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SVIC NOTES

MANY THANKS

On behalf of the Shock and Vibration Information Center I wish to publicly thank the many members of the shock and vibration technical community for their help in reviewing the papers to be published in the 55th Shock and Vibration Bulletin. We appreciate the time you took from your busy schedule to help us, but I am sure the authors appreciate your suggestions for improving their papers even more. Again, many thanks for your help.

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DOCUMENTATION OF EXPERIMENTAL WORK

The **DIGEST** Literature Review section has always suffered from a lack of papers on experimental work. It appears that this trend reflects the state of the literature in the shock and vibration field. In general, experimentalists have not been as prolific in paper and book publishing as analysts and theoreticians. The nature of the work performed and the end use of it have contributed to this situation. In addition, publication prejudice has precluded the documentation of much good experimental work. It is unfortunate that each year test work goes undocumented -- leaving the wheel to be reinvented.

One of the reasons that experimental work often goes undocumented is that it is of service nature. The testing and experiments are conducted in the process of developing hardware or diagnosing problems. While this work may not be the focal point of the research and development, it is important to the success of the program whereas mathematically oriented work often is the final product within itself. In many cases test work may not appear to be original and/or innovative; however, many new techniques are developed to do routine work. These techniques may or may not be documented. Normally the test data will be documented in a report which usually is not available to the public. Seldom is it published in the open literature -- because there isn't time or it is deemed unnecessary. These techniques and data would be valuable to future researchers if they were documented in a concise and organized manner.

The publication process is by no means easy for test engineers and technicians. Except for periodicals like the **Shock and Vibration Bulletin** journals are not interested in experimentally oriented papers. These papers are filtered out in the review or editorial process because only mathematical papers are viewed as genuine contributions to the literature. Thus there is a need for better balance in the publication process.

Somehow the situation on the publication of experimentally oriented literature must be changed so this important technology appears in print. Perhaps the new MIL STD 810 will motivate the process and result in the development of much test technology. Hopefully a mechanism will be developed to get this work documented -- with procedures and data formats.

R.L.E.

STIFFNESS AND DAMPING COEFFICIENTS OF RUBBER

M. Issa Abdulhadi*

Abstract. A study has been carried out on a rubber pad (Neoprene GN) in the shape of a solid circular cylinder. The pad is subjected to a vibrating force. A mathematical model is used to evaluate stiffness and damping coefficients for the rubber and the damped energy. A heat conduction equation describing the temperature field in the rubber specimen is formulated; analytical results agree fairly well with temperatures measured in the rubber.

Vibrating forces generated by machines and engines are often unavoidable, but they can be reduced substantially by vibration isolators. Rubber pads are widely used; many physical characteristics of rubber vary with changes in temperature. When these changes are known, variations in the physical properties of rubber can be interpreted.

A rubber pad under the action of a vibrating force undergoes repeated compression in the longitudinal direction and bulging in the lateral direction. Each rubber molecule experiences these movements, but their motion is resisted by neighboring molecules. The only damping force assumed in this problem is the equivalent viscous type. It is proportional to the first power of the rate of displacement and is represented by a dashpot with an equivalent damping coefficient C_{eq}. The damping force F_d is given by

(1) $$F_d = - C_{eq}\dot{x}$$

The dot denotes the derivative with respect to time t. The estimated stiffness and damping coefficients are strongly related to the temperature inside the vibrating rubber pad. A simulated mathematical model that accounts for stiffness and damping parameters can be used to evaluate the heat generated per unit time per unit volume inside a vibrating rubber cylinder.

The rubber cylinder has a known load resting on top; it is excited into vibratory motion that has a specific frequency and acceleration of excitation. Experimental temperature readings match the trend in behavior of the temperature predicted by the analytical solution. Hence the proposed model appears to have the potential for extension.

ANALYTICAL APPROACH

A sample of the rubber pad has the shape of a solid circular cylinder with known dimensions. Figure 1 shows a rubber cylinder placed on the supporting table of an electrodynamic shaker. A weight w is resting on top of the cylinder. The rubber cylinder can be simulated by a spring of stiffness K and dashpot of equivalent viscous damping coefficient C_{eq}. The entire system is excited by a prescribed motion of the lower support, which is the upper table of the electrodynamic shaker.

To facilitate the mathematical approach to the problem, the system is considered to be equivalent to a spring-mass system excited by a support motion as shown in Figure 2. If x and y represent the vertical displacements of the mass M and of the support table respectively, the differential equation of motion can be written in the form [3, 4]

(2) $$M\ddot{x} + C_{eq}\dot{x} + Kx = C_{eq}\dot{y} + Ky$$

The motion of the support table as excited by the vibration exciter is taken to be sinusoidal and of the form

(3) $$y = Y \sin\omega t$$

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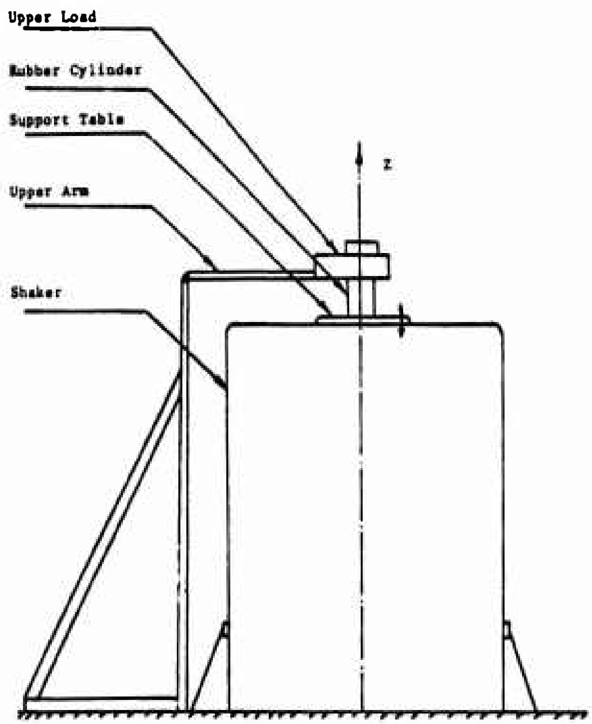
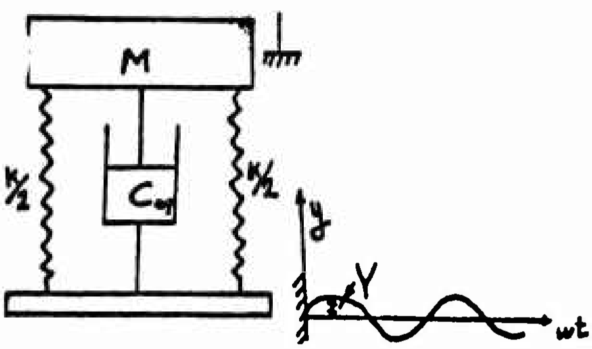


Figure 1. Rubber Cylinder on Support Table. Upper Load



$$y = Y \sin\omega t$$

$$Mx + C_{eq}x + Kx = C_{eq}\omega Y \cos\omega t + KY \sin\omega t$$

Figure 2. Simulating Model

If y and $\dot{y}$ are replaced by their corresponding expressions, the equation of motion can be rewritten in the form

(4) $$M\ddot{x}+C_{eq}\dot{x}+KX=C_{eq}\omega Y\cos\omega t+KY\sin\omega t$$

The general solution of equation (4) is [4]

(5)
$$x = A \exp\left(-\frac{C_{eq}}{2M}t\right) \sin \left|\left(\frac{K}{M} - \frac{C_{eq}^2}{kM}\right)^{\frac{1}{2}} t + \Psi\right| +$$

$$+ (k^2 + C_{eq}^2\,\omega^2)^{\frac{1}{2}} \left|(k - M\omega^2)^2\right.$$

$$\left. + C_{eq}^2\,\omega^2\right|^{-\frac{1}{2}} \sin(\omega t + \phi)$$

where

(6)
$$\tan\phi = MC_{eq}\,\omega^3 \left|k^2\left(1 - \frac{\omega^2}{\omega_0^2}\right) + C_{eq}^2\,\omega^2\right|^{-1}$$

A and Ψ are arbitrary constants that depend on the initial conditions. The first term in equation (5) is transient and damps out with time. The second term represents the steady-state solution.

EXPERIMENTAL INVESTIGATION

For each weight placed on top of the rubber cylinder the support table is subjected to an oscillatory motion with various values of acceleration $\ddot{Y}$ (measured from mean value to peak). For the same acceleration the frequency of excitation ω was varied. For each frequency ω amplitudes of the displacements for the support table Y and for the load X were measured by relevant vibration meters and recorded. When X/Y is plotted vs ω, the line X/Y = 1.0 determines the natural frequency $\omega_0 = |K/M|^{1/2}$. This can be seen from the analytic relation

(7) $$X/Y = (K^2 + C_{eq}^2\,\omega^2)^{\frac{1}{2}} \left|(k - M\omega^2)^2 + (C_{eq}\omega)^2\right|^{-\frac{1}{2}}$$

that reduces to $X/Y = 1.0$ for $\omega/\omega_0 = \sqrt{2}$

From the plot of stiffness coefficient K vs acceleration $\ddot{Y}$ of excitation as shown in Figure 3, it is concluded that for the same $\ddot{Y}$ the stiffness coefficient K varies with the weight applied.

The damping coefficient C_{eq} is estimated from the dimensionless term $C_{eq}\omega/K$. This term is obtained from displacement-frequency plots [4]. Replacing ω with ω_o in equation (7) results in

$$C_{eq}\omega/K = |(X/Y)^2 - 1|^{-\frac{1}{2}} \tag{8}$$

Figure 4 shows the variation of $C_{eq}\omega/K$ with the acceleration of excitation for various applied loads. The various plots can be used to estimate the magnitude of K; the parameter $C_{eq}\omega/K$ can then be found after frequency and acceleration of excitation under the action of the applied weight are known. From the known values of K and $C_{eq}\omega/K$ the magnitude of the damping coefficient C_{eq} can be estimated.

TEMPERATURE MEASUREMENT

The rubber cylinder is 50 mm in height and 18 mm in diameter. Two discs of thermally insulating material, each 2 mm in thickness and having the same radius as the cylinder, are fixed firmly to the two bases of the rubber cylinder. The cylinder is placed on the support table of the shaker together with a known weight resting on top. Sixteen thermocouples of copper-constantan gage 30 were used in temperature measurements at various locations in the rubber cylinder. A potentiometer was used to read the potential difference between hot and cold junctions. The cold junction was kept at 0^oC by immersing the cold junction in ice water.

The locations at which temperature was measured are shown in Figure 5. Because of azimuthal symmetry of the cylinder each point is located by specifying its radial distance from the central axis and its axial distance from the lower base.

The thermocouples were fixed in holes. The rubber cylinder was placed on the supporting table of the shaker with the thermocouples extending out of the cylinder and connected to the potentiometer via a selective multi-channel switch.

The rubber cylinder with the known weight on its top was excited into an oscillatory motion at known amplitude and frequency. After a steady-state condition was attained, temperature readings were recorded. Figure 6 is a representative sample of the experimental data; it is a plot of the temperature distribution for different z-sections taken perpendicular to the axial direction when the cylinder was vibrating with a frequency of 22 cycles/sec and with an amplitude of 0.2 in. peak to peak. The results show that the temperature variation was decreasing in the radial direction for each z-section. In addition, the temperature maintained an almost constant value for the same cylindrical surface of known radial distance r from the central axis.

TEMPERATURE FIELD OF THE VIBRATING CYLINDER

Under certain justifiable assumptions, mainly that the rubber cylinder is homogeneous and isotropic, the temperature field T (x,y,z,t) is governed by the general heat conduction [1] equation

$$\nabla^2 T + \frac{q}{\kappa} = \frac{1}{\alpha}\frac{\partial T}{\partial t} \tag{9}$$

where

$$\alpha = \frac{\kappa}{\rho c p}$$

is the thermal diffusivity, κ is the thermal conductivity, c_p is the specific heat, ρ is the densitiy, and q is the heat generated per unit volume in unit time.

The solution of equation (7) requires that q be evaluated. It is the heat equivalent to the dissipated mechanical energy due to longitudinal damping and is a function of both r and z. For simp'icity q is assumed to be constant; any contribution due to lateral damping is disregarded.

