imaginary in addition to complex wavenumbers in an infinite plate are explored in detail and compared with the solution of the Rayleigh-Lamb frequency equation from the three-dimensional theory.

72-1132

AMIC NONLINEAR RESPONSE OF BUCKLING SENSITIVE CYLINDRICAL SHELLS TO ASYMMETRIC PRESSURE LOADING

Mente, L. J. (Kaman AviDyne, Burlington, Mass.)

AIAA/ASME/SAE 13th Structures, Structural Dynamics and Materials Conf., San Antonio, Tex. (Apr. 10-12, 1972) AIAA Paper No. 72-357, 13 pp, 13 refs

Key Words: cylindrical shells, dynamic buckling

A reasonable computerized analysis is sought through an energy formulation employing Lagrangian equations of motion based on assumed series expansions for the displacement components with undermined time dependent coefficients. These governing equations are established within the framework of large displacement theories for thin cylindrical shells and conservative nonlinear material behavior. A numerical analysis scheme is presented which solves the set of governing equations through Hamming's modified predictor-corrector method and Gaussian quadrature techniques for the spatial integrations. For selected shells, the dynamic buckling response behavior, initial imperfection sensitivity, and geometric nonlinearity effects are examined under asymmetric pressure loading.

72-1133

NATURAL FREQUENCIES OF MEMBRANES AND PLATES WITH SLIGHTLY NONCIRCULAR BOUNDARIES

Nesseth, D.L.

Air Force Inst. Tech., Wright-Patterson AFB, Ohio, GA-MC-71-7 (June. 1971) 117 pp

Key Words: membranes, natural frequencies, perturbation method, plates

A theoretical study was made to determine whether or not the first natural frequencies of noncircular membranes and plates could be obtained using regular perturbation theory. The boundary equation of the noncircular membrane or plate is given by a chosen circular radius plus a term which represents the deviation of the noncircular boundary from a circle. The mode shape of free vibration for the noncircular membrane or plate is assumed to be represented by an asymptotic series which contains the mode shape for a circular membrane or plate plus additional terms of decreasing magnitude. Boundary conditions are imposed on the resulting expressions and through Taylor series expansions about the circular radius, a characteristic

equation for frequency is obtained for the noncircular membrane or plate. The correspondence between the term of the boundary expression giving the noncircularity of the membrane or plate and any general shape varying from circular is established. Specific values of the term are given for an ellipse and a square.
AD-729778

72-1134

THE RESPONSE OF A PLATE BONDED TO A RANDOMLY VIBRATING VISCOELASTIC HALF-SPACE
Remington, P.J. (Bolt Beranek and Newman, Inc., 50 Moulton St., Cambridge, Mass.)
J. Acoust. Soc. Amer. 51(3), 974-984 (Mar. 1972) 6 refs

Key Words: Bernoulli-Euler method, dynamic response, plates

The response of an infinite Bernoulli-Euler plate placed on the surface of a randomly vibrating viscoelastic half-space is calculated, allowing for the presence of shear stresses between the plate and the half-space. The shear stresses arise from the condition that the relative motion between the plate and the half-space vanishes at the interface. The three components of displacement of the free surface of the half-space (before the plate is added) are assumed to be stationary homogeneous random functions of position and time. From the wavenumber-frequency spectra of these displacements the frequency spectra of the three components of displacement of the plate half-space interface are calculated. As an example, the frequency spectrum of the vertical interface displacement is calculated for two assumed forms of the wavenumber spectra of the free surface displacements.

72-1135

RESPONSES OF A MULTILAYER PLATE TO RANDOM EXCITATION
Saunders, H. (Gen. Elec. Co., Aircraft Engine Group, Cincinnati, Ohio)
U. S. Naval Res. Lab., Shock Vib. Bull. 42(5), 27-35 (Jan. 1972) 12 refs

Key Words: laminates, plates, random response

Formulas are presented that can be employed to determine the mean square acceleration, displacement and stresses of multilayer plates caused by an externally applied random excitation. The derived expressions are general and can be applied to multilayer plates having different boundary conditions. The main theme in this paper is slanted toward all edges of the multilayer plate being simply supported. Examples of a three layered plate and a sandwich plate having an external layer protecting the upper facing are given.

72-1136

COMPUTATION OF NATURAL FREQUENCIES AND INITIAL BUCKLING STRESSES OF PRISMATIC PLATE ASSEMBLIES
Williams, F.W. (Dept. Civil Engr., Univ. Birmingham, Birmingham B15 2TT, England)
J. Sound and Vib. 21(1), 87-106 (Mar. 8, 1972) 10 refs

Key Words: computer programs, natural frequencies, rectangular plates

Many structures consist of a set of thin rectangular flat plates of uniform thickness which are rigidly connected together along their longitudinal edges. Two computer programs which are applicable to such structures are described, GASVIP and VIPAL. These programs use an exact method of analysis, either to find natural frequencies in the presence of uniform longitudinal stress, or to find the initial buckling stress in uniform longitudinal compression. GASVIP sets up the overall stiffness matrix of the structure, whereas VIPAL enables substructures to be used. There are some types of problem which cannot be solved by using VIPAL, but where it can be used it often takes much less computer time than the other code. VIPAL also has the advantage that there is virtually no limit on the number of nodes (i.e., line junctions between component plates) which can be handled within about 4K of core store.

RINGS

72-1137

DAMPING OF A CIRCULAR RING SEGMENT BY A CONSTRAINED VISCOELASTIC LAYER
Almy, C.R. and Nelson, F.C. (U.S. Army Electronics Command, Ft. Monmouth, N.J.)
U. S. Naval Res. Lab., Shock Vib. Bull. 42(4), 121-124 (Jan. 1972) 3 refs

Key Words: curved beams, rings, viscoelastic damping

An analytical study is reported of the variation of the composite loss factor with opening angle and shear stiffness of the viscoelastic layer for a constrained viscoelastic layer on a circular ring segment. There is evidence that optimum damping of a curved beam requires a stiffer viscoelastic layer than the corresponding straight beam.

SPRINGS

72-1138
DEVELOPMENT OF A LIGHTWEIGHT, LINEAR MECHANICAL SPRING ELEMENT
Keeffe, R.E. (Kaman Sci. Corp., Colorado Springs, Colo.)
U. S. Naval Res. Lab., Shock Vib. Bull. 42(3), 179-185 (Jan. 1972) 2 refs

Key Words: shock testing, springs, test instrumentation

The analytic and experimental development of an annular plate spring element suitable for pulse shaping studies is presented. This element has the desirable characteristics of linearity and low weight combined with the capability for obtaining the wide range spring rates necessary for transient shock pulse shaping experiments.

72-1139
LARGE DEFLECTIONS OF IMPACTED HELICAL SPRINGS
Phillips, J.W. and Costello, G.A. (Dept. Theoret. and Appl. Mech., Univ. Ill., Urbana, Ill.)
J. Acoust. Soc. Amer. 51(3), 967-973 (Mar. 1972) 12 refs

Key Words: springs

A theoretical formulation of the large deflections of helical springs is given, and coupled nonlinear equations of motion for a typical spring element are derived. Linearized forms of these equations are solved numerically and compared with experimentally obtained streak photographs of an impacted spring. The agreement between theory and experiment is good, as long as adjacent coils of the spring do not touch.

SYSTEMS

ACOUSTIC ISOLATION

72-1140
DETERMINATION OF DECAY COEFFICIENTS FOR COMBUSTIONS WITH ACOUSTIC ABSORBERS
Mitchell, C.E.; Espander, W.R.; and Baer, M.R.
Colorado State Univ., Fort Collins, Colo., NASA-CR-120836 (Jan. 1972) 80 pp

Key Words: acoustic damping, sound absorbers

An analytical technique for the calculation of linear decay coefficients in combustors with acoustic absorbers is presented. Tuned circumferential slot acoustic absorbers designed for the first three transverse modes of oscillation are used. Decay coefficients for these absorbers are found as a function of backing distance for seven different chamber configurations. The effectiveness of the absorbers for off-design values of the combustion response and acoustic mode is also investigated. Results indicate that for tuned absorbers the decay coefficient increases approximately as the cube of the backing distance. For most off-design situations the absorber still provides a damping effect. However, if an absorber designed for some higher mode of oscillation is used to damp lower mode oscillations, a driving effect is frequently found.
N72-14798

AIRCRAFT
(Also see Nos. 1057, 1060, 1080, 1097, 1098, 1159)

72-1141
EXTERNALLY BLOWN FLAP NOISE
Dorsch, R.G.; Kreim, W.J.; and Olsen, W.A.
Natl. Aeronaut. and Space Admin., Lewis Res. Ctr., Cleveland, Ohio, NASA-TM-X-67991 (1972) (Paper presented at 10th Aerosp. Sci. Meeting, San Diego, Calif. Jan. 17-19, 1972) 19 pp

Key Words: aircraft noise, engine noise, noise reduction

Noise data obtained with a large externally blown flap model is presented. A fan-jet engine exhaust is simulated by a 1/2-scale bypass nozzle supplied by pressurized air. The nozzle is pylon mounted on a wing section having a double-slotted flap for lift augmentation. Noise radiation patterns and spectra are obtained for nozzle exhaust velocities between 400 and 1150 ft/sec. The blown flap noise data are in good agreement with previous small model results extrapolated to test conditions by Strouhal scaling. The results indicate that blown flap noise must be suppressed to meet STOL aircraft noise goals.
N72-15959

72-1142

COMMERCIAL APPLICATIONS OF QUIET AIRCRAFT TECHNOLOGY

Griffith, E.D. and Roberts, G.F. (Lockheed Missiles & Space Co., Inc.)

SAE Preprint No. 720339, 6 pp, 7 refs

Key Words: aircraft noise, noise reduction

Recent experimental developments in military programs in aircraft quieting are reviewed, with suggestions on acoustic technology applications appropriate to general aviation. Comments are offered on the possible impact of developing noise abatement concerns, requirements, and legislation on general aviation. Potentially productive design tradeoff studies necessary to ensure minimum cost and an acceptable level of performance in the field of commercial light aircraft design are suggested. Reduction in the external acoustic noise signature of light piston-engine aircraft may logically be sought in the area of propulsion system design.

72-1143

ESTIMATION OF CONTROL SURFACE DYNAMIC DERIVATIVES FROM FLIGHT TEST DATA

Hall, B.M.; Sholar, M.S.; and Allred, A.P. (McDonnell Douglas Astron. Co., Huntington Beach, Calif.)

AIAA/ASME/SAE 13th Structures, Structural Dynamics and Materials Conf., San Antonio, Tex. (Apr. 10-12, 1972) AIAA Paper No. 72-379, 8 pp, 3 refs

Key Words: aerodynamic response, aircraft, flutter

A method is presented for the estimation of the dynamic hinge moment coefficients of control surfaces based on measurements of other system states. Criterion used to minimize estimate error includes minimizing the square of the differences between measured states and estimates of the states obtained from a system model. An example of the application of the method illustrates the mathematical steps and indicates how measurement noise affects the accuracy of the estimates. It is concluded that use of this method may either avoid or minimize the cost of test programs needed to establish data for flutter and servoelastic analyses.

72-1144

UNSTEADY AERODYNAMICS OF NONPLANAR WINGS AND WING-TAIL CONFIGURATIONS OF ELASTIC FLIGHT VEHICLES IN SUPERSONIC FLIGHT

Morito, J., II and Rowe, W.S. (The Boeing Co., Seattle, Wash.)

