Similitude Approximations for Vibrating Thin Shells

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four air stream modulators and a laminated fiberglass progressive wavetube. Model configuration and position were varied during testing. Acclerometers, strain gauges, and displacement probes were used to measure the acoustic field external and internal to the model. Acoustic noise levels to 140–146 dB were produced in the progressive-wave tube. The results of this program indicated that acoustic testing using a simple fiberglass enclosure is an effective means of producing broad-band dynamic response of flexible vehicles. In addition, minor variations in structural configuration and variations in structural configuration and variations of model position in the test facility indicated minor effects on the test results.

2:45

G4. Changes in Laser Speckle as a Tool for Vibration Analysis. Nils Fernelius and Conrad Tome, *Argonne National Laboratory, Argonne, Illinois 60439.*—An object that is vibrating in a resonant mode and has a moderately rough surface illuminated by dispersed laser light shows patterns analogous to Chladni (strewn sand) patterns. The laser speckle patterns differ from the rest of the surface by appearing as regions in which the laser speckle has more dark areas interspersed with brighter light areas. These patterns appear at antinodes and are thus complementary to most Chladni patterns. Some examples of this observation along with Chladni patterns at the same resonant frequency are given. A heuristic theoretical discussion is also presented. [This work was performed under the auspices of the U. S. Atomic Energy Commission.]

3:00

G5. Seismic Waves Generated by Sonic Booms. Joe W. Posey, *Massachusetts Institute of Technology, Cambridge, Massachusetts 02139.*—Seismic waves produced by sonic booms striking the earth's surface have been observed and reported by several investigators. The incident N wave of sound pressure emanating from a supersonic aircraft in level flight moves across the ground at a speed below the speeds of seismic waves. Thus, all of the boom energy is reflected and the seismic disturbance decays exponentially with depth. R. K. Cook has solved the problem of the penetration of a sonic boom into water. Cook's technique is applied to the generation of seismic waves, and similar results are found. The pressure at the interface has a positive singularity at both the leading and trailing edges of the N wave and includes a precursor and a tail, each being weak and positive. Strains and displacements are small and pose little threat to structures.

3:15

G6. Transient Wave Propagation in a Transversely Isotropic Rod. H. D. McNiven and Y. Mengi, *University of California, Berkeley, California 94720.*—The response of a semi-infinite, transversely isotropic rod to a time-dependent input on the end of the rod is found using the method of characteristics. The rod is of circular section and the material of the rod is arranged so that axes of isotropy are parallel to the axis of the rod. To reduce the problem to one where motions depend on only one space variable and time, an approximate theory is developed, which is a three-mode theory and which is valid for an extensive frequency range. Numerical results are found for an input that has a step distribution in time and for two different materials, magnesium and a fiber-reinforced material. For each material, the response is found in terms of four quantities—radial strain, axial strain both on the lateral surface and along the axis of the rod, and the generalized stress.

3:30

G7. Approximate Theory of Torsional Wave Propagation in Elastic, Composite Cylinders. D. W. Haines, *University of South Carolina, Columbia, South Carolina 29208,* and P. C. Y. Lee, *Princeton University, Princeton, New Jersey 08540.*—One dimensional equations of motion are obtained for axially symmetric torsional deformation in elastic, composite cylinders. Under consideration are cylinders composed of two materials: a circular inner core surrounded by an annulus of different material properties. These approximate equations were obtained from the variational equations of motion of a linear elastic medium by assuming a set of simple, orthogonal displacement functions. These functions were chosen to give the first two branches of the dispersion diagram for torsional waves in the composite cylinder. The slope of the first branch at the origin of the dispersion diagram is identical with the corresponding slope obtained from the "exact" analysis. Two correction factors are introduced in the approximate equations in order for the second branch to match the exact analysis at two particular points. The dispersion relations obtained from the resulting corrected equations are very accurate through a wide range of frequencies for real wave numbers. Conditions at the end of finite cylinders, sufficient to provide a unique solution, are provided.

3:45

G8. Similitude Approximations for Vibrating Thin Shells. W. Soedel, *Herrick Laboratories, School of Mechanical Engineering, Purdue University, Lafayette, Indiana 47907.*—True dynamic similitude in the Newtonian sense proves often to be too restrictive in experimental investigations of dynamic characteristics of large shell structures by use of smaller models. Also, design information yielded by true similitude considerations is limited because of the usual requirement of total geometrical scaling. Thus, approximate similitude relationships were derived starting with Love's equations of motion for thin shells. Depending on the relative dominance of bending and membrane stress influences, selection is made betwen two similitude expressions. This allows the introduction of shell thickness as a parameter independent of the scaled surface geometry. Free as well as forced vibrations are examined. Some of the implications of approximate similitude are illustrated using as example a simply supported circular cylindrical shell.

4:00

G9. Nonmodal Solution to a Cylindrical Shell Problem. D. Feit, *Cambridge Acoustical Associates, Inc., Cambridge, Massachusetts 02138.*—When dealing with the vibrational response of structures, the classical modal type analysis is quite adequate for low-frequency vibration problem. With increasing frequency, the modal analysis becomes more difficult to numerically evaluate owing to the slow convergence of the sums. Using a Sommerfeld–Watson type transformation [D. Feit and M. C. Junger, J. Appl. Mech. 36, 859–864 (1969)], the modal sum for the response of a point-excited cylindrical shell is converted to a sum consisting of a finite number of terms. Each of these terms can be interpreted in terms of the flexural wavefield of a point-excited infinite flat plate. [Work supported by the Structural Mechanics Branch of the Office of Naval Research.]

4:15

G10. Closed-Form Solution of Forced Vibrations of Spherical Shells with Attachments. M. C. Junger, *Cambridge Acoustical Associates, Inc., Cambridge, Massachusetts 02138.*—The forced vibrations of a finite elastic system can be analyzed as a superposition of normal modes or as waves in