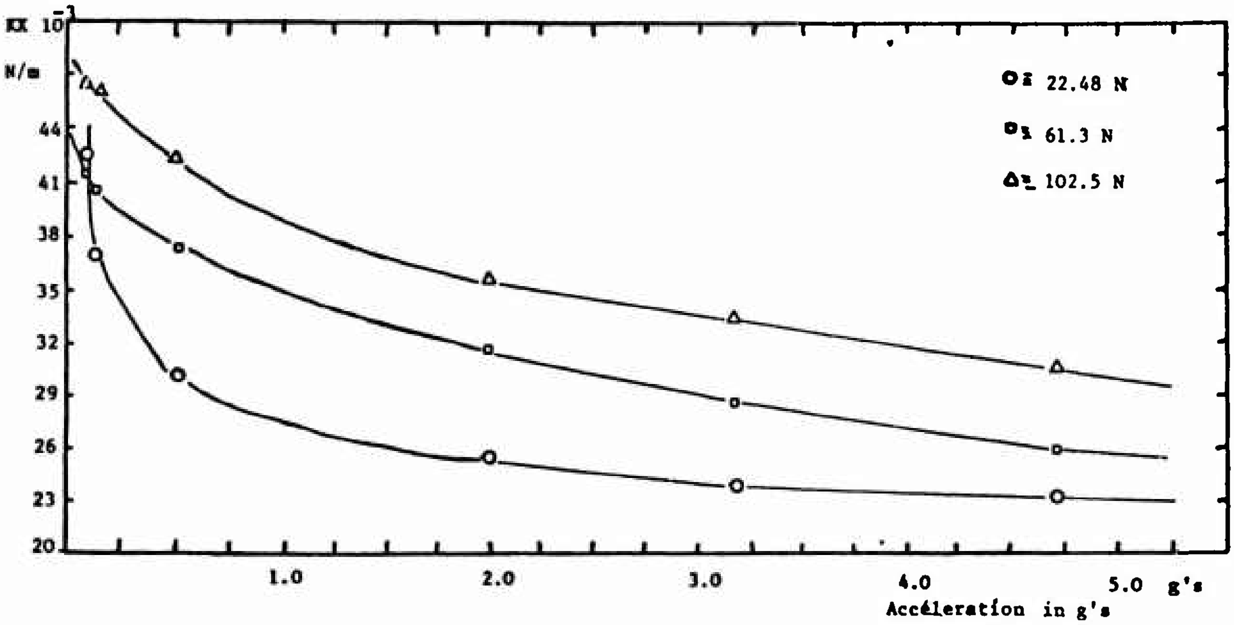


Figure 3. Stiffness vs Acceleration of Support Table

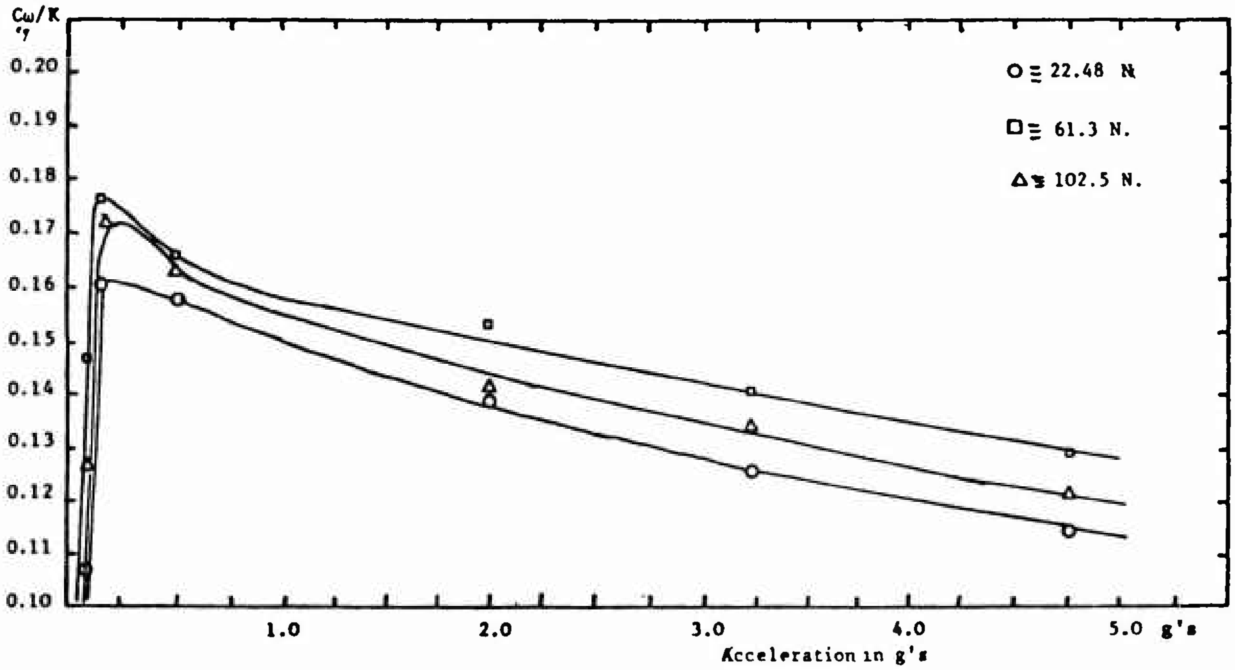


Figure 4. Dimensionless Parameter $C_{eq}\omega/K$ vs Acceleration of Support Table

The amount of dissipated energy (D.E.) due to viscous damping per cycle [4] is

$$\text{(10)} \qquad D.E. = \pi C_{eq} \omega X^2$$

Hence the heat generated per unit volume per unit time (one hour) can be evaluated after the damping coefficient C_{eq} is determined.

The acceleration $\ddot{Y}$ of the base table for the frequency 22 cycles/sec and amplitude Y = 0.2 in. can be calculated as

$\ddot{Y}$ (mean to peak measured in g's)

$$= \frac{\omega^2}{2} \frac{1}{g} = 4.9 \text{ g's}$$

The plots in Figures 3 and 4 can be used to evaluate the values of K and C_{eq} corresponding to Y = 4.9 g's. The heat q generated per cubic meter per hour can be calculated from expression (10).

At the steady-state condition, the temperature T (r,z) is governed by the heat conduction equation. Cylindrical coordinates can be used to write

$$\text{(11)} \qquad \frac{\partial^2 T}{\partial r^2} + \frac{1}{r}\frac{\partial T}{\partial r} + \frac{\partial^2 T}{\partial z^2} + q/\kappa = 0$$

The boundary conditions are

$$\text{(12)} \quad \text{(a)} \ \frac{\partial T}{\partial z} = 0 \text{ at } z = 0$$

$$\text{(13)} \quad \text{(b)} \ \frac{\partial T}{\partial z} = 0 \text{ at } z = L$$

$$\text{(14)} \quad \text{(c)} \ \kappa \frac{\partial T}{\partial r} \Big|_{r = r_o} = h(T - T_a) \Big|_{r = r_o}$$

$$\text{(15)} \quad \text{(d)} \ T(r = 0, z) < \infty$$

where

h = coefficient of surface conductivity W/m^2C^o

T_a = ambient temperature

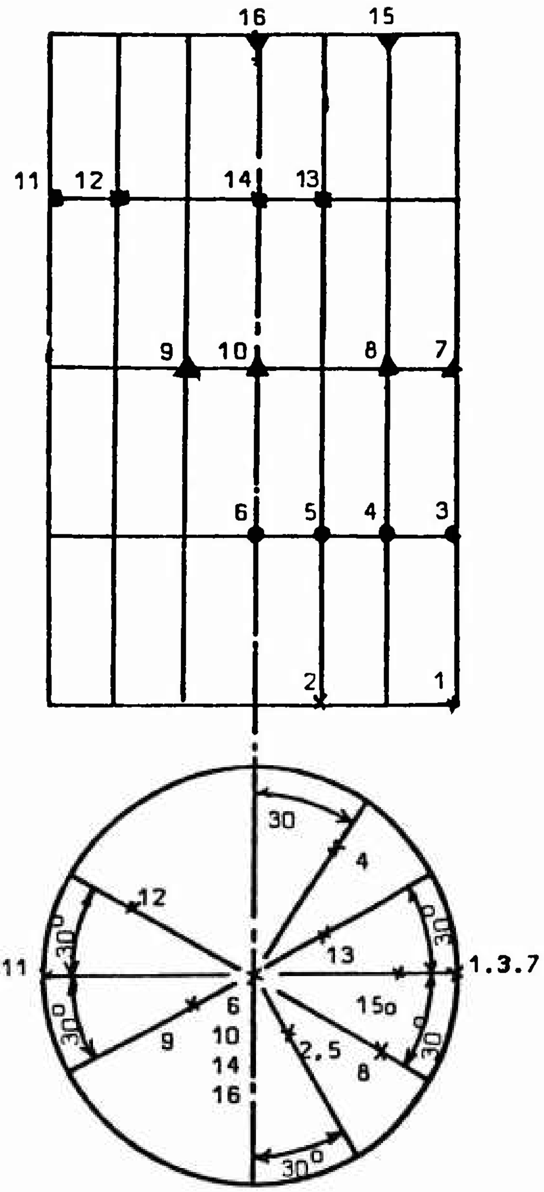


Figure 5. Elevation and Plan Views of Rubber Cylinder with Thermocouple Locations

The solution of the above boundary value problem [2] assumes the form

(16)

$$T = \frac{q}{\kappa}\left(\frac{r_o^2}{4} - \frac{\kappa}{2h} r_o\right) + T_a - (q/4\kappa)r^2 =$$

$$a - q/4\kappa\, r^2 = F(r) \text{ only}$$

(17)

$$\text{where } a = q/\kappa \left(\frac{r_o^2}{4} - \frac{\kappa r_o}{2h}\right) + T_a = \text{constant}$$

T is independent of the variable z and has a decreasing parabolic variation with radius r at each z-section. The behavior of T with r as predicted by the analytic solution of the P.D.E. (11) is in line with the experimental results shown in Figure 6.

CONCLUDING REMARKS

A rubber cylinder is conceived as equivalent to a spring of stiffness K and a dashpot of equivalent viscous damping coefficient C_{eq}. The spring and dashpot support a mass resting on the rubber cylinder. The external force that excites the system into vibratory motion is provided by an electrodynamic shaker. The mathematical model and experimental data provide a means by which K and C_{eq} can be estimated.

From the experimental results, it is concluded that the stiffness coefficient K as well as the equivalent viscous damping coefficient C_{eq} vary with the weight and with the acceleration of excitation (Figures 3 and 4). After the dissipated energy is calculated, the heat equation describing the temperature field inside the vibrating cylinder, subject to certain existing boundary

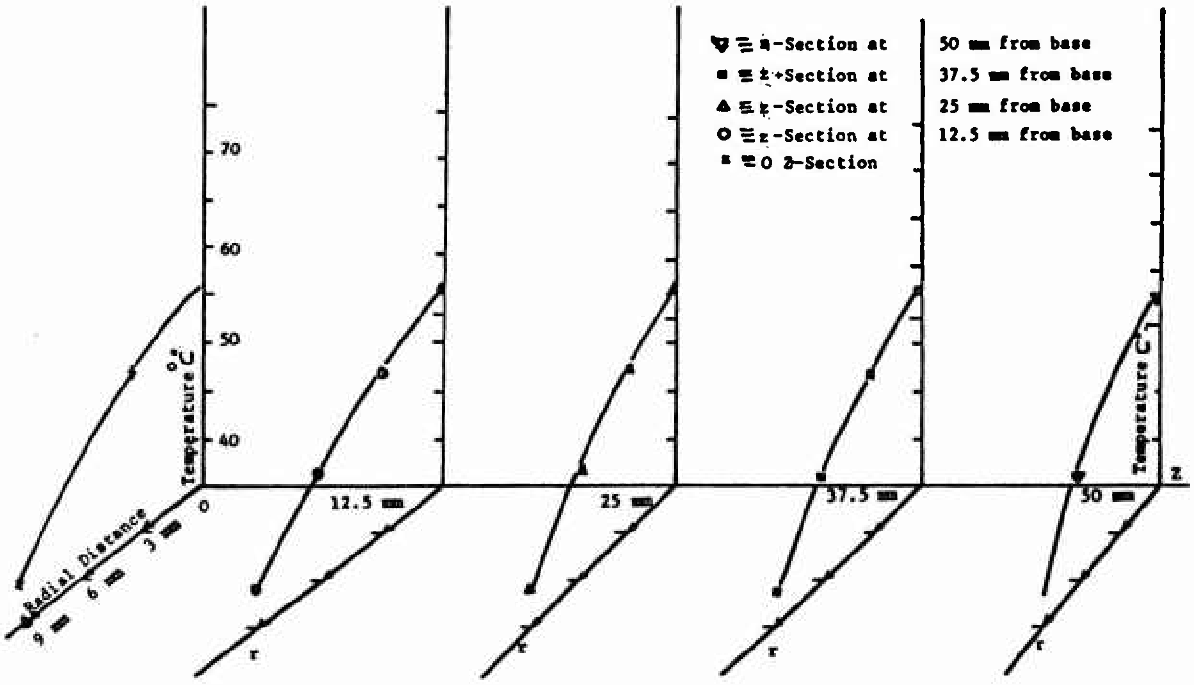


Figure 6. Temperature Readings in Soft Rubber Cylinder for different z-sections in the axial direction under amplitude = 0.2" and frequency = 22 cycles/sec with ambient temperature Ta = 26°C

conditions, can be solved. The temperature distribution inside the cylinder has been investigated experimentally. Comparison of experimental results with the analytic solution shows that both approaches lead to the conclusion that temperature is a decreasing parabolic function in the radial direction. This matching between experimental and analytical results validates the mathematical model.

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LITERATURE REVIEW: survey and analysis of the Shock and Vibration literature

The monthly Literature Review, a subjective critique and summary of the literature, consists of two to four reviews each month, 3,000 to 4,000 words in length. The purpose of this section is to present a "digest" of literature over a period of three years. Planned by the Technical Editor, this section provides the **DIGEST** reader with up-to-date insights into current technology in more than 150 topic areas. Review articles include technical information from articles, reports, and unpublished proceedings. Each article also contains a minor tutorial of the technical area under discussion, a survey and evaluation of the new literature, and recommendations. Review articles are written by experts in the shock and vibration field.

CURRENT RESEARCH ON CIRCULAR SAW AND BAND SAW VIBRATION AND STABILITY

C. D'Angelo III, N.T. Alvarado, K.W. Wang, and C.D. Mote, Jr.*

Abstract. The topics covered in this review are circular saw and band saw vibration; saw guides, which are fluid-film bearings used to control saw position and vibration; guided saw vibration; and generation of noise by vibration and aerodynamic sources in high-speed sawing.

This article, the fifth in a series of reviews on saw vibration and noise literature [1-4] addresses current literature and previously discussed literature that pertains to recent developments. Tables 1-4 summarize the references for the topics discussed in the article. The review reflects the authors' opinion of important research. Every effort was made to uncover pertinent literature.