AIAA/ASME/SAE 13th Structures, Structural Dynamics and Materials Conf., San Antonio, Tex. (Apr. 10-12, 1972) AIAA Paper No. 72-378, 15 pp, 19 refs

Key Words: aerodynamic excitation, aircraft

A method for predicting the unsteady aerodynamic loadings of flexible aircraft with nonplanar wings and wing-tail surfaces in supersonic flow is presented. The aerodynamic interference between the wing and tail is taken into account. The computation considers dihedral angles on both wing and tail, and longitudinal and vertical separations between them. The aerodynamic influence coefficients associated with velocity potential, upwash, sidewash, and longitudinal wash are developed. The AIC's are manipulated to avoid numerical integration problems caused by their singular natures at Mach hyperbola. The boundary conditions of the "interfered" surfaces in the disturbed flowfield are discussed. Illustrative examples for the computed aerodynamics and flutter speed are presented and correlated with empirical data.

72-1145

SOME SPECIAL INVESTIGATION AREAS IN LIGHT AIRCRAFT FLUTTER

Pate, C.C.; Punatar, M.K.; and Winn, R.W. (Cessna Aircraft Co.)

SAE Preprint No. 720309, 7 pp, 4 refs

Key Words: aircraft, flutter

A brief description is given of one approach taken by a manufacturer of light business and personal aircraft to the flutter analysis of propeller whirl flutter, twin-boom aircraft, T-tail configuration, servotabs, and all-moving tail. Effects of structural variations that may occur in the service life of an aircraft are presented, and the effect of ice formation on control surfaces is discussed.

72-1146

APPLICATION OF AN APPROXIMATE METHOD OF SOLVING NONLINEAR DIFFERENTIAL EQUATIONS TO SOME PROBLEMS IN FLIGHT DYNAMICS

Ross, A.J. (Royal Aircraft Estab., Farnborough, Hants, U.K.)

Symp. on Nonlinear Dynamics held at Loughborough Univ. Tech., England (Mar. 27-28, 1972) 20 pp, 10 refs

Key Words: aircraft, oscillation

Analytic solutions of equations of motion with nonlinearities present are given for a variety of aircraft responses which exhibit oscillatory behavior, obtained from an improved version of the Kryloff and Bogoliuboff method. As examples of second-order systems, some experimental results of control surface buzz are analyzed to give possible variation of hinge moment damping with amplitude, and the solution is obtained for linear equations with damping and stiffness proportional to time-dependent V and V^2 respectively. For higher order systems, with one oscillatory mode, the lateral motion of a slender wing aircraft at high angle of attack is considered, the force and moments due to sideslip being nonlinear. The criterion for the existence of a limit cycle is found to be a modified form of Routh's discriminant, and comparisons with digital solutions show excellent agreement for the frequency and amplitude. The nature of the sustained oscillations experienced by the HP 115 aircraft is also given satisfactorily, comparisons being made with results obtained from a wind tunnel simulation of the full-scale response. The possibilities of applying the method to systems with two oscillatory modes are discussed, with reference to some simplified equations.

72-1147

DEVELOPMENT OF A TECHNIQUE FOR THE ANALYSIS OF NON LINEAR DYNAMIC CHARACTERISTICS OF A FLIGHT VEHICLE

Titchener, I.M. (Royal Aircraft Estab., Farnborough, Hants, U.K.)

Symp. on Nonlinear Dynamics held at Loughborough Univ. Tech., England (Mar. 27-28, 1972) 17 pp, 4 refs

Key Words: flight vehicles, nonlinear response

An existing approximate method for analyzing nonlinear differential equations having almost periodic solutions is adapted for the analysis of the nonlinear dynamic motion response of a class of flight vehicles typified by continuously changing damping and frequency. The investigation results in a practical method of analysis for this type of nonlinear oscillatory response data, yielding a concise representation of the dynamic response of the system, even for cases where the explicit form of the governing equation is not known. This representation comprises a local damping, frequency and center of oscillation, each being a unique function of the local amplitude independent of the initial conditions of the motion.

ARTILLERY

72-1148

DEFORMATION AND FRACTURE OF TANK BOTTOM HULL PLATES SUBJECTED TO MINE BLAST

Haskell, D.F. (U.S. Army Ballistic Res. Lab., Vulnerability Lab., Aberdeen Proving Ground, Md.)

U. S. Naval Res. Lab., Shock Vib. Bull. 42 (2), 87-96 (Jan. 1972) 1 ref

Key Words: explosions, mines, tanks (combat vehicles), vulnerability

A method is developed for predicting the deformation and fracture characteristics of flat rectangular tank bottom hull plates subjected to blast attack from shallow buried mines located under the plate's center. The method does not require electronic digital computers in its application, and is an easy to use, accurate, and directly applicable tool for vulnerability assessments and engineering design. The method is based on large structural plastic deformation, a semi-inverse energy method and a reasonable description of material behavior including a static stress-strain curve and strength failure criterion. Blast loading is characterized by the energy associated with the blast wave. Plate deformation is calculated by equating blast energy imparted to the plate to the strain energy absorbed by the plate in reaching its final deformed shape. These formulations correlate within an average error of 7 percent with available aluminum and steel plate mine blast test results. The results of the effort are presented in simple graph and nomogram format for rapid armor areal weight determinations and mine blast tank bottom plate evaluations. This method of analysis will facilitate vulnerability assessments and engineering design of armor subjected to mine blast attack.

BIOENGINEERING

72-1149
EXPERIMENTAL STUDIES OF LATERAL AND TORSIONAL VIBRATIONS OF INTACT DOG RADII
Thompson, G.A.
Stanford Univ., PhD Thesis (1971) 144 pp

Key Words: bones, lateral response, mathematical models, torsional vibration

A study of the lateral and torsional vibration characteristics of excised dog radii to provide information which can be used as a guideline in developing a mathematical model for whole bone vibrations is presented. The radii are mounted in a cantilever configuration and are subjected to static lateral loads, free and forced lateral vibrations, and forced torsional oscillations. Cantilever beam boundary conditions are ascertained by casting epoxy resin caps over the distal (wrist) ends of the radii and clamping and capped ends to a support. Deviations in the dynamic behavior of the dog radii from the simple model considered are postulated to be caused by: (1) viscoelastic effects; (2) twist of the principal axes of the bone cross section; (3) anisotropy; or (4) nonuniformities in the geometric and elastic properties along the length of the bones. Results show that the geometric variations along the length of the radii produce shifts in the spacing of resonance frequencies which closely correspond to the values measured in the experiments. Hence, the nonuniformities are judged to be of major importance in a mathematical model for the dynamic behavior of whole bones. U.M.72-11681

BRIDGES

72-1150
THE COMPARISON OF THE RESPONSE OF A HIGHWAY BRIDGE TO UNIFORM GROUND SHOCK AND MOVING GROUND EXCITATION
Johnson, N.E. and Galletly, R.D. (Mechanics Research, Inc., Los Angeles, Calif.)
U. S. Naval Res. Lab., Shock Vib. Bull. 42 (2), 75-85 (Jan. 1972) 4 refs

Key Words: bridges, dynamic response, finite element technique

This paper compares the dynamic response of a highway bridge structure subjected to: (1) the uniform ground acceleration time history for the May 18, 1940 El Centro earthquake; (2) moving ground acceleration; and (3) an average acceleration shock spectrum for strong ground motion. An analytical procedure is outlined for predicting the response of a highway bridge structure whose ground motion varies between its supports and is dependent upon seismic wave propagation characteristics. A typical six-span highway bridge is presented. A finite element model of this bridge is developed including representation of soil foundation stiffness and damping characteristics. The response of this structure is evaluated for the various ground motion conditions using normal mode techniques. The dynamic analysis is predicted using the MRI/STARDYNE Structural Analysis System.

BUILDING

72-1151
BEAM-COLUMN SUBASSEMBLAGES UNDER REPEATED LOADING
Bertero, V.V.; Popov, E.P.; and Krawinkler, H. (Univ. Calif., Berkeley, Calif.)
ASCE Struct. Div. 98 (ST5), 1137-1159 (May 1972) 12 refs

Key Words: experimental results, multistory buildings, seisn ic response

The behavior of two types of structural steel half-scale subassemblages of a multistory unbraced frame is investigated experimentally. These subassemblages are subjected to simulated gravity and cyclic seismic loads. The results obtained in the tests of the upper story specimens show that the weakest element of the subassemblage is the panel zone, where large shear deformation and diagonal buckling occur. The weakness of the subassemblages representing a lower story, is associated with lateral torsional instability of the beams, which is triggered by local instabilities. From the results, it is concluded that for an efficient design of earthquake resistant structure, it is advisable to have a design which provides a balance between the inelastic deformations, which may take place in each of the critical regions (beam ends and panel zone). It also appears that the energy absorption and dissipation capacity of properly designed steel subassemblages exceed the required energy even for cases of extreme earthquakes.

72-1152
SOUND TRANSMISSION THROUGH A DOUBLE-LEAF WALL
Donato, R.J. (Building Phys. Sec., Div. of Building Res., Natl. Res. Council of Canada, Ottawa, Canada)
J. Acoust. Soc. Amer. 51(3), 807-815 (Mar. 1972) 11 refs

Key Words: sound transmission, walls

The classical approach to the calculation of sound transmission loss through double-leaf walls is reformulated and various devices employed to reduce the resulting integrals to a tractable form for analytical solution. An approximation is made at low frequencies whereby, using a transform technique, the finite size of the wall may be included. Comparisons with experimental measurements show good agreement with theoretical predictions.

72-1153
RESPONSE OF BUILDINGS TO GROUND VIBRATIONS RESULTING FROM CONSTRUCTION BLASTING
Dowding, C.H., III
Univ. Ill., Champaign, Ill., PhD Thesis (1971) 219 pp

Key Words: buildings, multistory buildings, response spectrum technique

The damage potential of blasting vibrations is assessed through the application of response spectrum analysis techniques. A method to predict response spectra based upon preliminary blasting and geologic information is described. This procedure eliminates the necessity of using a digital computer to calculate the response spectra for anticipated ground motions.
U.M. 72-12143

72-1154
ESTABLISHING AN UPPER BOUND FOR WINDOW RESPONSE TO THE SONIC BOOM
Seshadri, T.V. and Lowery, R.L. (Fruehauf Res. and Dev., Detroit, Mich.)
J. Sound and Vib. 21(2), 149-158 (Mar. 22, 1972) 6 refs

Key Words: sonic boom, windows

A simple method to estimate the greatest upper bound of stress obtainable in windows due to sonic boom excitation is presented. The effects of damping and nonlinearity are not included; hence, if the most severe case can be determined for the linear, undamped case, then all actual stress levels must fall below that value.