TABLE 1. TOPICS IN CIRCULAR SAW VIBRATION

Topics	References
Tensioning:	
Roll Tensioning	5-7
Heat Tensioning	6, 7
Thermal Tensioning	7, 8, 26, 27
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Sources of Asymmetry	9-12
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Vibration of Disks with Asymmetrically Distributed Inertia:	
Theory	15, 16
Experiments	13-15, 17, 18
Passage through a Critical Speed:	
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Control Using Electromagnetic Forces	24
Control Using Thermal Tensioning	26, 27
Signal Modeling of Vibration	25

*Department of Mechanical Engineering, University of California, Berkeley, CA

TABLE 2. TOPICS IN BAND SAW VIBRATION

Topics	References
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Band Saw Equilibrium Configuration	32
Experimental Verification of Model	33
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Strip Response under Moving Loads	34-41
Response under Edge Loads	29
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TABLE 3. TOPICS IN SAW GUIDES AND GUIDED SAWS

Topics	References
Pressure Generation by Saw Guides:	
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Squeeze-Film Pressure	48
Pressure from Fluid Inertia	50, 51
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Particle Contamination of Lubricant	53
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Pneumatic Hammer	48, pp 694-707
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Incompressible Fluid-Film Guides	55, 56, 58
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TABLE 4. TOPICS IN CIRCULAR SAW NOISE

Topics	References
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Slots	60
Noise Guards around Saw	77, 78
Damping Layers on the Saw	79

CIRCULAR SAW VIBRATION

Circular saw tensioning. Tensioning either permanently alters or actively controls saw membrane stresses to increase the lowest critical speed of a saw. Active control of membrane stresses through thermal tensioning is discussed later in this section.

Roll tensioning induces membrane stresses into a saw by plastically deforming the saw between two rollers. Even when the rolling load is constant, deformation increases with each circuit [5]. Membrane stresses and natural frequencies of a rolled saw are predictable [5]; the lowest critical speed can be maximized by rolling at any single radius [5] or along multiple paths at different radii [6].

Heat tensioning involves heating an annular ring in a saw until its material structure changes from martensite to bainite [7]. Experiments indicate that maximum efficiency occurs when the ring radius is 70% to 90% of the rim radius and the ring temperature is 350°C to 400°C [6]. No model currently exists that predicts the membrane stresses and natural frequencies of a heat tensioned saw.

In a recently published review, Schajer [7] summarized all circular saw and band saw tensioning processes; he emphasized roll tensioning. Improved roll and thermal tensioning procedures have also been reviewed [8].

Asymmetric saws. An asymmetric saw has non-axisymmetric distributions of inertia, stiffness, damping, or any combination of these. Sources of asymmetry typically are slots and holes in the saw [9], saw guides [10], saw non-flatness [11], and eccentricity of the central hole [12].

In an axisymmetric disk, two identical and independent components of each vibration mode are superimposed to form a mode shape without specific angular orientation on the disk. Introduction of asymmetry splits each pair of redundant components into two modes with different natural frequencies, amplitudes, and damping [13, 14]. The split mode shapes are fixed to the disk; thus, standing wave resonance cannot occur when the disk rotates [13, 14]. The mode shapes are oriented to maximize the natural frequency of one component and minimize the natural frequency of the other [14].

Changes in the low frequency modes of a circular disk are easily predicted when concentrated masses places along the rim cause the asymmetry [15]. Expressions have been derived [16] that permit computation of the natural frequencies of a disk with any number of arbitrarily located concentrated masses. An analogous development that accounts for geometrical sources of asymmetry, such as slots and holes, remains undeveloped.

The resonance response of a disk with asymmetrically distributed inertia depends upon the excitation frequency and the difference between the split mode natural frequencies [13, 17, 18]. These papers are highly recommended for their experimental results.

Although linear finite element analysis of a thin, undamped, spinning disk predicts small amplitude response at many rotation speeds above the lowest critical speed [19], large amplitude vibration can persist at speeds at which stable operation is expected (Figure 1). In-plane deformation, which is significant when vibration amplitude is large, couples the split modes. Because of this coupling, a nonlinear traveling wave with a beating amplitude develops [20]. The minimum vibration amplitude required to establish this traveling wave increases with stiffness but is reduced by excessive damping [21]. Experiments have shown that the traveling wave eventually decays in some disks [14] but not in others [22]. Present models do not explain these observations.

Parametric excitation. A stationary disk experiences sum combination resonances when excited by an oscillating, concentrated load tangent to the rim. When the excitation is applied uniformly around the rim in the tangential direction, sum and difference combination resonances occur [23]. Excitation of combination resonances in an operating circular saw has not been studied.

Active saw vibration control. A control system that dampens a dominant saw vibration mode by the application of electromagnetic forces has been developed [24]. Two simultaneous fast Fourier transforms identify the dominant mode and locate it on the saw before activating the control forces that reduce vibration amplitude. Nevertheless, frequency distortion of the control force can cause instability at high control gains. Signal modeling also predicts the frequency of the dominant mode, but it cannot separate closely spaced natural frequencies [25].

Vibration control of circular saws using thermal tensioning has been relatively successful. Regulation of saw temperature distribution during operation maximizes the lowest critical speed; experiments show vibration amplitude reductions of 90% [26]. A promising design uses saw guides with a heated lubricating fluid to thermally tension the saw in addition to positioning it [27]. Significant benefits will be realized if a thermal tensioning criterion is formulated for asymmetric saws.

BAND SAW VIBRATION AND STABILITY

Band saw system modeling. Figure 2 shows a schematic of a band saw system. Early band saw models consisted of an axially moving beam or plate. The boundary conditions, located at the wheels or the guides, which bound the cutting span, are either clamped or simply supported. This model assumes that the cutting span is straight and is mechanically isolated from the remainder of the band mill. The model has been validated [1, 2] by comparison of theoretically predicted and experimentally observed natural frequencies of band saws moving at low speed under high tension; low tension band saws translating at high speed were not considered. Predictions of band saw response from a beam model have not been experimentally verified.

The model described above does not predict recently observed coupling of cutting and non-cutting spans [28-31]; see Figure 3. Small rotational oscillations of the wheels transfer energy between spans and cause coupling. The coupling depends upon the curvature of the band saw at equilibrium (Figure 4). Zero curvature results in no coupling; finite curvature causes coupled span motions and can produce beating oscillations. The equilibrium shape of the band saw is similar to that of a belt loop stretched between two cylindrical rollers. Asymptotic expansions of the belt deformation and stress have been presented [32].

The natural frequencies of a band saw depend on transport speed and wheel tilt angle, which is the acute angle formed by the intersection of the planes of the wheels [33]. Experiments have shown self-excited torsional and transverse vibrations, but the sources were not identified [33].

A band saw system model should consider elements other than cutting span [28-33]. These elements are the entire band saw loop, the wheels, wheel support, and saw guides.

Band excitation. Transverse excitation of a band saw arises from the following sources: cutting forces, passage of the band weld over the wheels, guides (the weld binds the band saw into a loop), and

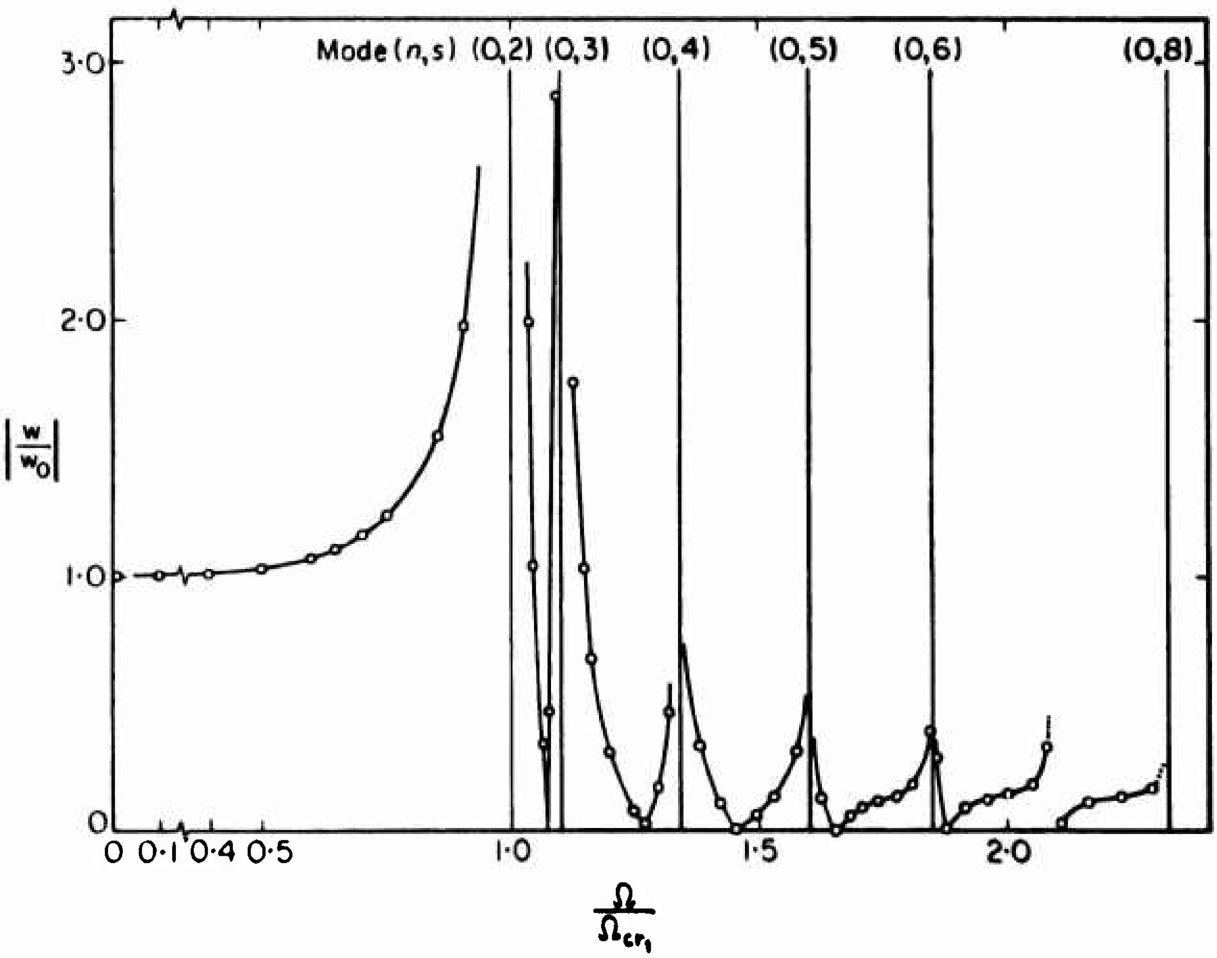


Figure 1. Response of a Rotating Steel Disk (0.1" thick, 20" dia.) Clamped between Two Disks (4" dia.) to a Transverse Force F Applied at an 8" Radius from the Shaft. Ω_{cr_1} = 3114 RPM; w_o = 2.90" when F = 1 kip

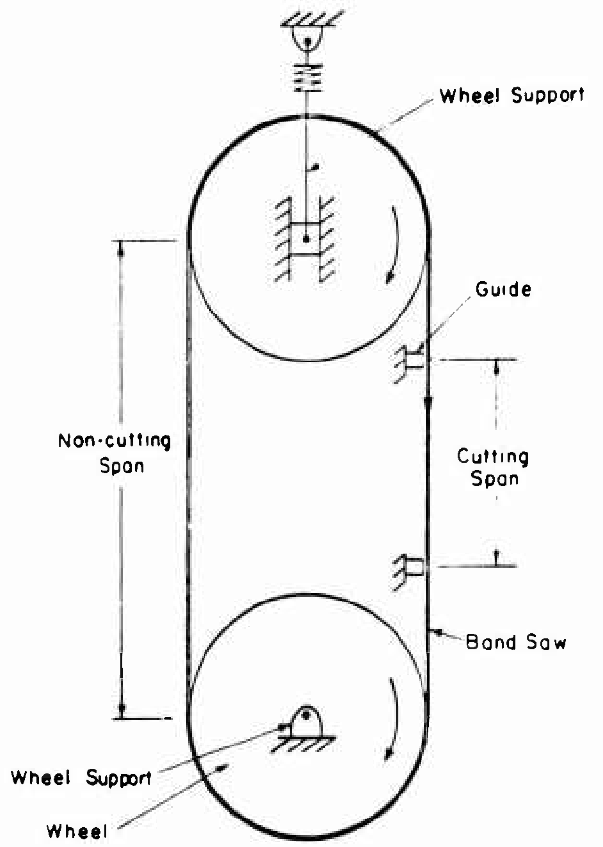
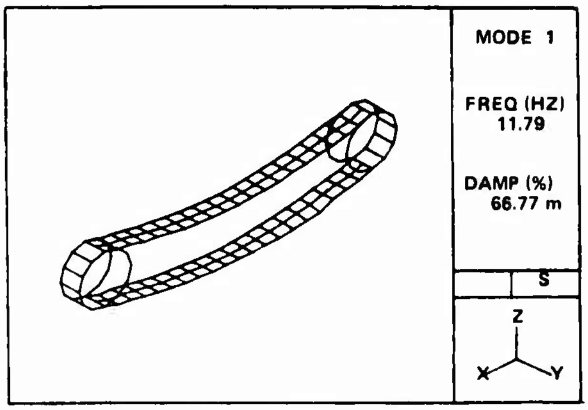
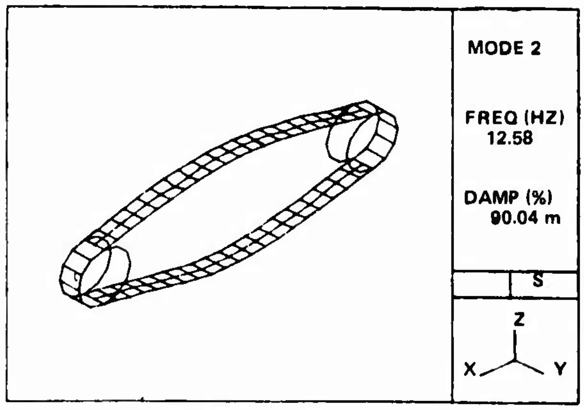


Figure 2. Schematic of a Band Saw System

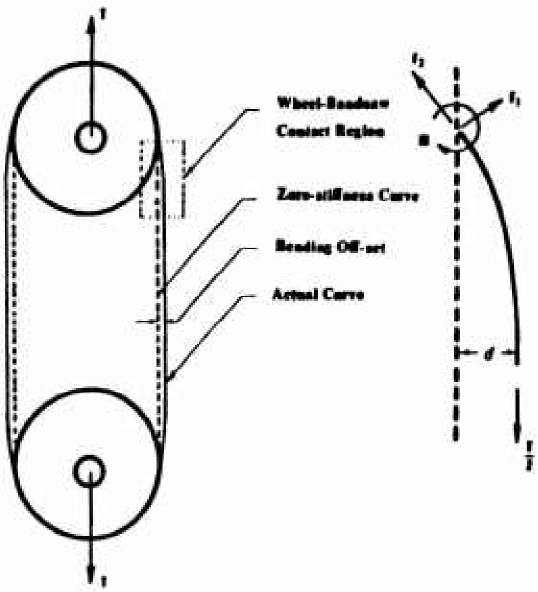


(A) In-phase Mode



(B) Out-of-phase Mode

Figure 3. Coupling Modes of a Band Saw System



(a) Off-set between Zero stiffness and Actual Configurations

(b) Free Body Diagram of a Wheel-Bandsaw Contact Region

Figure 4. Equilibrium Configuration of a Band Saw System

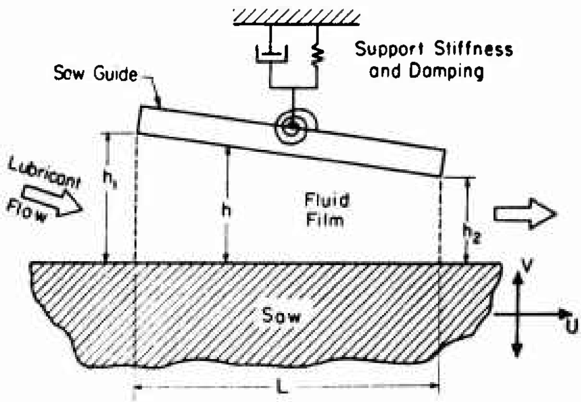


Figure 5. Saw Guide Schematic

eccentricities and irregularities of the wheels. Studies on the transverse vibrations of a stationary beam forced by moving loads that can represent band saw excitations include arbitrary distributed line loads [34], pressure point loads [35], discrete loads [36, 37], couples [38], random loads [39], randomly spaced loads [40], and loads of varying speed [41].

Cutting forces apply in-plane edge loads to a band saw. Static in-plane edge loads can cause buckling; periodic in-plane edge loads can parametrically excite combination resonance and simple internal resonance [29]. In-plane edge loads couple bending and torsional vibration modes.

Measurements of transverse band saw vibration recorded during cutting have shown that stable response is primarily torsional and that unstable response is transverse [42]. Experiments have also verified coupling between bending and torsional response. Practical issues that determine the natural frequency spectrum of a band saw during sawing have been discussed [43].

Automatic vibration control in band saws. Feed forces generated during cutting displace a band saw laterally on the wheel. This can cause instability of the band saw. A prototype controller [44] reduced this displacement by applying feedback controlled forces to the band saw.

To the authors' knowledge no other automatic control scheme has been applied directly to the band saw. The following literature pertains to a class of problems that includes the band saw.

The discretized model of the moving beam is an example of a gyroscopic system. Any gyroscopic system is governed by an equation of the form

$$M\ddot{\underline{y}}(t) + G\dot{\underline{y}}(t) + K\underline{y}(t) = 0$$

The G matrix is skew-symmetric, M and K are symmetric matrices, and $\underline{y}$ is the generalized coordinate vector. Modal space control is applicable to gyroscopic systems [45, 46]. This scheme chooses control parameters independently for each controlled mode, thus minimizing the higher mode truncation error caused by discretization. Because the moving beam is a translating system, controller gain should adapt to translation speed [47].

Certain work that has been reported contains only theoretical predictions [44-47]. No mention is made of such practical aspects as noise-contaminated and multifrequency control inputs that can excite uncontrolled or unmodeled higher modes of a system.

SAW GUIDES AND GUIDED SAWS

Saw guides are fluid-film bearings that constrain saws and reduce saw vibration (Figure 5). The film thickness h is much smaller than the guide length L. The lubricating fluid is either water, oil, air, or mixtures. In a hydrodynamic guide, saw translation at velocity U draws the lubricant into the guide. A hydrostatic guide is fed pressurized fluid through the guide face.

The literature that focuses specifically on saw guides or guided saws is scant indeed. Nevertheless, many papers on fluid-film lubrication discuss problems related to guide pressure generation and to guided saw vibration stability. Space limitations prevent a complete review of these papers. Consequently, this section highlights a few papers to introduce important topics to the reader.

Pressure generation by saw guides. The three sources of pressure in a hydrodynamic guide are steady pressure, squeeze-film pressure, and pressure caused by fluid inertia. In a hydrostatic guide, the lubricant supply pressure supplements these pressure sources.

Steady pressure and squeeze-film pressure have been studied for many years. The authors recommend one book [48] for a thorough discussion of these topics. The steady pressure and resulting thrust of four typical circular sector saw guides have been published [49].

Fluid inertia, which is neglected in classical lubrication theory, is an important pressure source in saw guides, especially when the vibration velocity V is large. Let

$\mathbf{x}$ be the fluid position vector, $\mathbf{u}$ the fluid velocity vector, and t time. Fluid-film models must include the unsteady inertia $\partial \mathbf{u}/\partial t$ when $\partial h/\partial t$ is large [50, 51]. Convective fluid inertia $\partial \mathbf{u}/\partial \mathbf{x}$ is significant when flow becomes turbulent [51], a common occurrence in high speed ($U > 50$ m/s) vibrating, guided saws. A model that accurately accounts for fluid inertia in a saw guide film remains undeveloped.

When incompressible fluids are used, the pressure generated by a saw guide is often less than the predicted pressure because of incomplete lubrication of the guide [52] or particle contamination of the lubricant [53]. Cavitation of the fluid, caused by large amplitude saw vibration, can also reduce guide pressure, as it does in journal bearings [54].

Stability of guided saws. Gas lubricated hydrostatic bearings can excite vibration of a guided system through pneumatic hammer instability [48]. Increasing the film stiffness increases the likelihood of instability [48]. Preliminary experiments by the authors have shown that circular saws guided by air bearings experience this instability.

For small amplitude vibration, an incompressible guide behaves like a linear mass-spring-damper (MSD) system applied to the saw [55, 56]. The model mass equals the guide mass; model stiffness and damping are those of the guide film at equilibrium. The film stiffness and damping of gas lubricated guides are highly frequency dependent because of film compressibility [48]. A linear MSD system models a gas-lubricated guide only under small-amplitude, low-frequency saw vibration. Certain analyses [57, 58] might be directed to formulation of a guided saw model.

CIRCULAR SAW NOISE

Noise is generated by the interaction of a rotating saw and teeth with the workpiece (cutting noise) and with air (aerodynamic noise).

Cutting noise. Cutting noise sources have been studied using radiation efficiency and power radiation concepts [59], as well as experimentally [60-62]. Noise reductions up to 19 dB(A) are possible with reduced saw thickness and introduction of slots oriented at an angle to the radial direction [60]. Slots, vibration damping material, and uneven tooth pitch reduce measured sound pressure levels (SPL) by 12 to 15 dB(A) [61]. Measured SPL is insensitive to changes in the tooth rake angle in the 10° to 20° range, but it is slightly sensitive (1 to 2 dB) in the 0° to 15° range [61].

Aerodynamic source identification. A dipole with its axis perpendicular to the plane of a rotating saw, called a normal dipole, is often identified as the dominant noise source [62-68]. This source results from fluctuating pressures that act on the saw and tooth surfaces. At the rim of the saw, shedding of vortices from different edges and turbulent flow organize these pressure fluctuations around specific frequencies [64, 65, 68]. Prediction of these frequencies from acoustic source models remains open. Measurements have shown that the sound power radiated by a saw is proportional to U^n; U is the tooth speed and $4.9 < n < 5.6$ [63, 64, 69]. For a theoretical normal dipole source, $n = 6$. Acoustic scattering from the saw contributes to this deviation [70].

A dipole with its axis parallel to the plane of a rotating saw, called a shear dipole, is also a noise source. The turbulent boundary layer on the saw surface causes this source [70], just as it does on a toothless, collarless, rotating disk [71].

Air flow at the rim. As a result of saw rotation, air will flow in the plane of a saw and cross lines normal to the radius at an angle between 2° and 9°; this angle increases with increasing radial location and with rotational speed [72]. Air velocities equal to 70% [63] and 81% [72] of the rim speed have been measured.

A better description of the organization of the flow around a rotating saw would include the coupling between the air flow and the saw vibration. Visualization of the flow close to the rim of a saw has had limited success to the present [73] but would facilitate model formulation.

Important parameters in saw noise generation. Tooth speed is the single most important parameter in saw noise generation. The SPL increases 14 to 18 dB per doubling of tooth speed [62, 66, 69, 74].

Irregular tooth spacings can reduce SPL [61, 75]. A possible reason for this reduction is that the irregular spacings broaden the aerodynamic excitation spectrum. A gullet width to thickness ratio of about 2.5 maximizes the measured SPL [66].

Experiments have shown that reduction of the rake angle and increases in the number of teeth, clearance angle, and tooth height also increases whistling noise [76]. These observations reinforce the concept of a vortex shedding mechanism.

Slots and holes can excite aerodynamic noise and need not always be beneficial. The holes are often filled with a damping material to reduce vibration amplitude and to eliminate this source of aerodynamic excitation [60]. Guards positioned parallel to the saw can reduce saw noise by up to 20 dB(A) [77, 78].

Viscoelastic material attached to a saw surface significantly dampens saw vibration; a 10 dB(A) noise reduction is possible [79]. This method, however, reduces only resonance vibration noise and not direct aerodynamic noise. Addition of damping layers is often impractical for production saws because the saw cannot be hammered, rolled, or straightened, and the layer delaminates at high temperatures. General recommendations for noise control are available [59, 64-66].

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BOOK REVIEWS

DYNAMIC TESTING AND SEISMIC QUALIFICATION PRACTICE

C.W. deSilva
Lexington Books, D.C. Heath & Company
Lexington, MA, 1983, 375 pages, $48.50

Seismic qualification of equipment for nuclear power plants falls generally under guidelines given by various IEEE and ASME standards and by regulatory guides published by the NRC. This book carefully recognizes these standards; IEEE 344 (1975) -- "Recommended Practices for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations," is the most pertinent. However, of necessity, the standards are nontutorial in content. Therefore, the intent of the book is to provide an introduction to various principles of dynamic analysis and experimental methodology that are typically useful in acceptable equipment qualification practice. The book is also intended as a reference for the practicing engineer.

Approximately the first half of the book deals with fundamentals of dynamic testing, complementary use of simple and complex finite element analytical models for system response prediction, Fourier and spectral analysis techniques, damping, and methods of signal synthesis for complex dynamic environments. A mix of both analytical and experimental information is appropriate because seismic equipment qualification can be performed by testing, analysis, or both. The latter half of the book discusses typical approaches to equipment seismic qualification and reporting of results therefrom. Extended discussion for pretest procedures and planning includes exploratory resonance search and natural mode determination, conduct of simulated seismic tests under a variety of excitation waveform and multiaxis arrangements, and descriptions of typical excitation and data acquisition and analysis hardware schemes. The author draws on his own experience and from various references in covering the subject area. However, the major portion of the references are presented in bibliographic form rather than individual subject citations and are thus more difficult for the reader to sort out.

The book is an excellent introductory compilation of equipment qualification fundamentals and suggested test laboratory practices. However, the reader must bear in mind that it was not intended to provide comprehensive coverage of knowledge necessary to perform seismic qualification; in fact, the book does not provide such coverage. It was published just prior to a rapid expansion of research in equipment seismic qualification; as a result it is already somewhat obsolete in specific areas. Most of these areas are covered in the revision to IEEE 344, which is to appear in draft form in 1985. For example, the author carefully describes (and rightfully so!) methods to synthesize excitation signals that contain the proper frequency content. However, the issue of stationarity -- that is, the amount of the test time that such frequencies are present -- is ignored. Similarly, the use of prerecorded analog taped excitation synthesis signals provided to the test laboratory by the equipment vendor or plant builder is stated as a typical procedure; in fact, only a response spectrum is typically provided, and the methodology for signal synthesis is usually left up to the test laboratory. The use of prerecorded analog synthesis signals has now been relegated to special power plant cases.

One of the most useful discussions for the experienced engineer deals with cross-axis coupling in test specimens and the use of single axis vs multiaxis correlated or uncorrelated excitations. This issue has been a thorn in the side of the current IEEE 344 revision committee; it has not yet been completely resolved.