EARTH

72-1155
SOIL PARAMETERS REQUIRED TO SIMULATE THE DYNAMIC LATERAL RESPONSE OF MODEL PILES IN STIFF CLAY
Brown, R.A.
Texas A&M Univ., PhD Thesis (1971) 131 pp

Key Words: dynamic response, pile structures, simulation

Methods to obtain the soil parameters needed to simulate the dynamic response of a laterally loaded pile are developed. 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 the field and predicted response of the pile are evaluated. Results indicate that the two soil parameters, (spring and quake) that represent the nonlinear characteristics of the soil are functions of the pile diameter. Together these two 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 or frequency of vibration and is significant for the velocities and frequencies encountered in this study.
U.M. 72-13204

HELICOPTORS

72-1156
AN EXPERIMENTAL STUDY OF HELICOPTER ROTOR IMPULSIVE NOISE
Bauch, W.E.; Munch, C.L.; and Schlegel, R.G.
United Aircraft Corp., Stratford, Conn., Sikorsky Aircraft Div., USAAVLABS-TR-70-7223 (June. 1971) 245 pp

Key Words: helicopter noise

Results of a study of helicopter rotor impulsive noise (RIN) are presented. Rotor noise, together with rotor blade dynamic and pressure data, measured during hover and cruise of a CH-53A helicopter, is used in a correlation study of calculated and measured noise. In addition, the rotor rotational noise analysis described in U.S. Army Aviation Materiel Laboratories Technical Report 70-1B is modified to reduce computation time and to include blade flapping and coning motions. The inclusion of these motions, however, is shown to have little effect on the predicted noise. Correlation of calculated and measured noise harmonic amplitudes is generally within 5 dB through the third harmonic at distances

less than 1000 ft in front of the helicopter. Waveform correlation of calculated and measured time histories of acoustic pressure is good. RIN is identified as being primarily a rotational noise phenomenon, ordered at the blade passage frequency and its harmonics, rather than amplitude modulated broadband noise. Hover RIN is shown to be caused by vortex interference (blade/wake interaction RIN), while cruise RIN is shown to be caused by the combination of acoustic effects of a high subsonic tip Mach number on wave propagation and blade drag and is referred to as advancing blade RIN.
AD-730359

72-1157

HELICOPTER AURAL DETECTABILITY
Ollerhead, J.B.
Wyle Labs., Inc., Hampton, Va., USA
AMRDL-TR-71-33 (Jul. 1971) 198 pp

Key Words: helicopter noise

Methodology for the prediction of helicopter aural detection thresholds from measured or estimated parameters of significance is developed. The subjective aspects of helicopter noise are discussed. A review is presented of the effects of atmospheric and terrain features upon the observed sound, and of the limitations in the measurement and analysis of helicopter noise. An experimental program is described, in which a group of subjects listened to a large number of synthetic and recorded helicopter sounds inside a specially designed acoustic chamber. Through these experiments, a model for calculating aural detection thresholds is developed, tested, and found to be accurate to within plus or minus 4 dB. Appendixes to the report include detailed instructions for applying several versions of the developed method and also provide simplified procedures for estimating propagation losses.
AD-730788

HUMAN

72-1158

WAVE ANALYSIS OF SHOCK EFFECTS IN COMPOSITE ARMOR
Filbey, G.L., Jr. (USAARDC Ballistic Res. Labs., Aberdeen Proving Ground, Md.)
U. S. Naval Res. Lab., Shock Vib. Bull. 42 (5), 97-100 (Jan. 1972) 3 refs

Key Words: composite structures, shock wave propagation

Enhanced performance by composite armor in layered configurations against kinetic energy projectiles, hypervelocity particles and metal jets has been an accepted fact based on numerous observations. A rationale for the improved performance is given in terms of an analytic model based on one-dimensional nonlinear wave propagation and reflection at material interfaces. Included as special cases are one-dimensional hydrodynamic shock waves and elastic waves. The model is specifically worked out for the dispersive wave case of a plastically deforming metal in uniaxial stress on one side of a boundary against a linearly elastic metal on the other side, but the principles apply generally. Details of the calculations of the developed stress fields in the two material cases are carried through and compared favorably with experiment. It is definitively shown that regions occupied by "harder" materials are those subjected to the larger stresses and thus these "harder" materials may be thought of as stress raisers.

72-1159

NOISE ASSOCIATED WITH T-41A AND T-41C TRAINER AIRCRAFT
Gasaway, D.C.
Sch. Aerosp. Medicine, Brooks AFB, Tex.
SAM-TR-71-22 (Aug. 1971) 24 pp

Key Words: aircraft noise, noise measurement

Acoustic noise measurements were obtained within Cessna T-41A and T-41C trainer aircraft during various phases of ground and airborne operation. Factors contributing to speech interference and auditory risk were identified, and recommendations are provided relative to improving voice communications and reducing auditory risks. Ambient noise within the T-41A and T-41C interferes significantly with speech, but this problem can be reduced when earplugs, such as the V-51R, are worn. The attenuation provided by the V-51R earplugs should prevent temporary or permanent noise-induced hearing loss.
AD-731128

72-1160

NOISE AND HUMAN PERFORMANCE
Grether, W.F.
Aerosp. Medical Res. Labs., Wright-Patterson AFB, Ohio, AMRL-TR-70-29 (June 1971) 50 pp

Key Words: noise tolerance

The possible effects of noise on human performance have been the subject of considerable research dating back to 1916. Thus interest has been stimulated by concern about noise in factories, offices, schools, aircraft and military vehicles. Two very direct and harmful effects of noise, permanent hearing loss and auditory masking, are treated only briefly in this review. Special attention is given to the so-called nonauditory effects on such performance measures as reaction time, vigilance, time estimation, tracking, manual manipulation, intellectual capacities, and industrial work tasks. Overall, the research data on noise and human performance appear rather contradictory and inconsistent. While many studies have found no performance impairment, and even improvement, there are some types of measures that rather consistently show decrements from exposure to noise. Some theoretical explanatory mechanisms to account for effects of noise on performance are included in the review.
AD-729213

72-1161
FINITE AMPLITUDE SHOCK WAVES IN INTERVERTEBRAL DISCS
Hartman, W.F. (The John Hopkins Univ., Baltimore, Md.)
U. S. Naval Res. Lab., Shock Vib. Bull. 42 (2), 213-219 (Jan. 1972) 15 refs

Key Words: biomechanics

The nonlinear deformation of intervertebral discs is discussed. The upward turning stress-strain curve implies that the discs will tend to shape pulses having submillisecond rise-times into shock waves and that shock inputs will propagate as shocks. These implications are explored for axial compressive impact of the spine, such as is incurred during aircraft-pilot ejection or during a fall onto the buttocks. Correlation with experimental results suggests that the application of finite amplitude wave theory to the shock loading of the spine should be further investigated.

72-1162
STABILITY OF HUMAN PERFORMANCE UNDER INTENSE NOISE
Stevens, S.S. (Laboratory of Psychophysics, Harvard Univ., Cambridge, Mass.)
J. Sound and Vib. 21 (1), 35-56 (Mar. 8, 1972) 6 refs

Key Words: environmental effects, human factors engineering, noise tolerance

Glare pollution is as common as noise pollution, and, to a psychophysicist, the eye and the ear are strikingly similar in their reactions to stimulation. It is curious, therefore, that the level of environmental agitation against glare pollution is infinitesimal by comparison with that against noise pollution. Examination of the evidence accumulated to date demonstrates that, apart from causing feelings of annoyance, neither sound nor light does harm, unless the level reaches such a high value that it affects the sense organ itself. Part of this evidence is in unpublished reports and the purpose of this paper is to review its main features, in the context of present-day concern about noise pollution.

ISOLATION
(Also see No. 1169)

OFF-ROAD VEHICLES
(Also see No. 1042)

PACKAGE

72-1163
DEVELOPMENT OF A PRODUCT PROTECTION SYSTEM
Young, D.E. and Pierce, S.R. (IBM General Systems Div., Rochester, Minn.)
U. S. Naval Res. Lab., Shock Vib. Bull. 42 (1), 223-234 (Jan. 1972) 16 refs

Key Words: packaging

A workable method for development of a product protection system, based on hardware and established procedure, is presented. The data and techniques used in product design determine the inherent strengths and fragilities of a product. These characteristics are determined by fragility assessment. Coincidentally, a continuing program statistically quantifies the nonuse environment through which the product must pass. This data, along with knowledge of packaging methods and material characteristics, are combined to engineer the package. Once engineered, the package and product are tested by dynamic simulation of the nonuse environment. The packaging program described indicates that the method maximizes the packaging engineer's chances of submitting the ideal economic and protective package the first time.

PUMPS, TURBINES, FANS, COMPRESSORS

72-1164

EFFECT OF CIRCUMFERENTIAL NON-UNIFORMITY OF FLOW DIRECTION ON RESONANCE VIBRATIONS OF COMPRESSOR ROTOR BLADES
Kulagina, V.A.
NASA-TT-F-14107, Transl. into English from Vliyaniye Okruzhnoy Neravnomernosti Napravleniya Potoka na Rezonansnyye Kolebaniya Lopatok Rabochego Kolesa Kompressora, Lopatochnyye Mashiny i Struinyye Apparaty (USSR), No. 5 (1971) 96-107, 19 pp

Key Words: natural frequency, rotor blades (rotary wings)

The effect is estimated of a circumferential nonuniformity of the flow direction, in front of a compressor wheel, on the amplitude of resonance vibrations of the rotor blades. The effect of the boundary conditions behind the wheel on the intensity of the flow spread in the inlet section of the compressor and on the blade vibrations is shown.
N72-15274

RAIL

72-1165

DYNAMIC INTERACTIONS OF HIGH-SPEED TRACKED AIR CUSHION VEHICLES WITH THEIR GUIDEWAYS -- A PARAMETRIC STUDY
Biggers, S.B., Jr.
Duke Univ., PhD Thesis (1971) 142 pp

Key Words: interaction: vehicle-guideway, iteration, mathematical models, normal modes

A mathematical model of a tracked air cushion vehicle and its guideway is formulated in order to investigate the vertical dynamic response of the vehicle-guideway system resulting from high speed vehicle passage. A train of vehicles can be represented by using a large number of mass system in tandem. The guideway is modeled as a series of simply supported Bernoulli-Euler beams with provisions for an elastic subgrade, combined structural and external damping, and a uniform axial compressive force. The solution for the guideway response is obtained using the normal mode analysis which allows both the mass and flexibility of the guideway to be considered as distributed parameters. The interaction of the vehicle response and the guideway response is handled by iterating until the correct solution is approximately reached at each small step in time as the vehicle travels along the guideway. By the proper choice of the system design parameters, the maximum vertical accelerations of the upper vehicle masses may be held to arbitrarily low limits. However, if economics dictate the use of rather flexible guideways, advanced passive suspensions or active secondary suspension systems will be required to satisfy the ride comfort criteria defining a ride of excellent quality.
U.M. 72-11066

72-1166

A GENERAL PURPOSE COMPUTER PROGRAM FOR THE DYNAMIC SIMULATION OF VEHICLE-GUIDEWAY INTERACTIONS
Dailey, G.; Caywood, W.C.; and O'Connor, J.S. (The John Hopkins Univ., Silver Spring, Md.)
AIAA/ASME/SAE 13th Structures, Structural Dynamics and Materials Conf., San Antonio, Tex. (Apr. 10-12, 1972) AIAA Paper No. 72-339, 8 pp, 4 refs

Key Words: computer programs, dynamic response, interaction: vehicle-guideway, finite element technique

A general purpose computer program for calculating the dynamic response of vehicles traveling over surface or elevated guideways is described. The program has application to a broad class of transportation systems and hence eliminates the need for numerous specialized programs. The program is modular in design and is based on the finite element or building block method in which a complex dynamic system is made up of a number of components. The program is equipped with several output options and the user can request as little or as much output as he wishes. On-line printer plots or on-line CalComp plots of the response can be obtained. Additional building blocks can be easily added to the program whenever desired.

72-1167

VEHICLE DYNAMIC CONSIDERATIONS FOR GUIDEWAY DESIGN OF THE MORGANTOWN PERSONAL RAPID TRANSIT SYSTEM
Doherty, C.S. (The Boeing Co., Seattle, Wash.)
AIAA/ASME/SAE 13th Structures, Structural Dynamics and Materials Conf., San Antonio, Tex. (Apr. 10-12, 1972) AIAA Paper No. 72-321, 6 pp, 3 refs

Key Words: railroad tracks, railroad trains, specifications

Design considerations for a guideway for the Morgantown Personal Rapid Transit System are discussed. Contour specifications are determined and allowable roadway perturbations are limited. Ride comfort criteria for the vehicle is selected for vertical and lateral vibratory accelerations. Vehicle response is calculated from analog simulations with a simple suspension system and a rigid steering system. Vehicle accelerations are determined separately for vertical and lateral motions as a function of sinusoidal input excitation. The input is for a 1 in. amplitude wave height of varying frequency. The wave lengths are thus determined by the input frequency and vehicle velocity. Allowable input variations of the guideway and guiderails can be determined by referring to the chosen allowable vehicle accelerations. The specifications for the guideway are determined as peak-to-peak deviations for given specified lengths of the guideway and guiderails.