Various technical issues now considered commonplace in current equipment qualification practice are not mentioned in the book because of publication lag time. For example, in-situ test methodology, response spectrum to power spectrum transformations and vice versa, direct generation of floor response spectra (without use of time history), and adequacy of signal stationarity are examples. It would have been helpful if the author had included a supplementary revised list of available references just prior to publication. This information is available otherwise only in NRC NUREG Contractor Reports and various recent technical journals.

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SPACECRAFT DYNAMICS

T.R. Kane, P.W. Likins, and D. Levinson
McGraw-Hill, New York, NY
1983, 436 pages, $49.50

This text is the result of years of professional experience that culminated in formal courses taught at Stanford University and the University of California, Los Angeles.

The book is divided into four chapters. The first chapter on kinematics discusses background information on the dynamics of spacecraft. Topics range from direction cosines, Euler parameters, and successive rotations to the angular velocity matrix, instantaneous axis of zero velocity, and angular acceleration.

The second chapter concentrates on the influence of gravitational forces on spacecraft. It makes available to a large audience specialized material that until now had remained in the research literature.

The third chapter discusses the dynamics of simple spacecraft consisting of a single rigid body or a simple gyrostat. The chapter describes the rotational motion of a torque-free axially symmetric rigid body and discusses various effects of gravitational moment and orbit eccentricity on the motion of such a body. The study is extended to a rigid body that does not exhibit any special symmetry.

The fourth chapter considers complex spacecraft with multiple degrees of freedom and containing elastic components. The equations of motion are developed following a particular formulation due to Kane that acquires increasing importance as the dynamics of the system become more complicated. A distinctive feature of this chapter is the introduction of computer programs that accomplish symbolic manipulation. Programs such as MACSYMA and REDUCE 2 can now carry out operations of algebra and calculus. The program (FORMAC) is used to formulate the equations of motion that model complex spacecraft.

The text provides four sets of problems at the end of the four chapters; each set corresponds to material covered in one chapter. Partial solutions range from simple answers to elaborate suggestions and formulations.

This reviewer believes that use of the book would have been enhanced by introducing the Lagrangian treatment of the subject. This treatment is more familiar to the engineering mechanics community. The problem sets should have been placed at the end of each chapter or at the end of each unit of study. The comprehensive problems could have been left as review problems at the end of each chapter. The authors should be commended, however, in their attempt to fill a gap in an important area of present and future importance.

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CLASSICAL MECHANICS

H. Goldstein
Addison-Wesley, Reading, MA
1980, 672 pages, $35.95

This is a text in classical mechanics first written by the author in 1950; the revision has been in preparation for 30 years. The second edition, like the first, is written by a physicist for physicists. It reflects little of the revolution that has taken place in engineering mechanics and engineering science since the advent of the space age in 1957. The scope of the work reflects the author's point of view, which is substantiated by critical comments about the suggested references given at the end of each chapter.

The book is roughly divided into two parts, Lagrangian and Hamiltonian mechanics. The first seven chapters are devoted to Lagrangian dynamics including special relativity. The remaining five chapters treat Hamiltonian dynamics in detail. Because of the engineering interest of the readers of this Digest, the present review concentrates on those topics of general concern to an engineering audience.

The first chapter reviews elementary principles of mechanics and derives Lagrange's equations. In the second chapter variational principles are developed and lead to conservation theorems and symmetries. In this chapter the derivation of the Jacobi integral is not motivated. It might have been better to begin with Lagrange's equation multiplied by generalized velocities and then derive the Jacobi energy integral. The explanation of impulse and momentum is limited to a problem, hardly sufficient for engineering purposes. Students will not be able to solve impulsive problems with the information contained in a single problem in Chapter two.

The third chapter treats central force problems. Here, a vector due to Vujanović would have provided a natural transition to the Laplace-Runge-Lenz vector. It would also have furnished the fourth conservation law to provide a complete set of first integrals for the Kepler problem.

Chapter 4 is an excellent treatment of the kinematics of rigid body motion. The Euler angles are reconsidered in Appendix B, in which alternate conventions are given. This is particularly useful to readers trying to reconcile the notations they encounter in various papers that appear inconsistent. Chapter 4 also develops the equations of motion for rigid bodies.

Chapter 6 develops the theory of small oscillations. The reviewer believes that the important work by Caughey and his collaborators on the existence of classical normal modes in linearly damped dynamic systems should have been included. Chapter 7 treats special relativity.

Chapter 8 introduces the reader to the Hamiltonian equations. They are derived through the Legendre transformations as well as by means of a variational process. It would have been better to derive the general result first and then obtain all the particular cases from it. Indeed, this would have led to Noether's theorem for rigid body dynamics, which the author introduces only in Chapter 12 for continuous systems and fields. Surely students would have an easier transition if they had been exposed to the discrete version of the theorem first.

Chapter 9 deals with canonical transformations, Poisson symmetry groups, and Liouville's theorem. Chapter 10 considers the Hamilton-Jacobi theory in some detail and concludes with action-angle variables and their application to the Kepler problem.

Chapter 11 is reserved for perturbation theory, adiabatic invariants, and the Lewis invariant for the time-dependent harmonic oscillator. The reviewer would have preferred a constructive derivation of the invariant instead of an assumption of its expression; the author should have shown that it is a constant of the motion upon appropriate substitutions. Those interested in the original derivation by Lewis should be cautioned that the paper was published in 1968 and not in 1973 as indicated in a footnote. Chapter 12 contains an extension of analytical to continuous systems.

The reviewer regrets the omission of such topics as the Appell equations and the

Gauss principle of least constraint. The impact of the extensive material developed in the book can be judged only by the ability of the student to apply it to lengthy problems, where probing in various directions is possible. From that point of view those intending to use this text in their engineering classes may wish to consider supplementing it with their own problems, or building on those given by others.

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ACOUSTIC EMISSION

J.R. Matthews, Ed.
Gordon and Breach Science Publishers
New York, NY, 1983, 163 pages, $39.50
ISBN 0-677-16490-4

This volume is the second of a series called "Nondestructive Testing Monographs and Tracts." Often, if one hasn't seen the preceding volumes of a series, the volume of interest is too difficult or dependent on earlier work to be of much use. Happily, this book is a stand-alone text for formal or informal instruction in the field of acoustic emission. The book, although small in size, is useful.

The first chapter on acoustic emission evaluation is a brief but comprehensive and readable discussion of the field. It provides readers with the fundamental concepts of acoustic emission, so that they can read and discuss the rest of the volume. This chapter is not a pedestrian discussion of acoustic emission; in order to understand fully the chapter some familiarity with metallurgy, stress analysis, and instrumentation is necessary. Nevertheless, readers with an undergraduate education will find the chapter readable. The list of references includes current citations.

The second chapter, on acoustic emission by dislocation motion, occupies most of the book. In spite of the title, which appears to be metallurgically oriented, the chapter discusses experimental techniques, models of acoustic emission, and effects of material variables; 159 references are cited. The section on experimental techniques treats sensors and signal processing, both of which are extremely important for a fundamental acoustic emission inspection. I am happy to see the note that information of only the frequency content of burst- and continuous-type acoustic emission makes relating results to the source mechanism an extremely complex problem. Also discussed is calibration of sensors -- a technique that apparently remains to be developed.

Perhaps the most interesting observation is that the only microscopically sensitive parameter measured is acoustic emission; on the macroscopic level load and deflection are typically the only data available. It thus is difficult to determine that a source of acoustic emission necessarily results from a load deflection. In general, this chapter is most easily read by those who are either familiar with acoustic emission practices or have done some work with metallurgy and are familiar with the terms involved.

The chapter on acoustic emission signal characterization presents very simply methods for analyzing signals. Ring-down counts and the mathematical formulations used in their determination are described. Other methods include the energy analysis approach and the distribution of events and amplitudes. The correlation between acoustic emission techniques and others -- mainly ultrasonic and magnetic strain measurement techniques -- is presented briefly. In a discussion of spectral analysis for acoustic emission signal characterization, it is noted that the variety in reporting spectral characteristics of acoustic emission signals is so great that the question of whether frequency spectra changes are due to deformation has not been adequately resolved. Of importance is whether or not the frequency response of transducers strongly affects frequency components of the acoustic emission signal. It is pointed out that one problem is acoustic emission sensor design; it is also pointed out that extremely sophisticated signal analysis can accomplish little if sensor responses are not well known and calibrated (and mounted correctly). The many references are all relatively up to date and useful.

The last chapter deals with analysis of acoustic emission signals. Ways of determining source location based on the use of acoustic emission sensors are described. In the time domain the most common method for acoustic emission signal analysis, ring-down counting, provides reasonably accurate source location. That frequency analysis of signals helps qualitatively to assess emitting sources but has limitations is stressed.

The book ends with a reasonably thorough index that is unusual in publications of this type but is valuable and useful. I believe this book is a good one for either the practicing acoustic emission specialist or for the sophisticated reader who wants a short introduction to the field of acoustic emission.

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STANDARDS NEWS

Avril Brenig, Standards Manager

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

William A. Yost

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

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

Calendar

The next meetings of the ASA standards committees are scheduled for Austin, Texas, 8–12 April 1985.

1984 April 08, ASA Committee on Standards, 7:30 p.m., Villa Capri, adjacent to the University of Texas. Meeting of the Committee that directs the ASA Standards Program.

1984 April 10, Accredited Standards Committee S2 on Mechanical Shock and Vibration (also Technical Advisory Group for ISO/TC/108 and IEC/SC/50A), 2:00 p.m., Villa Capri, adjacent to the University of Texas. Review of international and S2 activities and planning for future meetings.

1984 April 11, Accredited Standards Committee S12 on Noise (also Technical Advisory Group for ISO/TC43/SC1), 9:30 a.m., Villa Capri, adjacent to the University of Texas. Review of international and S12 activities and planning for future meetings.

1984 April 11, Accredited Standards Committees S1 (Acoustics) and S3 (Bioacoustics) (also Technical Advisory Group for ISO/TC/43, IEC/TC/29, and IEC/TC108/SC4) at 1:30 p.m., Villa Capri, adjacent to the University of Texas. The S3 meeting will be held first. Review of S1, S3, and international standards activities and planning for future meetings.

Standards News from the United States

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

ANSI elects directors

Seven new members have been elected to the Board of Directors of the American National Standards Institute, and five members have been reelected.

The new directors are:

Lee L. Gray, director, Office of Consumer Affairs, U.S. Department of Commerce

Edward J. McCarthy, vice-president, industrial products, Rubber Manufacturers Association

Richard C. Messinger, vice-president, research and development, Cincinnati Milacron, Inc.

Marco R. Negrete, director, corporate standards, Hewlett–Packard Company

Sava I. Sherr, staff director of standards, Institute of Electrical and Electronics Engineers

G. Russell Sutherland, director, product engineering, Deere&Company

James W. Tucker, president, ETL Testing Laboratories, Inc.

The reelected directors are:

William T. Birge, vice-president, engineering and technical planning, Allied Corporation

Harrison C. Bristoll, Jr., Manager government relations, Stanley Vidmar Division, The Stanley Works

Donald C. J. Gray, assistant administrator, Office of Federal Supply and Services, General Services Administration

Dr. Zdenek, J. Lansky, corporate vice-president and technical director, Parker–Hannifin Corporation

Y. D. Oleksiw, manager, Merchandise Testing Center, J. C. Penney Co., Inc.

New Safety Catalog available from ANSI

ANSI's 1984–1985 Catalog of American National Standards for Safety and Health has just been published. This edition lists all new and revised safety and health standards approved by ANSI since the previous edition was published in September 1983.

The 900 standards listed provide authoritative guides to industrial safety and to protection of the individual. The standards in the catalog are divided into ten categories: agriculture, construction, consumer and recreational products, electrical devices and wiring, fire protection, health, highway and traffic, nuclear, occupational safety, and security.

The 32-page safety and health catalog is now available free of charge from the Institute's Sales Department.

OSHA amendment struck down

Hearing conservation rules issued in 1982 by the Occupational Safety and Health Administration as an amendment to the OSHA noise standard are struck down by the Fourth Circuit Court of Appeals, which rules that the hearing conservation amendment makes no distinction between occupational and nonoccupational noise sources.

Major changes announced in laboratory accreditation procedures

NBS has made the first major revision of procedures for the National Voluntary Laboratory Accreditation Program (NVLAP) since it was established eight years ago. The revised procedures are designed to increase efficiency and reduce costs without affecting technical quality. Among the major revisions are a simplified method for requesting a new laboratory accreditation program, elimination of repetitious language in the procedures document, updated NVLAP criteria for compatibility with new national and international standards criteria, and reciprocal recognition of NVLAP-accredited laboratories by foreign accreditation systems. For a copy of the new procedures, or for information on the NVLAP program, contact: Associate Manager Laboratory Accreditation, A531 Administration Building, National Bureau of Standards, Gaithersburg, MD 20899, telephone (301) 921-3431.

Research facilities. Programs at NBS reviewed in brochures

A new catalog from NBS highlights some of the special facilities available at the bureau for *collaborative or independent research and testing*. As the nation's foremost science and engineering measurement laboratory, NBS has some of the premier facilities in the United States, and several of the laboratories are unequaled anywhere in the world. The catalog decribes each facility's capabilities, applications, and availability, along with a contact point. *Facilities of the National Bureau of Standards* (SP 682) is available for $1.75 prepaid from the Superintendent of Documents, U. S. Government Printing Office, Washington, DC 20402. Order by stock no. 003-003-02617-4. Also available is a brochure reviewing each of the major research and service programs at NBS and highlighting some of the more significant advancements made recently. Contacts are provided for those needing more detailed information about how they can take advantage of NBS's activities. Order *National Bureau of Standards* (SP 679) for $2.25 prepaid from the Superintendent of Documents, U. S. Government Printing Office, Washington, DC 20402. Order by stock no. 003-003-02618-2.