72-1168

DYNAMIC ANALYSIS OF A SUSPENDED VEHICLE SYSTEM FOR HIGH-SPEED GROUND TRANSPORTATION
Meisenholder, S.G. (TRW Systems Group, Redondo Beach, Calif.)
AIAA/ASME/SAE 13th Structures, Structural Dynamics and Materials Conf., San Antonio, Tex. (Apr. 10-12, 1972) AIAA Paper No. 72-405, 8 pp, 13 refs

Key Words: active isolation, dynamic properties, high-speed transportation systems, passive isolation, suspended structures

Analytical results are presented which define the dynamic characteristics of a conceptual high-speed ground transportation vehicle which is supported from an overhead guideway structure. The theoretical model used to dynamically characterize both the suspended vehicle and the guideway is reviewed. The effect of dynamic interaction between the vehicle and the relatively flexible guideway is discussed in terms of vehicle ride comfort and performance capabilities. The dynamic properties of both passive and active suspension systems are discussed, relative to the control of the vertical and lateral rigid body modes of the vehicle.

72-1169

DYNAMIC CHARACTERIZATION OF A LINEAR INDUCTION MOTOR SUSPENSION SYSTEM FOR A TRACKED AIR CUSHION VEHICLE
Meisenholder, S.G. and Guenther, C.R. (TRW Systems Group, Redondo Beach, Calif.)
AIAA/ASME/SAE 13th Structures, Structural Dynamics and Materials Conf., San Antonio, Tex. (Apr. 10-12, 1972) AIAA Paper No. 72-341, 9 pp, 4 refs

Key Words: dynamic properties, experimental results, ground effect machines, mathematical models

An analytical and experimental program is reported which defines the dynamic characteristics of an air cushion suspension system for the support and guidance of a linear induction motor for a tracked air cushion vehicle. The theoretical models used to design and optimize the air cushions and spring/damper secondary suspension are described. Results from frequency response tests of full-scale prototypes are presented and correlated to theoretical predictions.

72-1170

A NORMAL MODE ANALYSIS OF RAIL RESEARCH CAR T-3
Milner, J.L.; Haight, E.C.; and Hutchens, W.A. (The Mitre Corp., McLean, Va.)
AIAA/ASME/SAE 13th Structures, Structural Dynamics and Materials Conf., San Antonio, Tex. (Apr. 10-12, 1972) AIAA Paper No. 72-336, 7 pp, 4 refs

Key Words: high-speed transportation systems, mathematical models, mode shapes, natural frequencies, railroad trains, transportation systems

A multidegree-of-freedom dynamics model developed to study the behavior of a high speed railcar is described. The model determines the natural frequencies and normal modes of a rail research car and represents those motions which are thought to be most influential in determining the ride quality of the railcar. Primary emphasis is placed upon modeling vibration frequencies from 0 to 20 Hz. Selected railcar modes of vibration are described with reference to experimental railcar vibration data obtained during a recent test and identification of significant railcar stiffness and mass effects is made.

72-1171
STRUCTURAL DYNAMICS CONSIDERATIONS FOR PRT SYSTEMS
Polma, F. (Monocab, Inc., Garland, Tex.)
AIAA/ASME/SAE 13th Structures, Structural Dynamics and Materials Conf., San Antonio, Tex. (Apr. 10-12, 1972) AIAA Paper No. 72-324, 16 pp, 10 refs

Key Words: mathematical models, periodic response, railroad trains, suspended structures, transient response

A suspended monorail vehicle is analyzed for dynamic characteristics. A 48 degree-of-freedom dynamic model is made. Responses to various excitations are computed. These are transient phenomena and steady-state response caused by unevenness of the guideway. Filtering between the sprung and unsprung masses is shown in terms of frequency spectra. Selected test results from a similar prototype system are used for comparison to the analytical results.

ROAD

(Also see Nos. 1061, 1076, 1077, 1150)

72-1172
STRUCTURAL RESPONSE TO GROUNDBORNE VIBRATION
Boswell, L.F. (Dept. Civil Engr., City Univ., London, England)
J. Soc. Environ, Engr. 52, 6-9, 12 (Mar. 1972) 15 refs

Key Words: buildings, ground motion, traffic-induced vibration

This paper describes some results of research undertaken in an attempt to establish information concerning the behavior of six buildings subjected to road traffic and railway disturbances.

72-1173
VEHICLE-ROADWAY INTERACTION STUDIES BY MATH MODEL
Ross, H.E., Jr. and Ivey, D.L. (Texas Transportation Inst., College Station, Tex.)
ASCE Transp. Engr. J. 98 (TE2), 285-298 (May 1972) 15 refs

Key Words: automobiles, collision research, dynamic response, mathematical models

A math model capable of predicting the dynamic behavior of an automobile as it interacts with various roadway features is presented. Its potential is illustrated by several applications. Reviewed are studies concerned with sloping culvert grates, guardrail need criteria, guardrail location, earth slopes, side slope design, and friction requirements on curves. It is concluded that the math model can be a valuable tool for the research engineer and the highway engineer in their efforts to minimize hazardous roadway conditions.

ROTORS

72-1174
COMPARISONS OF EXPERIMENTAL AND THEORETICAL DYNAMIC ROTOR BEARING BEHAVIOR USING GAS LUBRICATION
Dayton, R.D.
Midwest Res. Inst., Kansas City, Mo., AFAPL-TR-71-44 (Nov. 1971) 57 pp

Key Words: dynamic response, journal bearings

The results of an investigation into the adequacy of presently available theory in predicting the dynamic behavior of a rotor supported in hydrostatic and hydrodynamic gas lubricated journal bearings are presented. Measurements of critical speeds, threshold of instability speeds, gas flow rates, and rotor whirl frequencies for several rotors supported in hydrostatic and hydrodynamic journal bearings are made and compared to theoretical predictions. Bearing load, bearing supply pressure, bearing and gas temperature, and type of bearing supply gas are investigated. Good agreement between the experimental and theoretical results is obtained.
AD-732211

72-1175
A DYNAMIC ANALYSIS FOR ELASTIC STRUCTURES INTERACTING WITH ROTARY MACHINES
Lee, T.H. (Gulf General Atomic, San Diego, Calif.)
AIAA/ASME/SAE 13th Structure, Structural Dynamics and Materials Conf., San Antonio, Tex. (Apr. 10-12, 1972) AIAA Paper 72-375, 8 pp, 8 refs

Key Words: elastic foundation, interaction: structure-foundation, rotors

A coupled modal method developed for solving the problem of dynamic interaction between flexible rotary machines and the elastic supporting structure is described. A special feature of the problem considered is that the rigid-body displacements of the rotor are identified with the structure modes; therefore, the customary component mode synthesis techniques are not

directly applicable. The present approach combines the free-free modes of the rotary machine directly with the structure modes. An example problem is solved for the case of a harmonic excitation. Interaction effects, including gyroscopic coupling, are investigated and discussed.

72-1176
GYROSCOPIC RESPONSE OF ELASTICALLY MOUNTED ROTORS
Schweitzer, G.; Schiehlen, W.; Müller, P.C.; Hübner, W.; Lückel, J.; Sandweg, G.; and Lautenschlager, R. (Institut B fur Mechanik, Technische Universitat Munchen, D-8 Munchen 2, Arcisstr. 21 (Deutschland))
Ing. Arch. 41(2), 110-140 (1972) 19 refs

Key Words: high-speed rotors, optimum design

High-speed rotors are of increasing technical interest. Their motion is influenced by gyroscopic forces and by the elasticity and damping of their suspension. Starting with the equations of motion, the authors investigate the rotor's natural and disturbance behavior. When the rotors are run at critical speeds, instationary motions appear. Axial forces lead to parametric excited vibrations. Optimal parameters of a rotor are determined. Experiments verify the theoretical results. (In German)

SATELLITE
(Also see No. 1099)

SELF-EXCITED
(Also see Nos. 1057, 1123)

72-1177
THEORETICAL PANEL VIBRATION AND FLUTTER STUDIES RELEVANT TO SPACE SHUTTLE
Dowell, E.H. (Princeton Univ., Princeton, N.J.)
AIAA/ASME/SAE 13th Structures, Structural Dynamics and Materials Conf., San Antonio, Tex. (Apr. 10-12, 1972) AIAA Paper No. 72-350, 10 pp, 14 refs

Key Words: acoustic response, flutter, mathematical models, panels, space shuttles

Two major themes are explored. Firstly, the effect of the aerodynamic layer on flutter instability boundaries and on providing damping to the stable panel below the flutter boundary using simple panel models. Secondly, theoretical structural models are developed for point supported panels typical of proposed space shuttle construction and suitable for vibration and flutter analyses. Representative results for panel natural frequencies and flutter boundaries are presented. These are obtained using quasi-steady aerodynamics which ignore the aerodynamic boundary layer.

72-1178
STALL FLUTTER ANALYSIS
Ericsson, L.E. and Reding, J.P. (Lockheed Missiles and Space Co., Sunnyvale, Calif.)
AIAA/ASME/SAE 13th Structures, Structural Dynamics and Materials Conf., San Antonio, Tex. (Apr. 10-12, 1972) AIAA Paper No. 72-380, 15 pp, 56 refs

Key Words: flutter, helicopters, space shuttles

Dynamic stall and stall flutter are problems that have received a great deal of attention by helicopter and compressor industry during the past 10 years. Recently, the problem has become of great concern also to the aerospace industry since some of the winged space shuttle vehicles experience stall flutter in their transition from very high-hypersonic entry angles to the substall angles of attack of the subsonic cruise portion of the reentry. The two flow phenomena that cause stall flutter are: (1) a dynamic overshoot of static stall and undershoot of static reattachment loads; and (2) an additional lag of the deep stall air loads over and above the Karman-Sears vortex wakelog.

72-1179
TRAVELING WAVE TYPE FLUTTER OF FLAT PANELS IN INVISCID FLOW -- PART I: INFINITE PANELS
Kornecki, A.
Technion - Israel Inst. Tech., Haifa, Dept. Agricultural Engr., Publ. No. 132 (Sept. 1971) 172 pp

Key Words: flutter, panels

An analysis of the traveling wave type flutter of flat panels in inviscid flow is presented. The limitations of different approaches are explained and the experimental results are reviewed. The condition of panels of infinite length in the streamwise direction is investigated. The traveling wave type character of flutter of finite panels is emphasized and compared with the standing wave type flutter. The flow velocities considered extend from incompressible to high supersonic.
N72-14911

72-1180

TRAVELING WAVE TYPE FLUTTER OF FLAT PANELS IN INVISCID FLOW -- PART 2: PANELS OF FINITE LENGTH
Kornecki, A.
Technion - Israel Inst. Tech., Haifa, Dept. Agricultural Engr., Publ. No. 133 (Oct. 1971) 99 pp

Key Words: panels, vibration response

An analysis of the vibrations of finite panels in moving air is presented. It is shown that the vibrations are the traveling wave type and the model shapes differ completely from those in vacuum or air at rest. The results obtained with infinite panels are compared with those for finite panels. Unstretched rectangular panels, simply supported along all edges are used.
N72-14912

72-1181

THE EFFECT OF HYPERSONIC NONLINEAR AERODYNAMIC LOADING ON PANEL FLUTTER
McIntosh, S. C., Jr. (Stanford Univ., Stanford, Calif.)
AIAA/ASME/SAE 13th Structures, Structural Dynamics and Materials Conf., San Antonio, Tex. (Apr. 10-12, 1972) AIAA Paper No. 72-345, 7 pp, 8 refs

Key Words: aerodynamic response, flutter, panels

The system considered is a two-dimensional isotropic panel on hinged supports with one end spring restrained in the plane. Panel geometric nonlinearities and third-order piston theory aerodynamic nonlinearities are included. The nonlinear aerodynamic loading produces an instability where the use of linear aerodynamics would predict stability, if the initial disturbance is large enough. The nonlinear aerodynamic effects are governed by a single new parameter. A nonlinear stability boundary for constant initial energy is briefly discussed, and a study is made of the effects of various other system parameters. The stability boundary is found to vary smoothly with the new parameter, but it depends in a very complicated and as yet incompletely determined manner on the initial disturbance.