Directory of U.S. standards activities available

Manufacturers, exporters, and importers, and others concerned with the standards developed by trade associations, technical and professional societies, federal agencies, and state governments will be interested in a new directory of mandatory and voluntary standards activities in the United States. *Standards Activities of Organizations in the United States* (SP-681) was prepared by the NBS Office of Product Standards Policy, which serves as the national focal point for domestic and international standards and certification information. The directory summarizes the standardization activities of more than 750 organizations in the United States, including federal and state agencies and approximately 420 private sector groups that develop standards. Copies are available for $13 prepaid ($16.25 foreign) from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402. Order by stock no. 003-003-02602-6.

ASTM activities in environmental acoustics

The circulation of air is crucial to an office environment, yet, a noisy air conditioner can create quite a disturbance to the employees within.

This is one concern of ASTM Committee E-33 on Environmental Acoustics, a group involved in writing standards to aid in the design of quiet offices.

At the 15–17 October 1984 meetings of E-33 in Norfolk, Virginia, a new task group was formed on Ceiling Insertion Loss Measurements. The group will examine ways to measure how well the noise from an air conditioning unit directly above a suspended ceiling can be isolated from the space below.

According to the Task Group Chairman, Dr. A. C. C. Warnock, industry input is needed to develop a test method, "particularly from architects, mechanical engineers, real estate, and other commercial interests."

Laboratories may contact Keith W. Walker, U. S. Gypsum Company, P. O. Box 460, Round Lake, IL 60073, telephone (312) 546-8288.

The next meeting of Committee E-33 will be in Pittsburgh, Pennsylvania on 22–24 April 1985. More information on E-33 committee activities is available from David R. Bradley, ASTM, 1916 Race Street, Philadelphia, PA 19103, telephone (214) 299-5504.

To participate on this E-33 task group, or to receive more information, contact Dr. A. C. C. Warnock, National Research Council of Canada, Division of Building Research, Montreal Road, Ottawa, Ontario, Canada, telephone (613) 933-2305.

The E-33 Task group on Two-Room Method has prepared a draft method to measure the sound insulation between two rooms sharing a common ceiling and plenum. Laboratories wishing to participate in round robin testing should contact Task Group Chairman Dr. Mark A. Lang, Owens–Corning Fiberglas Corporation, P. O. Box 415, Granville, OH 43023, telephone (614)587-8138.

Comments and recommendations are sought from users for possible revisions to recommend Practice E 497 for Installation of Fixed Partitions of Light Frame Type for the Purpose of Conserving Their Sound Insulation Efficiency, and Practice E 557 for Architectural Application and Installation of Operable Partitions.

The Task Group on Airflow Resistance is organizing a round robin test series to provide data on the precision of Test Method C 522 for Airflow Resistance of Acoustical Materials.

Standards News from abroad

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

Advance edition of I.E.V. for acoustics and electro-acoustics

A revised chapter of the International Electrotechnical Vocabulary (I.E.V.) covering Acoustics and Electro-Acoustics has just been published by the International Electrotechnical Commission (IEC).

It replaces chapter 50(08) Electro-acoustics published in 1960. As advance edition, oscillation; transducer parameters (under consideration); microphones; loudspeakers and earphones; various apparatus; physiological and psychological acoustics (under consideration); musical acoustics; architectural acoustics; and underwater sound.

The purpose of I.E.V. advance the editions is to permit the issue without loss of time of terminology work whose publication would otherwise be delayed and, in particular, work which does not exactly correspond to the general plane of the I.E.V.; for example, incomplete chapters, vocabularies extending beyond the framework of a normal chapter, or work relating to rapidly evolving fields.

The I.E.V. lists terms and definitions in English, French, and Russian and terms in six other languages.

New world standard for audio pages

A new world standard for audio pages, illiustrated on one side with an audio recording on the other, bring text, diagrams, and even pictures to life for many school children, has been issued by the IEC.

The advantage of Audio Pages, easy to use and of great value in primary and elementary education, is that the recording always remains with the illustration because it is made on the same sheet.

The publication of this standard will make it possible for different companies to compete in the market with models of equipment which, while perhaps having different facilities, all use the same compatible program material.

The IEC, the International Electrotechnical Commission, is the authority for world standards in electrical and electronic engineering. The IEC is composed of National Committees in 42 countries formed to represent in international discussions all their national electrical and electronics interests, including manufacturers, users, trade associations, the engineering profession, and government.

Standards approved and published by ANSI

The following standards were approved and published by ASA:

ANSI/ASC S1.6-1984	"Preferred Frequencies, Frequency Levels, and Band Numbers for Acoustical Measurement" (revision and redesignation of ANSI S1.6-1967)
ANSI S1.40-1984	"Specifications for Acoustical Calibrators"
ANSI/ASC S2.34-1984	"Experimental Determination of Rotational Mobility Properties and the Complete Mobility Matrix, Guide to"

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

International documents on acoustics received in the United States

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

The following documents have been received from ISO for vote:

ISO/DP 8798 (S3)	Acoustics—Reference Levels for Narrow Band Masking
ISO/DP 8821 (S2)	Rotor Shaft Key Convention for Balancing

The following documents have been received from ISO for comment:

ISO/DIS 7566 (S3)	Acoustics (TC 43) Standard Reference Zero for the Calibration of Pure-Tone Bone-Conduction Audiometers
ISO/DIS 8253 (S3)	Pure-Tone Audiometric Test Methods

S12 meets in Minneapolis

Ken Eldred, Chair, has submitted the following report on the activities of Accredited Standards Committee S12 on Noise. The committee met in Minneapolis, Minnesota during the fall meeting of the Acoustical Society of America in October 1984.

Chairs of Working Groups and Technical Advisors report on progress on both national and international standards as follows:

S12-1 Advisory Planning Committee—*W. Melnick, Chair*

Mr. Melnick reported on the planning committees recommendations as follows:

(1) S1.23-1976	American National Standard Method for the Designation of Sound Power Emitted by Machinery and Equipment
S3.17-1975	American National Standard Method for Rating the Sound Power Spectra of Small Stationary Noise Sources

A new working group will be proposed to consider these two standards with a view to coordinating their contents and harmonizing their information.

(2) ISO/TC 43/SC 1/WG 24—Sound Propagation Outdoors. A coordinator will be appointed to monitor the recommendations with regard to the U.S. role and needs in the area of sound propagation.

(3) ISO/TC 94/SC 12—Hearing Protection. This group is evaluating the safety and effectiveness of hearing protectors as worn. E. Berger is involved in the national and international activities. A new working group will be proposed to support the national activities for which S12 has been designated by ANSI as the official U.S. TAG. Dr. von Gierke is proposed as the interim TAG Chair for this activity, such appointment to be ratified by vote of S12.

(4) The question of *annoyance* and its division between S3 and S12 (the working groups charged with assessing the effects of auditory stimuli) will be discussed with the chair of S3.

S12-2 Terminology, Abbreviations and Symbols—*R. K. Hillquist, Chair*

Mr. Hillquist, at the last meeting, said that an initial listing of candidate terms is being formulated, and that liaison had been established with ASC Y10, Letter Symbols.

It was agreed that Mr. Hillquist should proceed to develop a document on terminology for S12 as soon as possible. Questions of liaison and/or overlap with other areas of terminology could be taken care of at a later date.

S12-3 Measurement of Noise from Office and Data Processing Equipment—*L. Luttrell, Chair*

Mr. Luttrell reported as follows at the meeting:

Fifth draft revision of ANSI S1.29-1979 has been completed and is ready for letter ballot. Task groups formed to address special problems with impulsive noise, prominent tones, and high-frequency noise have met and are expected to complete technical reports within one year.

The results of the round robin test in the U.S.A. have been analyzed and will be reported at Inter-Noise. Further tests in Europe are planned.

We hope ISO/DIS 7779 will be balloted soon. At the last meeting we reported that the document was forwarded to the Central Secretariat.

S12-6 Insertion Loss of Outdoor Noise Barriers at Sites of Interest—*W. Bowlby, Chair*

Mr. Bowlby reported as follows at the meeting:

Working Group S12-6 met on 10 October to review a largely completed draft. The group held a workshop in Los Angeles in June 1984 to receive State highway agency feedback. Florida DOT completed a field evaluation that provided good data and good insight into technical and editorial problems. Evaluation efforts by other highway agencies and the Federal Highway Administration that were planned for summer/fall of 1984 have been delayed until spring/summer of 1985. The U.S. DOT contract to support the standard development is functionally well. A planned December 1984 completion date will be extended as long as needed to the advantage of the field evaluations.

Any organization that would like to field test the standard and prepare a test report should contact Mr. Bowlby.

S12-7 Statistical Sampling Procedures for Noise Emission Requirements—*L. Luttrell, Chair*

Mr. Luttrell reported as follows at the meeting:

Fourth draft of proposed ANSI S12.3-198X has been completed and submitted to the Standards Secretariat for 30-day review.

U.S.A. comments on ISO/DIS 7574/1-4 were drafted based upon comments received on S12.3 from S12 ballot and from the American Society for Quality Control.

S12-8 Determination of Interference of Noise with Speech Intelligibility—*M. J. Collins, Chair*

The first task assignment is the review of ANSI S3.14-1977—American National Standard for Rating Noise with Respect to Speech Interference. Ms. Collins reported as follows at the meeting:

Review of the current standard indicates a need for expansion to address issues related to reverberation and effects of hearing loss or at least a statement of applicability of the SIL table to hearing impairment. Some concern exists regarding overlap of efforts with S3 working group on the AI. Two of our working group articulation members (Don Dirks and Candy Kamm) are also on the Index working group, thus facilitating coordination. The S12-8 working group will meet in November (as ASHA meeting in San Francisco) to determine potential data basis for expansion of the S12 curves for various values of reverberation.

S12-9 Annoyance Response to Impulsive Noise—*L. Sutherland, Chair*

The document, "Method for Assessment of High Energy Impulse Sounds with Respect to Residential Communities" was submitted to S12 ballot on 1 July 1983.

Mr. Sutherland reported that current efforts to resolve the negative votes should be completed by the Fall ASA meeting. At the meeting, it was decided that the document should be sent to a 30-day review of S12, with whatever negative comments are still unresolved, in one month.

S12-10 Hearing Protectors—*C. Nixon, Chair*

The revision of the standard (ANSI S3.19-1974/ASA 1-1975) has been completed and submitted to S12 ballot on 16 April 1984. Efforts are being made to resolve the negative votes. At the meeting it was agreed that the reversals of negative votes should be sent in writing to the Standards Secretariat.

At the last meeting, Mr. Nixon said that S12 should consider making a charge to this working group to prepare a field method of evaluation.

S12-12 Evaluation of Hearing Conservation Programs—*L. Royster, Chair*

Mr. Royster reported as follows at the meeting:

The initial meeting of the reorganized S12-12 working group was held on 11 October 1984 in Minneapolis, MN. The reorganized committee presently has 11 members.

The initial objective of the committee will be the formulation of a composite audiometric data base for utilization in evaluating committee identified potential Audiometric Data Base (ADBA) techniques. Presently the committee has a commitment of approximately 15 Audiometric Data Bases. A master tape of the composite completed data base will created and made available for general utilization.

The second objective for the committee will be the identification of various ADBA techniques presently being utilized to evaluate hearing conservation programs and the development of potential new techniques.

The present agreed upon goal of the committee will be the development of guidelines for recommended ADBA techniques that will be submitted to ANSI for general publication and trial use by all parties concerned with evaluating HCPS.

S12-13 Community Response to Noise Levels—*F. Hall, Chair*

At the last meeting, Mr. Hall reported that the working group was in general agreement on the outline for a proposed standard.

S12-15 Measurement and Evaluation of Outdoor Community Noise—*P. Schomer, Chair*

A draft standard has been prepared and submitted to S12 for ballot on 16 April 1984. It was closed on 1 June 1984. A revised document is being proposed for S12 ballot and expected for circulation by December 1984.

There is a move toward the direction of TC 43/SC 1/WG 20 in this national activity.

S12-18 Criteria for Room Noise—*S. L. Yaniv, Chair*

The proposed draft ANSI Standard Procedure for Measuring and Rating Steady-State Room Noise was submitted to ballot on 22 September 1982. The ballot closed on 3 November 1982. Ms. Yaniv reported prior to the meeting that she hoped to have a new draft of this standard available shortly.

S12-19 Measurement of Occupational Noise Exposure—*J. P. Barry and W. Thornton, Co-Chairs*

The new charge to ISO/TC 43/SC1 (which developed ISO 1999), i.e., to produce a standard on noise at the workplace, which would be comprehensive, was discussed previously. Factors to be included are noise, annoyance, and other nonauditory health effects at the workplace. It was suggested that this working group could be the national counterpart for the international activity.

Mr. Thornton has circulated a draft of the proposed standard on Measurement of Occupational Noise Exposure to the working group. It should be available for ballot in S12 shortly.

At the meeting, it was agreed that it would be helpful to circulate a questionnaire on this subject. Mr. Thornton also mentioned the need for guidance on what units to use to measure the loss of hearing.

S12-20 Specification of the New Machinery at the Operator's Position—*R. D. Bruce, Chair*

Mr. Eldred said he would determine what progress was being made in this area.

S12-21 Determination of Sound Power Using Sound Intensity Measurements—*M. J. Crocker, Chair*

Mr. Donovan reported for Mr. Crocker that a committee meeting was held on 10 October 1984. Since the last meeting at the ASA conference in Norfolk, an initial draft standard has been substantially completed. The document is entitled "Engineering Methods for the Determination of the Sound Power Level of Noise Sources Using Sound Intensity." The document was circulated to the membership prior to the 10 October meeting. Written comments on the draft document were to be fowarded to Alan Wolfe by 27 October 1984.