72-1182

THEORETICAL INVESTIGATION OF SUPERSONIC CASCADE FLUTTER AND RELATED INTERFERENCE PROBLEMS
Platzer, M. F. and Chalkley, H. G. (U.S. Naval Postgrad. Sch., Monterey, Calif.)
AIAA/ASME/SAE 13th Structures, Structural Dynamics and Materials Conf., San Antonio, Tex. (Apr. 10-12, 1972) AIAA Paper No. 72-377, 8 pp, 14 refs

Key Words: aerodynamic excitation, flutter, plates, vibrating structures

Two methods developed to analyze supersonic flow past oscillating flat plate cascades with supersonic loading-edge locus are discussed: (1) a linearized method of characteristics valid for arbitrary frequencies; and (2) an elementary analytical theory valid only for low frequencies of oscillation. Pressure distributions, aerodynamic forces, moments and torsional flutter boundaries are presented for various solidities, stagger angles, elastic axis positions, Mach numbers, density ratios, and structural damping coefficients. Also, the related problem of supersonic wind tunnel interference and extensions to cascades with finite blade thickness are considered.

SHIP

(Also see Nos. 1048, 1055)

72-1183

NOISE REDUCTION ON A RHINE CRUISE SHIP DUE TO DAMPING MATERIAL
Buiten, J. (Institute of Applied Physics, TNO-TH, Delft, The Netherlands)
J. Sound and Vib. 21(2), 159-167 (Mar. 22, 1972) 4 refs

Key Words: material damping, noise reduction, ships

In order to attenuate the structure borne sound generated by the resiliently mounted auxiliary diesel engines and propagated via the decks to the passenger cabins of a Rhine cruise ship, two decks and the hull between them were treated with 400 m^2 elastodissipative material. Measurements of the sound pressure levels in a cabin, situated between these decks, and vibration measurements, carried out both before and after the application of the damping material, indicate only small level reductions. The reduction caused by completion of the fitting out of the

ship, however, appreciably exceeds the influence of the damping material. The usefulness of the application of damping materials on board a ship is therefore considered to be doubtful.

72-1184
SIMPLIFIED METHOD FOR THE EVALUATION OF STRUCTURE BORNE VIBRATION TRANSMISSION THROUGH COMPLEX SHIP STRUCTURES

Chernjawski, M. and Arcidiacono, C. (Gibbs and Cox, Inc., New York, N. Y.)
U. S. Naval Res. Lab., Shock Vib. Bull. 42(5), 235-243 (Jan. 1972) 6 refs

Key Words: shipboard equipment response

A simplified method for analyzing the transmission of vibration in ship structures is presented. In the first part of the paper, the reflection and transmission of bending and longitudinal elastic waves in plates or beams forming cross-shaped connections is investigated. The second part analyzes the propagation of bending waves through an infinitely long plate which is stiffened by structural elements of arbitrary shape. Finally, a multipath plane structure is investigated for bending wave transmission.

SPACECRAFT
(Also see Nos. 1043, 1091, 1101, 1177, 1193)

72-1185
THE INFLUENCE OF STRUCTURAL STABILITY ON THE DYNAMIC RESPONSE OF SPINNING SPACECRAFT

Bodley, C.S. and Park, A.C. (Martin Marietta Corp., Denver, Colo.)
AIAA/ASME/SAE 13th Structures, Structural Dynamics and Materials Conf., San Antonio, Tex. (Apr. 10-12, 1972) AIAA Paper No. 72-348, 9 pp, 19 refs

Key Words: dynamic response, rotating structures, spacecraft

A unique approach for dynamic response analysis of highly flexible, rotating spacecraft is presented. The formulation includes dynamic coupling between elastic deformations and spacecraft rotation rates. The coupling is shown to be a significant influence on vehicle angular rates and conversely, elastic response is strongly influenced by (if not entirely caused by) vehicle spin rates. It is shown that angular motion is most strongly influenced by changes in inertial characteristics caused by elastic deformation and that the elastic deformation is influenced by centrifugal and coriolis forces. Numerical results for a typical configuration are presented.

72-1186
INVESTIGATION OF LAUNCH TOWER MOTION DURING AEROBEE 350 LAUNCH

Kinsley, R.L. and Case, W.R. (NASA, Goddard Space Flight Ctr., Greenbelt, Md.)
U. S. Naval Res. Lab., Shock Vib. Bull. 42(5), 77-86 (Jan. 1972)

Key Words: launching response, spacecraft, towers

A task team formed to investigate the disturbance of the attitude of an Aerobee 350 as it exited the launch tower presents its findings. It is shown that the tower's second mode is consistently excited at launch. The potential for tipoff as a result of the measured tower motion is determined analytically. The excitation mechanism is isolated and found to be a low-frequency pressure oscillation in the building hut created by the rocket blast. The recommended solution of the problem is to remove hut panels to prevent the initial pressure buildup.

72-1187
EVALUATION OF TECHNIQUES TO ESTIMATE TITAN III-C FLIGHT LOADS

Marx, M.H.; Adkins, A.W.; Bucciarelli, L.L.; and Hyland, D.C. (Lincoln Lab., Lexington, Mass.)
J. Spacecraft Rockets 9(4), 264-270 (Apr. 1972), 8 refs

Key Words: Fourier transform, launching response, spacecraft

Two techniques to predict satellite boost phase inertia loads are evaluated. The first is a straightforward application of Fourier transforms. The input data are known spectra of the booster/payload interface accelerations and forecast payload transfer functions, based on anticipated payload dimensions, mass distribution, and important modes, frequencies and damping. Application to a multidegree-of-freedom system is demonstrated. The second approach models the interface accelerations as a superpositioning of a finite number of enveloped narrowband excitations whose center frequencies lie at the lower natural frequencies of the booster. The envelope functions reflect the transient, nonstationary character of the excitation. If the envelope is assumed to be "slowly varying", obtaining the mean square modal response of the satellite is relatively simple.

72-1188
UNIQUE SOLUTIONS OF SPACECRAFT STRUCTURAL DYNAMICS PROBLEMS
Trubert, M.R. (Jet Propulsion Lab., Pasadena, Calif.)
AIAA/ASME/SAE 13th Structures, Structural Dynamics and Materials Conf., San Antonio, Tex. (Apr. 10-12, 1972) AIAA Paper No. 72-349, 9 pp, 19 refs

Key Words: spacecraft

New ideas and techniques recently put to use at the Jet Propulsion Laboratory for design and dynamic testing of spacecrafts are presented. The paper deals with practical problems rather than advanced mathematical theories and is concerned with the system approach for structural dynamics. This approach, borrowed from electrical engineering, has received attention in the recent past due to the advent of the fast Fourier transform algorithm permitting an economical use of digital computers. The concept of dynamic mass in the frequency domain in introduced. A combination of digital and analog techniques for special problems is presented. The examples reported are on actual spacecraft.

72-1189
STRUCTURAL DYNAMIC ANALYSIS AND TESTING OF A SPACECRAFT DUAL-TRACKING ANTENNA
Walters, D.D.; Heidenreich, R.F.; Woods, A.A.; and Wrenn, B.G. (Lockheed Missiles and Space Co., Sunnyvale, Calif.)
U. S. Naval Res. Lab., Shock Vib. Bull. 42(5), 191-202 (Jan. 1972)

Key Words: antennas, dynamic properties

The dynamic characteristics of flexible dual-tracking antenna structures subjected to gimbal motor stepping torques are discussed. The structural dynamic technology problems encountered are approached from both the analysis and test point of view. The analytical techniques and assumptions are thoroughly delineated. The correlation and application of this analysis is used to determine the most relevant test data assimilation, test techniques, and instrumentation requirements. Some typical problems encountered in the design, analysis and test of deployable antennas (fixed or flexible rib) that are mounted from spacecraft on rather large flexible booms and are excited by control forcing functions to accurately postion the system are pinpointed. Some of the problems that are encountered in the analysis and test such as gear backlash, backup structure flexibility, zero g simulation, instrumentation noise, gear stress and fatigue, etc. are discussed.

STRUCTURAL
(Also see Nos. 1048, 1069, 1071, 1175, 1184, 1186, 1188)

72-1190
DYNAMIC RESPONSE ANALYSIS OF GEOMETRICALLY NONLINEAR STRUCTURES SUBJECTED TO HIGH IMPACT
Gupta, K.K. (Jet Propulsion Lab., Calif. Inst. Tech., Pasadena, Calif.)
Intl. J. Numer. Methods Engr. 4(2), 163-174 (Mar./Apr. 1972) 8 refs

Key Words: computer programs, finite element technique, shells

An efficient digital computer method is presented for the determination of propagation of elastic stresses and deformations in certain geometrically nonlinear structures subjected to high impact loading. The finite element matrix displacement approach utilizing curved quadrilateral shell elements in conjunction with a nodewise predictor-corrector method employing Runge-Kutta extrapolation techniques is adopted. The related computer program written in FORTRAN V for the UNIVAC 1108 computer is effective for the solution of a range of practical problems including rectangular and cylindrical panels. Numerical results are presented for a relevant structure, the cell container and the negative electrode of an impact-resistant battery subjected to high impact, simulating its free landing on a planetary surface.

72-1191
ANALYSIS OF IN-PLANE VIBRATION OF BOX TYPE STRUCTURES BY A FINITE ELEMENT METHOD
Handa, K.N. (Dept. Building Construction, Chalmers Tech. Univ., Gothenburg, Sweden)
J. Sound and Vib. 21(1), 107-114 (Mar. 8, 1972) 1 ref

Key Words: box type structures, finite element technique

Application of the finite element technique in the analysis of box type structures is described. The box is developed from plate elements with two degrees of freedom per node and only in-plane free vibration is considered.

72-1192
ANALYSIS OF IN-PLANE VIBRATION OF SHEAR WALLS BY A FINITE ELEMENT METHOD
Handa, K.N. (Dept. Building Construction, Chalmers Tech. Univ., Gothenburg, Sweden)
J. Sound and Vib. 21(2), 169-180 (Mar. 22, 1972) 9 refs

Key Words: finite element technique, free vibration, walls

The application of a finite element technique in the free vibration analysis of shear wall type structures is presented. An in-plane plate element with six degrees of freedom per node is developed and the results are compared with those for other plate elements.

72-1193
COUPLING BETWEEN STRUCTURE AND LIQUID PROPELLANTS IN A PARALLEL-STAGE SPACE SHUTTLE DESIGN
Kana, D.D.; Ko, W.L.; Francis, P.H.; and Nagy, A. (Southwest Res. Inst. San Antonia, Tex.)
AIAA/ASME/SAE 13th Structures, Structural Dynamics and Materials Conf., San Antonio, Tex. (Apr. 10-12, 1972) AIAA Paper No. 72-347, 16 pp, 9 refs

Key Words: coupled response, fluid-containing containers, liquid propellants, natural modes, space shuttles

A study to determine the influence of liquid propellants on the dynamic loads for space shuttle vehicles is reported. A parallel-stage configuration model is designed and tested to determine the influence of liquid propellants on coupled natural modes. A 42 degree-of-freedom analytical model is also developed for predicting these modes. Currently available analytical models are used to represent the liquid contributions, even though coupled longitudinal and lateral motions are present in such a complex structure. Agreement between the results is found in the lower few modes.

72-1194
QUADRATIC EIGENVALUE PROBLEMS FROM A NONLINEAR STRUCTURAL ANALYSIS
Nachbar, W. and Jong, J.M.
Calif. Univ., Dept. Aerosp. and Mech. Engr. Sci., San Diego, Calif., AFOSR-71-1967TR (June 1971) 39 pp

Key Words: columns, eigenvalue problems, nonlinear response

When the modified structure method is applied to the study of the nonlinear behavior of continuous elastic structures, including bifurcation and snap-through, an eigenvalue problem occurs in which the eigenparameter appears quadratically in the coefficients of a linear differential equation. The elementary example of a fixed-free column loaded both axially and laterally is considered as a continuum problem, an approach possible within the scope of the modified structure method. Earlier studies of this problem in finite element formulation show nonexistence of an eigenvalue for very slender columns. The present paper investigates the question of existence of a positive eigenvalue in a hierarchy of linearized quadratic eigenvalue problems which result from the retention of higher order terms in the expansion of the potential energy functional. Nonexistence of eigenvalues for columns of sufficiently high slenderness ratio rho is shown, and the Rayleigh quotient method is used to bound the eigenvalue and give an approximation to the critical value of rho.
AD-731115

72-1195
DYNAMIC INTERACTION BETWEEN VIBRATING CONVEYORS AND SUPPORTING STRUCTURE
Paz, M. and Mathis, O. (Civil. Engr. Dept., Univ. Louisville, Louisville, Ky.)
U. S. Naval Res. Lab., Shock Vib. Bull. 42(2), 163-169 (Jan. 1972) 5 refs

Key Words: iteration, materials handling equipment, stiffness method, supports, vibrators (machines)

The dynamic analysis of the conveyor-structure system is presented using the stiffness method and an iterative scheme in which the structure and the vibrating conveyor are analyzed successively taking into account interacting effects. An example of a structural truss supporting a vibrating conveyor is given.

72-1196
RANDOM EIGENVALUE PROBLEMS IN STRUCTURAL ANALYSIS
Shinozuka, M. and Astill, C.J. (Columbia Univ., New York, N.Y.)
AIAA J. 10(4), 456-462 (Apr. 1972) 8 refs

Key Words: eigenvalue problems, mass-spring systems, Monte Carlo method

A computerized Monte Carlo simulation is presented for calculating the statistical properties of the eigenvalues of a spring supported beam-column. The spring supports and axial force

are treated as random variables; the distributions of material and geometric properties are considered to be correlated homogeneous random functions. Each sample distribution is generated using a new method for simulating multivariate homogeneous random processes having a specified cross-spectral density matrix. This method of solution is used to investigate the accuracy of the perturbation method for calculating the variance of the nth vibration and buckling eigenvalues. Numerical results are presented for the case where the axial load is equal to 27 percent of the fundamental buckling load and the distributions of material and geometric properties are uncorrelated. The perturbation method is shown to be acceptable for limited ranges of the statistical variations of properties.

72-1197
ON CUMULATIVE FATIGUE DAMAGE IN SEISMIC STRUCTURES
Suidan, M.T.
Univ. Ill., Urbana-Champaign, PhD Thesis (1971) 94 pp

Key Words: fatigue, seismic design, structural response

The viability of a cumulative fatigue damage criterion in the design of single degree-of-freedom seismic structures made of SAE 1015 steel is investigated. A procedure to evaluate cumulative fatigue damage is developed. It incorporates the rain flow cycle counting method, a factor to account for the mean stress of each strain reversal and an empirical adjustment of the log strain -- log fatigue life curve to take into account the order in which the reversals in a strain history occur.
U.M. 72-12402

72-1198
RESPONSE OF SIMPLE SPANS TO MOVING MASS LOADS
Wilson, J.F. (Duke Univ., Durham, N.C.)
AIAA/ASME/SAE 13th Structures, Structural Dynamics and Materials Conf., San Antonio, Tex. (Apr. 10-12, 1972) AIAA Paper No. 72-338, 8 pp, 12 refs

Key Words: dynamic response, ground effect machines, transportation systems

Forces moving at constant speed, composed of inertia and dead weight loads, are imparted to spans by compatible pressures. Effects of system parameters (passage frequency to span frequency ratio, traveling mass length to span length ratio, traveling mass to span mass ratio, and span damping) are evaluated. Dynamic span responses, although sometimes unbounded, are found to exceed static values by factors of two to three in practical cases. Results are applicable (with weight mostly concentrated in the chassis) which hover above the spans on relatively hard air cushions.

TURBOMACHINERY

72-1199
DYNAMIC MODELING OF HIGH BYPASS RATIO TURBO-FAN ENGINES
Breaks, J.C. (Lockheed-California Co., Burbank, Calif.)
AIAA/ASME/SAE 13th Structures, Structural Dynamics and Materials Conf., San Antonio, Tex. (Apr. 10-12, 1972) AIAA Paper No. 72-376, 6 pp

Key Words: aircraft engines, test models, whirling

The dynamic properties of the RB211 engines used to power the L-1011 airplane are successfully simulated with 0.045-scale models in an investigation of whirl phenomenon. Stiffness levels of engine mounts, engine shaft, internal A frames and engine support pylons and various failure conditions of fan blades, engine mounts and shaft bearings are simulated. Calibration and test results show that these models provide acceptable simulation.

USEFUL APPLICATION
(Also see No. 1157)

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BOOKS

ENVIRONMENTAL PHYSICS: ACOUSTICS
B. J. Smith,
American Elsevier Publishing Co.,
New York, N.Y. (1970)

This book is one volume of three on environmental physics, the other two bear the titles Heating and Lighting, respectively. The editor of the series states that it is essential for the construction engineer to have a sound knowledge of the fundamental principles in environmental design. The incorporation of the latest research information and the most modern techniques is stressed. It is therefore doubly unfortunate that the author of the acoustics volume has not kept this admirable goal in mind when discussing frequency analysis of sound. He uses interchangeably long discarded standard octave bands and *new preferred octave bands. As a book aimed* at construction engineers, it must be judged to be unsatisfactory and more likely to confuse than to teach the principles of noise control.

The inclusion of such a complex loudness unit as that introduced by S. S. Stevens is deplored. Surely, for engineers new to noise measurement and noise control, the much simpler dBA is difficult enough and certainly much easier to measure and to apply to practical problems. The same objection applies to the introduction of perceived noise level and other methods for measuring noise or noisiness, such as the noise criteria curves. The proposed ISO noise rating curves would at least have been more up to date. The chapter on "Room Acoustics" contains some useful data on this subject, including data on common building materials. It is, however, difficult to believe that by making the walls of a room a few millimeters out of parallel, flutter echoes can be avoided as stated in the title of Fig. 3.4.

In the next chapter on "Structure Borne Sound" the author gives the theory of wave propagation in solids in great detail. Why? The reduction of solid borne waves at corners of a structure is also given in detail. This would not seem to be of practical interest in noise reduction, but was at least news to your reviewer. The chapter on "Airborne Sound" includes information on noise reduction by (partial) walls, partitions and panels. Both ISO and British standards are mentioned, but not the sound transmission classes used in the US. The inclusion of examples to be worked out by the reader should be of help in understanding the use of the concepts introduced in the book. In summary, this book does not succeed in its objective of providing a sound knowledge of that part of acoustics applying to environmental design and can only be recommended if used with caution.

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VIBRATION OF DEFORMABLE SYSTEMS
A. P. Filippov
Izdatelstvo Mashinostroenie,
Moscow, USSR (1970)

This book introduces the reader to transverse vibrations and coupled bending-torsional vibrations of either straight or curved bars and vibrations of bars on elastic foundations. Vibrations of bars of variable cross section are treated briefly. Various types of damping are also treated. Free and forced vibrations of frames are treated in detail and the results put in form suitable for digital computation. Classical methods are applied to develop vibration characteristics of plane as well as rib-reinforced plates of various shapes in the presence of in-plane forces.

An entire chapter is devoted to vibrations of turbine blades with the results being offered in convenient form for digital evaluation. Bending vibrations of common geometry thin shells are treated briefly. The response of mass-spring system involving nonlinear springs is investigated and regions of stability determined. Lastly, shock effects on various elastic bodies are treated briefly.

This book may serve as an excellent reference book in its area since it offers a good introduction to vibrations of most types of elastic bodies of engineering significance.

W. A. Nash, USA
Courtesy of Applied Mechanics Reviews

PAPERS AND REPORTS

DYNAMIC ANALYSIS OF SHALLOW SHELLS WITH A DOUBLY-CURVED TRIANGULAR FINITE ELEMENT

Olson, M.D. and Lindberg, G.M.
J. Sound and Vib. 19(3), 299-318
(Dec. 8, 1971)

Refer to Abstract No. 72-320

The finite element analysis of thin shell structures under arbitrary static or dynamic loading is currently being pursued by many investigators using a wide variety of approaches. In the subject paper the authors generate a shallow curved displacement model through the application of conventional shell equations and the minimum potential energy theorem. A shell is modeled with doubly-curved elements, triangular in plan, whose initial curvatures and twist are restricted to be uniform throughout the element and whose thickness may vary linearly over the triangular area. The shallow shell theory of Novozhilov is used in the analysis. The work is a natural extension to dynamics of a static analysis described earlier by the authors (Intl. J. Solids and Struc. 6, 1133-1156, 1970) where high numerical accuracy was demonstrated.

A crucial feature of any finite element displacement analysis is the assumption of the localized displacement patterns which describe the behavior of the loaded element. In curved shell elements insufficient attention paid to the selection of displacement patterns has, in the past, often led to severe loss of accuracy and poor convergence. Here high-degree polynomial expressions are chosen for the displacement components; these are an incomplete quintic for the normal component, with three constraints employed to ensure that the normal derivative varies cubically along each element edge, and cubics for the two tangential components. The result is that the element has a total of 36 degrees of freedom including some higher displacement derivatives at the corner nodes whose presence is not strictly required by the variational formulation. These extra degrees of freedom have the disadvantages of imposing excessive continuity conditions at the nodes and of corresponding to forces whose physical significance is not readily apparent. However, the assumed displacement field has the important advantages of being conforming and of containing an accurate description of the curved element rigid-body motions.

The stiffness and consistent mass matrixes are obtained from the strain and kinetic energies in closed form. Considerable simplification and reduction in the size of the eigenvalue problem is achieved by assuming, as is commonly done, that in any practical vibration problem the normal component of motion will predominate and hence that the tangential inertia of the shallow shell can be ignored. The price paid for this simplification is that the calculated frequencies of a predominantly normal mode are slightly higher than they would otherwise be and that any possible predominantly tangential mode will not be predicted.

A large part of the paper is taken up with the presentation of example applications of the analysis. The natural frequencies and mode shapes of a spherical cap on a square base, two curved fan blades with uniform and linearly-varying thickness respectively, a spherical dish antenna model and a clamped cylindrical shell panel are considered. These examples are unfortunately all limited by the geometry of the element to shells having constant initial curvatures. The finite element results (which involve up to 29 natural frequencies in some applications) are compared with exact solutions in the case of the spherical cap and with comprehensive experimental measurements for the other shells. For the spherical cap rapid monotonic convergence of the calculated natural frequencies with mesh refinement and good agreement with the exact solutions is evident. For the other shells, of course, agreement of the finite element results with the comparative experimental results is not so precise since errors in the test models and measurements are bound to occur. In general, however, the calculated and test frequencies compare well and convergence of the finite element results (with fairly coarse grid works) is good, though the results for the antenna model are somewhat less convincing than for the other applications.

The paper is well-written and provides a valuable addition to the literature on the finite element analysis of the free vibrations of thin shells.

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AN ASYMPTOTIC THEORY FOR THE VIBRATION OF NONHOMOGENEOUS PLATES
Johnson, M.W. and Widera, O.E.
Acta. Mechanica 12(1-2), 131-142 (1971)

Refer to Abstract No. 71-1622

This paper is concerned with the derivation of the equations of motion of thin, anisotropic plates. The method used is that of the asymptotic integration of the equations of elasticity. While this method is by no means new, this application is both interesting and lends some insight into the theory of thin anisotropic plates.