At the 10 October meeting, comments from the committee members in attendance were presented and the draft document was reviewed in detail. In addition to the review of the draft, there was a general discussion of the scope of the draft standard. The primary concern was whether current scope was consistent with the desired engineering accuracy requirement of the draft standard.

A committee meeting has also been planned at the Inter-Noise 84 Conference in December. The question of scope of the document will be discussed further, or a consensus obtained.

S12-22 Impulse Sound Propagation for Community Noise Assessment—*R. Raspet, Chair*

Mr. Schomer reported that the working group will meet in November 1984 and that he would ask Mr. Raspet to communicate the results of this meeting to the Standards Manager.

S12-23 Determination of Sound Power—*P. K. Baade, Chair*

This working group will monitor the sound power series of standards (i.e., S1.30, 31, 32, 33, 34, 35, and 36) and complete the development of S1.37 and S1.38 (the latter to have S12 numbers).

The proposed ANSI Standard, S12.5-198X, Determination of Sound Power Levels of Noise Sources—Characterization and Calibration of Reference Sound Sources, Draft dated June 1983, was sent to ballot on 30 June 1983. (It is the counterpart to ISO/DIS 6926.)

S12-24 Placement of Personal Noise Monitoring—*A. Burks, Chair*

This is a new working group chaired by Mr. Burks.

Reports on Other Standards Organizations or Committees Involved in the Area of Noise

S12-4 IEEE/85 Committee on Noise Emitted by Rotating Electrical Machines—*R. G. Bartheld, Chair*

Counterpart to an international working group.

S12-14 Measurement of Noise from Pneumatic Compressors, Tools and Machines—(vacant)

It was proposed at the lst meeting that Mr. Kessler be asked to chair this activity.

S12-16 Measurement and Evaluation of Motor Vehicle Noise—*L. J. Eriksson, Chair*

The working group met in Chicago, Illinois on 6 September 1984.

S12-17 Measurement and evaluation of Aircraft Noise—*R. Linn, Chair*

This group is the counterpart to the SAE A-21 group on aircraft noise.

S23-25 ASTM E33 Committee on Environmental Acoustics—*C. W. Rodman, Chair*

This group is the counterpart to the ASTM Committee on Environmental Noise.

Documents without Working Groups submitted to S12 Ballot

The document entitled *Standard Methods for the Measurement of Impulse Noise, S 12.7-198X*, was formerly under the jurisdiction of S1 and designated as S1.28. It was revised and submitted to S12 ballot (and to S1 for information) on 15 March 1984.

Mr. Johnson reported at the last meeting that it was considered that all substantial issues could be resolved with the negative voters, and that a meeting had been held with Mr. Young (Eldred, Embleton, Johnson, and von Gierke present) to address the issues. As a key to resolution of the negative comments, Mr. Young had agreed to provide a complete set of figures showing various ways of presenting the spectra of a typical sonic boom by 10 June 1984.

A revised document is being prepared and will be submitted for ballot shortly.

S3 meets in Minneapolis

Laura Wilber, Chair, has submitted the following report on the activities of Accredited Standards Committee S3 on Bioacoustics. The committee met in Minneapolis, Minnesota during the fall meeting of the Acoustical Society of America in October 1984.

One standard, ANSI S3.29-1983 *Guide to the Evaluation of Human Exposure to Vibration in Buildings* has been published by the ASA since our last meeting.

The following reports of working groups were given:

S3-35 Audiometers—*Rufus Grason, Chair*

It was reported that a revised text is expected to be ready to ballot soon. Subsequent to this meeting the text was received by Wilber and has been sent to the standards secretariat for processing prior to vote. This working group has been asked to consider standards for computerized audiometry.

S3-36 Speech Intelligibility—*John Webster, Chair*

It was reported that a draft standard prepared by the subcommittee S3-36/1 on the threshold level for speech was sent for ballot, and the committee is currently working to resolve negative votes. The subcommittee S3-36/2 on speech discrimination has begun to collect information on the vocabulary to be used; to reporting procedures for speech discrimination tests; and to reporting procedures for new tests of speech discrimination testing. The third subcommittee, chaired by Mr. Hawley reported that they hope to have a draft standard ready for ballot by December of 1984.

S3-36 Coupler Calibration of Earphones—*Mahlon Burkhard, Chair*

It was reported that there was need for work on the current document.

S3-39 Human Exposure to Mechanical Vibration and Shock—*Henning von Gierke, Chair*

It was reported that resolutions of the SC4 meeting held in Edinburgh in September 1984 are available from the Standards Secretariat. Von Gierke also reported that three ISO documents were considered by the working group. The first was *Guidelines for the measurement and assessment of human exposure to hand-transmitted vibration*; the second, *Third draft Proposal for Human Response Vibration Measuring Instrumentation* received a negative vote from the U.S. and this, plus editorial comments, were submitted to ANSI in August; the third, *First draft Proposal on Standard Biodynamic Coordinate Systems*, also received a negative U.S. vote.

S3-43 Method for Calibration of Bone Conduction Vibrators—*Donald Dirks, Chair*

It was reported that the working group is preparing a revision of the current ANSI standard on *Artificial Head-Bone for Calibration of Audiometer Bone Vibrators*. It is expected that a draft will soon be ready for vote.

S3-48 Hearing Aids—*David Preves, Chair*

It was reported that a draft standard of *Methods of Measurement of Performance Characteristics of Hearing Aids, under stimulated in-situ working Conditions*, has been received and is being circulated for vote and comment to members of S3. Preves also reported that this group is studying correction factors for coupler measurements and standardized plugs for electrical inputs to hearing aids. He further reported that data were obtained from five laboratories for the second KEMAR round robin using an in-the-ear hearing aid. Average differences were calculated between the 2-cc coupler and KEMAR, and between Zwislocki ear stimulator and KEMAR to be considered for use as correction factors for predicting real ear performance of hearing aids. This working group has formulated a set of parameters for a standardized ear hood thread, and it is considering a proposal for updating the current hearing aid standard procedure for AGC hearing aids. Finally, Preves reported that an IEC document, draft *Guide to Hearing Aid Standards* was received and after comments it was recommended that the U.S. vote affirmatively on the document.

S3-56 Criteria for Background Noise for Audiometer Testing—*Gerald Studebaker, Chair*

Plans to initiate review of the current ANSI standard with a view toward clarifying the circumstances when testing to levels higher than 0 dB HTL would be appropriate.

S3-58 Hearing Conservation Criteria—*Juergen Tonndorf, Chair*

It was reported that a revised draft of a national version of the ISO document on hearing conservation criteria will be proposed for ballot shortly. Tonndorf also reported that the ISO draft international standard document on *Acoustics—Methods for Describing Infrasound* had been considered and that the U.S. had submitted a negative vote with comments.

S3-59 Measurement of Speech Levels—*Karl Pearsons, Chair*

It was reported that a draft document was ready but had not yet been circulated. Silbiger stated that new sources of data had been received and would be evaluated in terms of the new draft, but that hopefully it would be circulated shortly.

S3-60 Measurement of Acoustic Immittance of the Ear—*David Lilly, Chair*

This working group is considering the draft IEC document on the same subject. Subsequent to this meeting, the working group met and worked on a U.S. document which is somewhat different from the IEC one. It is hoped that the U.S. document will be ready for circulation early in 1985.

S3-61 Sound Pressure Distribution Around the Head and Torso—*George Kuhn, Chair*

It was reported that a paper for publication on the above topic has been accepted for publication. The group believes that when that manuscript has been published it should be disbanded.

S3-62 Impulsive Noise with Respect to Hearing Hazard—*Daniel Johnson, Chair*

This group has sent out a revised document on standard methods for the evaluation of the potential effect on human hearing of sound with peak A-weighted sound pressure levels above 120 dB and peak C-weighted sound pressure levels below 140 dB for ballot. Mr. Johnson reported that most of the negative votes on that document had been resolved and that the unresolved comments would be circulated to S3 for a 30-day review.

S3-63 Acoustical Warning Devices—*Milton Whitcomb, Chair*

It was reported that the ISO document of acoustical warning devices has been submitted to ISO for issuance as a draft international standard. At this meeting there was some discussion of the length of time taken to prepare a French translation. A delegate from France who happened to be at our meeting will look into the problem. Whitcomb also reported that there had been a lack of coordination in ANSI and as a result there are three ANSI standards on the same subject, two by the National Fire Protection Association and one by the American Nuclear Society. After discussion, it was decided to specifically include the words "auditory warning signals" in the scope of S3.

S3-67 Manikins—*Mahlon Burkhard, Chair*

It was reported that work is proceeding on a draft document on head and torso simulators within IEC. The national version is expected to be balloted shortly and will be circulated together with the document produced by the Hearing Aid committee (on *in situ* measurements).

S3-71 Artificial Mouths—*R. Sachs, Chair*

Mr. Sachs is the new chair. He replaces Mr. Whiteseil.

S3-72 Brainstem Evoked Response—*Roger Ruth, Chair*

It was reported that the group is still considering the activities which need to be implemented related to the measurement of auditory evoked potentials.

S3-73 Bioacoustical Terminology—*Herman Silbiger, Chair*

It was reported that a letter has been sent to working group chairs requesting a list of terms in the drafts for development as standards and for terminology already in existing standards and valid which should be included in the bioacoustical terminology standard. Mr. Silbiger reports that suggestions are welcomed for proposed terminology.

S3-76 Computerized Audiometry—*Craig Wier, Chair*

This is a new working group currently being formulated. The group will work on standardization of computer applications to audiometry including automated psychophysical procedures. It will interface with the working group on audiometers to make sure that recommended procedures are compatible with recommended equipment.

S3-77 High Frequency Audiometry—*John Fletcher, Chair*

This is a new working group which has just begun formulation.

S3-78 Thresholds—*William Yost, Chair*

This is a new working group which will provide liaison with ISO, IEC, and other national working groups for standards dealing with auditory thresholds and procedures to measure those thresholds. Yost is currently coordinating U.S. comments on the ISO document *Acoustics—Normal Equal-Loudness Controls for Pure Tones under Free-Field Listening Conditions*.

S3-79 Calculation of the Articulation Index—*Chas Pavolvic, Chair*

This is a new working group formulated to consider the current ANSI document on this topic. The group is currently being put together.

The following standards are being considered for reaffirmation, revision, or withdrawal:

ANSI S3.1-1977	American National Standard Criteria for Permissible Ambient Noise During Audiometric Testing
ANSI S3.13-1972	American National Standard Artificial Head-Bone for the Calibration of Audiometer Bone Vibrators

The following standards have been granted extensions until March 1985:

ANSI S3.5-1969 (R 1978)	Methods for Calculation of the Articulation Index
ANSI S3.20-1973 (R 1978)	Psychoacoustical Terminology
ANSI S3.21-1978	Manual Pure-Tone Threshold Audiometry
ANSI S3.6-1969 (R 1973)	Specifications for Audiometers

The following standards are now ready for consideration under the five-year rule:

ANSI S3.18-1979	American National Standard Guide for the Evaluation of Human Exposure to Whole-Body Vibration
ANSI S3.25-1979	American National Standard for an Occluded Ear Simulator
ANSI S3.7-1973	American National Standard Method for Coupler Calibration of Earphones

During this meeting it was reported that the new ASACOS *Editorial Guidelines* have been circulated to all working group chairs. Comments should be sent to the ASA Standards Secretariat for collection and use in the next revision of this document.

Four new working groups *Computerized Audiometry, High Frequency Audiometry, Masking,* and *Threshold* (mentioned above) were approved since the last meeting of S3.

In July the officers and individual experts for S3 were voted on by the membership. This was in accord with the new ANSI procedures. The officers elected for three-year terms were: Laura Ann Wilber, chair; and Herman Silbiger, vice chair.

An ANSI standard, Y10.11 1983 *Proposed Standard on Letter Symbols and Abbreviations for Quantities Used in Acoustics* was approved by that body but has been objected to by the Acoustical Society. This is now in the appeal process.

Mr. von Gierke drew attention to the question of *Voice Warning Signals* and the need for standardization in this area. It is requested that anyone working in the area, or who has information on the subject, should contact L. Wilber.

The next meeting of S3 will be held in April 1985 in Austin, Texas.

SHORT COURSES

JUNE

VIBRATION CONTROL

Dates: June 3-7, 1985
Place: San Diego, California
Objective: This vibration control course will include all aspects of vibration control except alignment and balancing. (These topics are covered in separate Institute courses.) Specific topics include active and passive isolation, damping, tuning, reduction of excitation, dynamic absorbers, and auxiliary mass dampers. The general features of commercially available isolation and damping hardware will be summarized. Application of the finite element method to predicting the response of structures will be presented; such predictions are used to minimize structural vibrations, during the engineering design process. Lumped mass-spring-damper modeling will be used to describe the translational vibration behavior of packages and machines. Measurement and analysis of vibration responses of machines and structures are included in the course. The course emphasizes the practical aspects of vibration control. Appropriate case histories will be presented for both isolation and damping.

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

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

Dates: June 3-7, 1985
Place: Santa Barbara, California
Dates: August 26-30, 1985
Place: Santa Barbara, California
Dates: December 2-6, 1985
Place: Santa Barbara, California
Dates: February 3-7, 1986
Place: Santa Barbara, California
Dates: March 10-14, 1986
Place: Washington, DC
Dates: May 12-16, 1986
Place: Detroit, Michigan
Objective: Topics to be covered are resonance and fragility phenomena, and environmental vibration and shock measurement and analysis; also vibration and shock environmental testing to prove survivability. This course will concentrate upon equipments and techniques, rather than upon mathematics and theory.