The authors nondimensionalized the field equations of elasticity and expanded the stress and strain tensors, displacement vector, density, and compliance tensor in a power series in a thinness parameter. The latter two quantities are expanded because the material is considered piecewise continuous in the thickness direction (i.e. layered). By equating like powers of the thinness parameter, the authors arrive at a system of three coupled equations, which are the simplest possible thin plate equations, plus systems of equations of higher order.

This method gives a theory which incorporates the thickness effects in a consistent manner. The theory gives the dominant stresses as the in-plane ones but also gives expressions for transverse stresses. It is shown that the in-plane frequency is of higher order compared to the transverse frequency. It was pointed out that the first approximation theory is applicable to those problems where the characteristic wavelength is of the order of a linear dimension of the plate.

It would be of great interest to see this method applied to the dynamics of nonhomogeneous, anisotropic shells of general shape.

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DYNAMIC STABILITY OF CIRCULAR CYLINDRICAL SANDWICH PANELS
Johnson, C.D. and Bauld, N.R.
J. Engr. Mech. Div. Proc. ASCE 97(EM6), 1643-1661 (Dec. 1971)

Refer to Abstract No. 72-425

In this paper the equations of motion for a simply supported circular cylinder sandwich panel with time-varying edge conditions are developed. Face sheets are assumed to be thin and isotropic with a common Poisson ratio; Young's modulus and thickness may differ for the front and back sheet. The core is continuous, homogeneous, and orthotropic and resists only transverse shearing deformations. Thickness of the panel is treated as small with respect to the reference surface radius of curvature and only transverse inertia terms are included.

Subsequent work leads the authors to a statement of panel dynamic stability in terms of an infinite set of equations of the Mathieu-Hill form for the case of superimposed static and periodic edge conditions. Specifically treated are the cases of a simply supported circular cylinder sandwich panel uniaxially loaded first by a static load and a superimposed square wave dynamic load, and second by a static load and a superimposed periodically applied impulsive load. Stability is concisely summarized in both cases by nicely parameterized α-β plots. The abscissa depends simply on the nm^{th} resonant frequency as modified by the applied static load and the period of the dynamic input, and the ordinate is proportional to the ratio of the dynamic load amplitude, and the difference between the nm^{th} buckling load and the static load amplitude.

A thorough application of this approach to an evaluation of stability is neither feasible nor is it necessary, as the authors describe and as Yao (Ref. 1) has demonstrated with perhaps more rigor. The failure of the authors, however, to

include damping in their model deserves to be criticized since the resulting stability plots are alarming and suggest the requirement for a considerable amount of stability work when a shell is to be designed to function with periodic edge conditions. Yao's contention, on the other hand, based on cases observed by him, that static stability implies dynamic stability ought to be viewed within the context of the large instability regions in the neighborhoods of panel resonances and twice panel resonances shown in the present paper. Designers pursuing the safe course would be advised to augment a buckling analysis by the dynamic stability analysis described by Johnson and Bauld whenever the periodic edge load has a strong frequency component in the neighborhood of a lightly damped panel resonance or in the neighborhood of twice such a resonance.

REFERENCE

1. Yao, J.C. "Dynamic Stability of Cylindrical Shells under Static and Periodic Axial and Radial Loads", AIAA J. I (6) 1391-1396 (June 1963).

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EFFECT OF A RIGID BOUNDARY ON THE FLUTTER OF A THIN PANEL
Sundararajan, V.
J. Sound and Vib. 19(2), 147-151
(Nov. 22, 1971)

Refer to Abstract 72-427

This paper is concerned with the effect on the panel flutter boundary of a rigid wall placed parallel to a long panel. The length of the panel is infinite and the width finite. The two sides of the panel are simply supported. Since only the flutter stability boundary is of interest, a linear plate vibration equation was used. Linearized potential theory was employed to calculate the aerodynamic loading. A traveling wave solution in the streamwise direction was assumed and only the first mode in the spanwise direction was considered for the plate motion. The aerodynamic pressure was determined by assuming the same wave pattern for the velocity potential and by satisfying the boundary conditions on the rigid wall and on the panel. This pressure and the assumed plate deflection function is then substituted into the plate equation of motion. Galerkin's technique was employed in the spanwise variable to reduce this resulting equation to an algebraic equation for wave speed c and wavelength 1. The minimum critical air speed U_{cr} is the smallest value of U which yields a complex value c.

Some numerical results were shown in Figs. 2 and 3. These figures clearly show the destabilizing effect of the rigid wall when it is placed close to the panel. This is very interesting information because this wall effect may bring some correction to the results of wind tunnel experiment, thus making the comparison between analytical and experimental results more meaningful. However, as pointed out by the author, when the wall is placed too close to the panel, the effect of the boundary layer should be taken into account.

The reviewer wants to bring out two points here. First, perhaps due to typing error, the labels on the lower right corner of Fig. 2 are confusing. There are two curves having the same label $d/b = 0.06$, $M = 0$. Compared to Fig. 7 of Ref. 1, the upper one of these labels should be $d/b = 1.5$ (and ∞), $M = 1.3$. So the second label from the bottom should be something else. Secondly, the reviewer feels that it will be very helpful to the reader if the particular value of μ (mass ratio) is indicated on Fig. 3.

This work should be of interest to those people working on panel flutter.

REFERENCES

1. Dowell, E.H., "Flutter of Infinitely Long Plates and Shells. Part I: Plate", AIAA J. 4(8) (Aug. 1966).

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A FINITE ELEMENT METHOD FOR CONTACT PROBLEMS OF SOLID BODIES -- PART I: THEORY AND VALIDATION
Chan, S.K. and Tuba, I.S.
Intl. J. Mech. Sci. 13(7), 615-625 (July 1971)

Refer to Abstract No. 72-317

The authors develop a modified finite element method for the solution contact problems in elasticity. The results obtained are compared to the classical exact solution of Hertz.

To achieve simplicity the authors consider the plane stress or plane strain problem of two plane bodies in contact. The body is divided into an assemblage of triangular elements, and the displacement is assumed to vary linearly within the triangle. The displacement of the body is then represented by the displacements of the nodal points. The potential energy is expressed in terms of nodal displacements, and is then minimized. The cases of slipping and nonslipping between contact surfaces are separately considered.

A computer program is developed, and is applied to the classical problem of two cylinders in contact. Since the solution of this problem found by Hertz is well known, a direct comparison is possible. The authors establish this comparison in curve form for two distinct load levels. The results show that the solutions are in better agreement for the higher value of the load.

The next problem considered is that of a smooth circular inclusion in an infinite plate under tension at infinity. The exact solution of this problem given by Stippes et al., and referenced in the paper is used for comparison. Curves showing the compressive stress on the contact surface determined by exact and finite element methods show some discrepancy. Circumferential stress evaluations by the two methods show good agreement.

The reviewer believes that the paper makes a significant contribution toward the application of finite elements to realistic contact problems with arbitrary geometry, material properties, and loading conditions. It would be of interest to have some comparisons made with a more extensive class of contact problems such as those considered by Galin (Ref. 1). It would be desirable to have an a priori estimate of the error and rate of convergence. The reviewer feels that recent work on the theoretical foundations of the finite element method (Ref. 2), instead of its mere heuristic use will provide some of these answers.

In conclusion, this paper is recommended to those who are interested in the practical solution of contact problems involved in engineering design, and Part II of the paper should be awaited with interest.

REFERENCES

1. Galin, L.A. "Contact Problems in the Theory of Elasticity", Appl. Math. Res. Group, Dept. Math. Engr. Res., North Carolina State Univ., Raleigh, N.C. (Oct. 1961).

2. Brauchli, H.J. and Oden, J.T., "Conjugate Approximation Functions in Finite Element Analysis", Q. Appl. Math. 29(1), 65-90 (Apr. 1971).

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NONCONSERVATIVE STABILITY BY FINITE ELEMENT
Mote, C.D., Jr.
J. Engr. Mech. Div., Proc. ASCE 97(EM3), 645-656 (June 1971)

Refer to Abstract No. 71-1016

Professor Mote has demonstrated in this study that the very powerful method of finite elements can be applied efficaciously to nonconservative problems in the theory of elastic stability. The technique is applied to two rather well-known problems, namely: (1) the problem of determining the flutter load of a cantilevered beam subjected to a follower force at its free end (Beck's problem); and (2) the problem of determining the critical flow rate of a flexible tube conveying a fluid in uniform flow. Both problems are formulated within the Euler-Bernoulli beam theory.

Since such problems are described by nonself-adjoint boundary value problems due to the fact that nonconservative forces do not possess potentials, the author introduces an extended form

of Hamilton's principle for each of the two problems. Consequently, the equations of motion are written in a "stationary" form that allows a Ritz type of discretization. The column or tube is decomposed into L subregions or elements, and the displacement $v^{(i)}(x,t)$ of the i^{th} element is approximated as

$$v^{(i)}(x,t) = \left[a_1(x), \ldots, a_4(x)\right]^{(i)} \begin{bmatrix} u_1(t) \\ \vdots \\ u_4(t) \end{bmatrix}^{(i)},$$

where the $a_n(x)$'s, n = 1, 2, 3, 4 are polynomials of degree three, selected so as to satisfy certain continuity conditions at the ends of each element. The spatial integration in the extended Hamilton's principle is performed and a discretized stationary value problem is obtained. Assuming a time dependence of the form $u = U \exp(i\lambda^{1/2}t)$ for Beck's problem and $u = U \exp(\sigma t)$ for the flow problem, Mote obtains real and complex eigenvalue problems, respectively, with unsymmetrical matrixes.

In the case of Beck's problem, the eigenvalues are computed with an eight element model. Particular attention is devoted to the first and second natural frequencies as functions of the magnitude of the follower load. Very good accuracy is obtained for the fundamental frequency, whereas the frequencies of the second mode are computed with somewhat less precision. These numerical calculations lead to a value of the critical flutter load that is within 1 percent of Beck's exact value, $P_{cr} = 2.03\pi^2 EI/\ell^2$.

In the case of the pipe containing a flowing fluid, 4, 6, 8, and 10 element models are used. The critical flow rate is determined by following the root loci for σ as the fluid velocity increases until one of the roots acquires a positive real part, thereby signaling an oscillatory motion with exponentially growing amplitude. The value of the critical flow rate obtained in this manner is found to compare very favorably with the value reported in Benjamin's work that deals with a two-piece articulated pipe model.

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AN APPROXIMATE NONLINEAR DYNAMIC THEORY FOR PLATES
Widera, O.E.
J. of Engr. Math. 5(2), 99-107 (Apr. 1971)
Refer to Abstract No. 71-1083

Theories for the analysis of the static and dynamic behavior of thin elastic plates and shells are usually derived from the three-dimensional elasticity theory via suitable simplifying assumptions. These approximations generally include well-defined geometric constraints (such as those represented by the Kirchhoff hypothesis) and/or ad hoc statements as to the relative magnitudes of the relevant field quantities. The present study by Widera, which is concerned with nonlinear vibrations of transversely isotropic plates, uses a slightly different approach in that the assumptions involved are implied indirectly rather than stated explicitly. The only significant exception to this rule seems to be that the plate thickness is explicitly assumed to be much smaller than a representative length along the boundary.

Except for the effect of lateral displacements on membrane strains, the basic elasticity equations that the theory is based on are essentially linear. The stresses and displacements are nondimensionalized, and "scaled" so that all the quantities dealt with are O(1). The scaling process proves to be the most crucial step in this development, as it indirectly amounts to assuming (arbitrary, although possibly intuitively reasonable) orders of magnitude for the various quantities involved. In this sense, the author's suggestion that his theory, unlike previous methods, is free of artificial assumptions is debatable.

The dimensionless field quantities are expressed as power series in the square of a dimensionless thickness parameter, and substituted into the elasticity equations. Rearranging, and setting the coefficient of each power equal to zero, successive systems of differential equations are obtained. Upon integrating, the first system leads to a dynamic counterpart of von Kármán's nonlinear theory of plates. It is important to note that the equations of this first approximation could have been written directly, after the scaling process, without recourse to series expansion considerations.

The effect of rotatory inertia is present in the first approximation theory, while the contribution of the transverse shear and normal stress appears only in the second approximation. Higher order approximations are neither derived explicitly in the paper, nor elaborated on from the viewpoint of their anticipated significance and properties.

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FREE VIBRATION OF A CURVED BEAM
Petyt, M. and Fleischer, C.C.
J. Sound and Vib. 18(1), 17-30 (Sept. 8, 1971)
Refer to Abstract No. 71-1476

In this paper the finite element method is used to determine the natural frequencies of a curved beam in radial vibration. Three different displacement functions were used, viz.: (1) linear function for the tangential displacement v and cubic function for normal displacement w; (2) similar expressions to that of functions (1) incorporating the rigid body displacements; and (3) cubic functions for both tangential and normal displacements v and w. The authors show faster convergence and greater accuracy for the natural frequencies of curved beams with the help of displacement function type (3), when compared with the other two functions. This result can be expected since function (3) incorporates a higher degree polynomial.

Using the third function and six elements for the beam, the results obtained for the natural frequencies of hinged and clamped beams for different subtended angles are presented in graphical form. These results are shown to compare well with the Rayleigh-Ritz solution where available. The results show that the odd modes undergo rapid changes for subtended angles below 40 deg. The odd modes for subtended angles greater than 40 deg and the even modes for almost all through the range are relatively independent of the subtended angle of the beam. The analysis presented in this paper could be useful to structural designers.

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NONLINEAR VIBRATIONS OF A BEAM ON A VISCOELASTIC FOUNDATION
Genin, J. and Radwan, H.
J. Sound and Vib. 18(2), 197-201
(Sept. 22, 1971)
Refer to Abstract No. 71-1606

In this paper the authors have derived the equation of motion for free transverse nonlinear vibrations of a beam on a viscoelastic foundation, as an extension of Bolotin's and their own earlier work. The equation is valid for modes symmetric about the center of the beam. They include the effect of change of longitudinal position of each beam element on the bending moment caused by the lateral inertia forces. Effects of transverse shear and rotatory inertia are not considered and the Euler-Bernoulli formula is used to relate moment to curvature.

The equation of motion thus derived is applied to a simply supported beam, in which there is no axial constraint at the support. Only the fundamental mode is considered and the equation of motion is solved approximately. The deflection is assumed in the form $f(t) \sin(\pi s/l)$. This function is substituted in the equation of motion and the error is multiplied by $\sin(\pi s/l)$, integrated over length and equated to zero. The resulting equation in f is solved following the Van der Pol method for a simplified case of elastic foundation.

The interesting observations made are: (1) the presence of the viscoelastic foundation diminishes the effect of the nonlinear elastic term; and (2) the nonlinear damping arising due to foundation is in opposition to the linear damping of the system.

In problems involving large displacements of beams the axial constraint of the support has a great influence on the results. Hence it would be interesting to study problems involving axial support constraints.

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SHOCK RESPONSE OF A THREE-LAYER SANDWICH BEAM WITH VISCOELASTIC CORE
Nakra, B.C. and Chawla, D.R.
J. Soc. India 23 (3), 135-139 (Aug. 1971)

Refer to Abstract No. 72-402

The transient solution to the equations of motion for a sandwich beam with a viscoelastic core are presented. The transient excitation considered is a uniform distributed load applied and removed in a step function of time. The beam analyzed is a three-part sandwich beam which is simply supported and consists of elastic face sheets and a viscoelastic core. The core is taken to be a material which can be represented as a four element model consisting of a spring, a viscous damper and a Maxwell model in parallel. It is correctly pointed out that the complex modulus representation is not valid when considering a transient response.

The solution to the equation of motion is found by assuming a power series solution of symmetrical sine wave for displacement and representing the spatially uniform step applied load also by a series of sines.

Comparison between the displacement resulting from the response to the uniformly applied step loading of an elastic and the sandwich viscoelastic beam are presented as results from a digital computer program. Parametric curves of maximum displacement and logarithmic decrement for the sandwich beam of varying core thicknesses are presented.

The solution technique presented does not seem to be readily applicable to many component structures due to the difficulty of handling the boundary conditions at interfaces of the components.

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THRESHOLD NOISE LEVELS
Young, M. F. and Woods, D. L.
Tex. Transp. Inst. 40 pp (Dec. 1970)

Refer to Abstract No. 71-1666

In a report entitled "Threshold Noise Levels", one would not expect information on maximum noise levels from highways. However, if one does not read this report, he will not miss any original research work in this area, just an evaluation of widely available literature. About half of the report is devoted to a rather critical but insufficiently precise review of recommendations given by Galloway et al. in the NCHRP Reports 78 and 118. Maximum noise levels given in these reports are generally lower by about 15 dBA than the authors' own recommendations.

The authors claim to be more realistic by recommending "maximum mean sound pressure levels" of 65 dBA at the property line of single family residences during the night and 60 dBA for hospitals and rest homes, rather than a median level L_{50} of 45 dBA as recommended by Galloway. The higher levels are based on referenced data of ambient noise levels which the authors realize to be due primarily to contributions from traffic noise.

What bothers the noise control engineer working in the field of traffic noise is not so much the authors' statement that the maximum noise levels "recommended are similar to those presently existing in California" (which means that traffic noise is presently no problem at all), but rather their neglect of the many facts about the intrusiveness and the potential abatement of highway noise that have been established from recent research work. In dealing with traffic noise, for which there are such rating scales as percentile levels L_{50} and L_{10}, the energy mean level, the Noise Pollution Level, the Traffic Noise Index, etc., the authors have been greatly remiss in recommending "maximum mean sound pressure levels" without even specifying the term "mean." The authors completely disregard interference with normal outdoor activities when they recommend daytime levels of 70 dBA in residential areas. They are just attacking the ever increasing problem of noise pollution at the wrong end when they consider soundproofing of homes along with some selective landscaping rather than substantial quieting of the noise sources.

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CALENDAR

Meeting	Date 1972	Location	Contact
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.
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. Crusen, 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.
Automotive Engineering Congress and Exposition, SAE	1973 JAN. 8-12	Detroit, Mich.	A. J. Favata, SAE Hq.

CALENDAR

Meeting	Date 1973	Location	Contact
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. Kina, 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 400B4, 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

SUMMARY COVER SHEET
43rd SHOCK AND VIBRATION SYMPOSIUM
PACIFIC GROVE, CALIFORNIA, 5-7 DECEMBER 1972

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2. Submission deadline is 21 August 1972. Earlier submissions will be appreciated.
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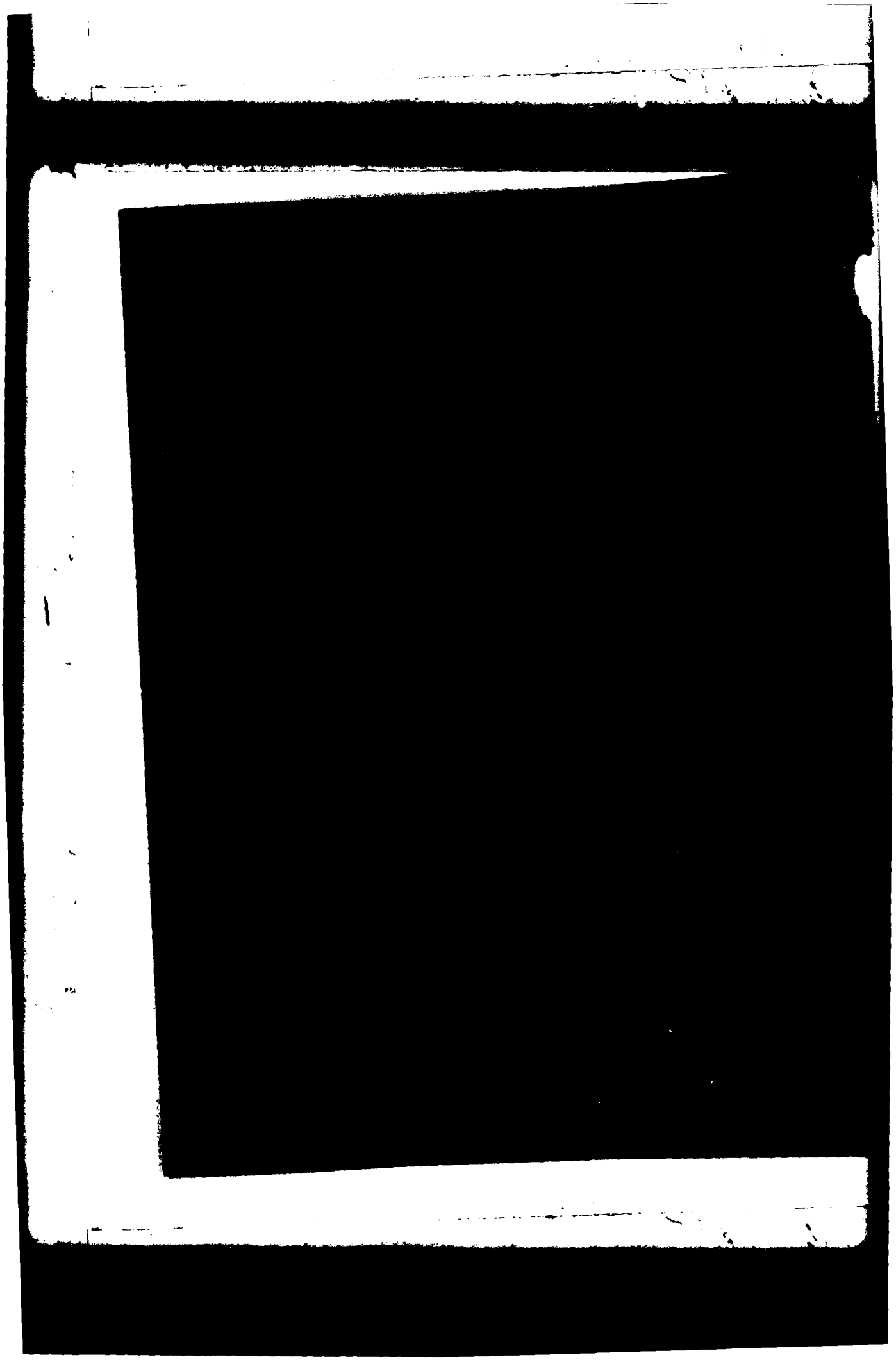

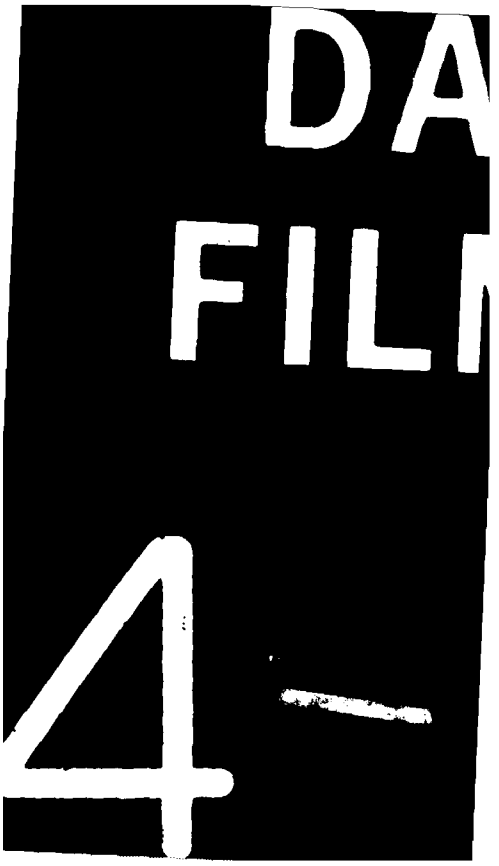
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