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

MACHINERY INSTRUMENTATION AND DIAGNOSTICS

Dates: June 4-7, 1985
Place: Pittsburgh, Pennsylvania
Dates: July 15-19, 1985
Place: Carson City, Nevada
Dates: September 10-13, 1985
Place: New Orleans, Louisiana
Dates: September 24-27, 1985
Place: Anaheim, California
Dates: October 8-11, 1985
Place: Philadelphia, Pennsylvania
Dates: October 21-25, 1985
Place: Carson City, Nevada
Dates: November 5-8, 1985
Place: Boston, Massachusetts
Dates: December 3-6, 1985
Place: Houston, Texas
Objective: This course is designed for industry personnel who are involved in machinery analysis programs. Seminar topics include a review of transducers and monitoring systems, machinery malfunction diagnosis, data acquisition and reduction instruments, and the application of relative and seismic transducers to various types of rotating machinery.

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

TIME DOMAIN MODAL VIBRATION TESTING TECHNIQUES

Dates: June 6-7, 1985
Place: Virginia Beach, Virginia
Objective: The seminar presents an in-depth study of the Ibrahim Time Domain (ITD) method, examining results of previous applications and the applied use of the computer program and its selected options. Through attendance at the workshop, participants will receive the complete computer program of the ITD method and should be able to use the technique in modal vibration testing applications.

Contact: Mr. W.C. Bentley, Industrial Programs, School of Engineering, Old Dominion University, Norfolk, VA 23508 - (804) 440-4243.

VIBRATION DAMPING

Dates: June 16-20, 1985
Place: Dayton, Ohio
Objective: The utilization of the vibration damping properties of viscoelastic materials to reduce structural vibration and noise has become well developed and successfully demonstrated in recent years. The course is intended to give the participant an understanding of the principles of vibration damping necessary for the successful application of this technology. Topics included are: damping fundamentals, damping behavior of materials, response measurements of damped systems, layered damping treatments, tuned dampers, finite element techniques, case histories, and problem solving sessions.

Contact: Michael L. Drake, Jesse Philips Center 36, 300 College Park Avenue, Dayton, OH 45469 - (513) 229-2644.

MACHINERY INSTRUMENTATION

Dates: June 25-27, 1985
Place: Denver, Colorado
Dates: November 12-14, 1985
Place: Calgary, Alberta, Canada
Objective: This seminar provides an in-depth examination of vibration measurement and machinery information systems as well as an introduction to diagnostic instrumentation. The three-day seminar is designed for mechanical, instrumentation, and operations personnel who require a general knowledge of machinery information systems. The seminar is a recommended prerequisite for the Machinery Instrumentation and Diagnostics Seminar and the Mechanical Engineering Seminar.

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

JULY

MECHANICS OF HEAVY-DUTY TRUCKS AND TRUCK COMBINATIONS

Dates: July 15-19, 1985
Place: Ann Arbor, Michigan
Objective: This course describes the physics of heavy-truck components in terms of how these components determine the braking, steering, and riding performance of the total vehicle. Covers analytical methods, parameter measurement procedures, computational and test procedures, useful for performance analysis prediction and design.

Contact: College of Engineering, The University of Michigan, Chrysler Center - North Campus, Ann Arbor, MI 48109-2092 - (313) 764-8490.

FINITE ELEMENTS IN MECHANICAL AND STRUCTURAL DESIGN A: LINEAR STATIC ANALYSIS

Dates: July 15-19, 1985
Place: Ann Arbor, Michigan
Objective: Presents energy formulation and modeling concepts. For engineers requiring stress, strain and displacement information. Attendees use personal computers to develop models of several problems and use MSC/NASTRAN in laboratory sessions. No previous finite element experience is required.

Contact: College of Engineering, The University of Michigan, Chrysler Center - North Campus, Ann Arbor, MI 48109-2092 - (313) 764-8490.

FUNDAMENTALS OF COMPUTER AIDED ENGINEERING, DESIGN AND MANUFACTURING

Dates: July 29 - August 2, 1985
Place: Provo, Utah
Objective: This short course gives an overview of state-of-the-art computer aided techniques in engineering, design, and manufacturing with with the intent of providing those engaged in CAEDM activities the opportunity to learn of the range of equipment and software that is currently available, see these tools operate, and be assisted in incorporating such tools to individual needs. Emphasis on an integrated computer assisted approach will be stressed.

Contact: Steven E. Benzley, 368L CB, Brigham Young University, Provo, Utah 84602 - (801) 378-6322.

AUGUST

BASICS OF VIBRATION DAMPING TECHNOLOGY

Dates: August, 1985
Place: Dayton, Ohio
Objective: A four day intensive seminar/workshop on basic damping technology, including viscoelastic material behavior, nomograms for representing effects of frequency and temperature on real material behavior, single degree and multiple degree of freedom systems, free layer, constrained layer and discrete damping techniques, and measurement basics will be given. Highlights include a new textbook on vibration damping, extensive use of participant exercises, worksheets and calculator applications to reinforce the learning process, and detailed evaluation of case histories. Attendance will be strictly limited to ensure an intensive and interactive work experience.

Contact: Dr. D. Jones, Damping Technology Information Services, Box 33514, Wright-Patterson AFB, OH 45433-0514.

MECHANICAL ENGINEERING

Dates: August 12-16, 1985
Place Carson City, Nevada
Objective: This course is designed for mechanical, maintenance, and machinery engineers who are involved in the design, acceptance testing, and operation of rotating machinery. The seminar emphasizes the mechanisms behind various machinery malfunctions. Other topics include data for identifying problems and suggested methods of correction.

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

MODAL TESTING OF MACHINES AND STRUCTURES

Dates: August 13-16, 1985
Place: Nashville, Tennessee
Objective: Vibration testing and analysis associated with machines and structures will be discussed in detail. Practical examples will be given to illustrate important concepts. Theory and test philosophy of modal techniques, methods for mobility measurements, methods for analyzing mobility data, mathematical modeling from mobility data, and applications of modal test results will be presented.

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

MACHINERY VIBRATION ANALYSIS

Dates: August 13-16, 1985
Place: Nashville, Tennessee
Dates: Oct. 29 - Nov. 1, 1985
Place: Oak Brook, Illinois
Objective: This course emphasizes the role of vibrations in mechanical equipment instrumentation for vibration measurement, techniques for vibration analysis and control, and vibration correction and criteria. Examples and case histories from actual vibration problems in the petroleum, process, chemical, power, paper, and pharmaceutical industries are used to illustrate techniques. Participants have the opportu-

nity to become familiar with these techniques during the workshops. Lecture topics include: spectrum, time domain, modal, and orbital analysis; determination of natural frequency, resonance, and critical speed; vibration analysis of specific mechanical components, equipment, and equipment trains; identification of machine forces and frequencies; basic rotor dynamics including fluid-film bearing characteristics, instabilities, and response to mass unbalance; vibration correction including balancing; vibration control including isolation and damping of installed equipment; selection and use of instrumentation; equipment evaluation techniques; shop testing; and plant predictive and preventive maintenance. This course will be of interest to plant engineers and technicians who must identify and correct faults in machinery.

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

BALANCING OF ROTATING MACHINERY

Dates: August 13-16, 1985
Place: Nashville, Tennessee
Objective: This course will emphasize the practical aspects of balancing in the shop and field including training on basics, the latest techniques, and case histories. The instrumentation, techniques, and equipment pertinent to balancing will be elaborated with case histories. Demonstrations of techniques with appropriate instrumentation and equipment are scheduled. Specific topics include: basic balancing techniques (one- and two-plane); field balancing; balancing machines and facilities; use of programmable calculators; turbine-generator balancing; balancing sensitivity; factors to be considered in high speed balancing; effect of residual shaft bow on unbalance; tests on balancing machines; flexible rotor balancing --training and techniques; a unified approach to flexible rotor balancing; and coupling balancing.

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

VIBRATION MEASUREMENT AND MODAL ANALYSIS

Dates: August 15-17, 1985
Place: Amherst, New York
Objective: This course covering dynamic and measurement systems, dynamic signals, applied signal analysis, vibration fundamentals and applied modal analysis will provide engineers with a background in both fundamental and applied aspects of vibration and modal testing. The course will be taught in a lecture/demonstration format making considerable in-class use of state of the art signal analysis and modal analysis instrumentation. Hands on lab experience will be available through informal evening sessions.

Contact: Mike Murph Kistler Instrument Corporation, 75 John Glenn Drive, Amherst, NY 14120 - (716) 691-5100.

OCTOBER

VIBRATIONS OF RECIPROCATING MACHINERY

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

procating machinery will be emphasized. Case histories and examples will be presented to illustrate techniques.

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

REVIEWS OF MEETINGS

ASME WINTER ANNUAL MEETING
December 10-14, 1984
New Orleans, Louisiana

The ASME Winter Annual Meeting was highlighted by three special symposia of interest to the Shock and Vibration Community: Symposium on Flow-Induced Vibration; Symposium on Constitutive Equations; Symposium on Innovative Methods for Nonlinear Problems.

Each of the above symposia were jointly sponsored by several divisions of ASME. The Symposium on Flow-Induced Vibration is described in a separate report which was written by Dr. Owen Griffin of the Naval Research Laboratory. No further mention of the papers that were presented in this symposium will be made in this report, except to say that all substantially contributed to a better understanding of the flow-induced vibration phenomena. The Symposium on Constitutive Equations contained six sessions, and it was sponsored by the Applied Mechanics, the Materials and the Pressure Vessel and Piping Divisions. The Applied Mechanics and the Materials Divisions jointly sponsored the Symposium on Innovative Methods for Nonlinear Problems which contained three sessions. The Shock and Vibration Committee of the Applied Mechanics Division sponsored a Symposium on Random Vibrations which contained two sessions. The Applied Mechanics Division sponsored other sessions of interest to the Shock and Vibration community, as did the Aerospace, the Dynamics Systems and Control, the Noise Control and Acoustics, and the Production Engineering Divisions.

The Aerospace Division sponsored two sessions on passive damping. The first of the two sessions concerned the characterization of the properties of passive damping materials. Michael Parin described some of the more common methods for characterizing the dynamic properties of damping materials, and he described how the reduced frequency-temperature plotting concept was used to present storage modules and loss factor data for damping materials as a function of temperature and frequency. David Jones discussed the uses of receptance and dynamic stiffness to analyze the effects of structural modifications on the dynamic behavior of systems; he used the addition of a tuned damper to a system as an example of how each approach could be used to define the elastic properties of the modified system.

A paper by Connor Johnson, David Keinholz, Eric Austin, and M. E. Schneider described the finite element analysis of viscoelastically damped structures. The authors included samples of applications in their paper which included the finite element analyses of a constrained layer damped box-beam foundation for rotating machinery and a mirror support structure damped with viscoelastic links. Richard Ely discussed the use of viscoelastically damped laminated structures for reducing vibration and stresses in aircraft structural components. The damped laminated structures were used in the redesign of the leading edge of an aircraft wing, and they were used in the design of an aircraft equipment rack to reduce the dynamic stresses.

The next two papers concerned the Air Force RELSAT program. RELSAT is a shortened acronym for Reliability of Satellite Equipment in Environmental Vibration. The purpose of this program is to improve the reliability of electronic equipment for satellites by using added viscoelastic damping material treatments, at the initial design stage, to reduce the vibration inputs. A paper by Roy Ikegami, William Walker, and Clark Beck described the analytical and the experimental efforts to develop two candidate damping treatments for the equipment support structure in the Inertial Upper Stage. Both damping treatments significantly reduced the response of the equipment support structure. The paper on the RELSAT program, which was written by Clyde Stahle, Jim Staley, and J. E. Strain, described the use of added damping treatments for reducing the vibration input to electronic components mounted on one bay of a transponder panel on the DSCS satellite. As in the previous case of the equipment support structure, the added damping treatment substantially reduced the vibration input to the components which were mounted on the DSCS satellite transponder panel.

The final paper in this session by Charles White, George Morosow, and Connor Johnson concerned the evaluation of the dynamic response of large structures in support of the Air Force PACOSS program. PACOSS is an acronym for Passive and Active Control of Space Structures. The goal of this program is to use passive and active damping technology to control the low frequency, low level vibrations of large space structures. In this study the authors analyzed and tested a large generic truss structure to determine its inherent damping capacity, and to determine the effectiveness of several candidate damping concepts.

The Dynamic Systems and Control Division sponsored a session on the Dynamics and Control of Ground Vehicles. Kenneth Moorman described a modeling and identification procedure for analyzing and simulating the performance of hydraulic and gas pressurized vehicle shock absorbers. He also presented a comparison between the simulated and the measured performance characteristics of the shock absorbers. B.I. Bachrach and D.L. Wilson described methods for analyzing a vehicle's handling characteristics in the design and development stage. The authors described the two types of codes that are used in vehicle handling analyses, e.g., a general mechanism-based code and a dedicated vehicle code, how they are used and the necessary input parameters for performing the analysis. E.H. Law and I. Haque discussed the measurements of wheel creep forces which were made on the Roll Dynamics Unit at the Transportation Test center at Pueblo, CO. These measurements were made to assess the effects of rail surface contaminants, e.g., oil, grease or water, on the wheel creep forces and the creep force coefficients. Note, wheel creep refers to the slippage that occurs between the wheel and the rail during rolling contact. Two other papers were presented in this session, and their titles are, "The Bayesean Estimate of Transit Vehicle Parameters," by R.H. Fries and N.K. Cooperider, and "Pneumatic Actuators for Vehicle Active Suspension Applications," by D. Cho and J. K. Hedrick.

The Noise Control and Acoustics Division sponsored a session on Structure and Flow Interaction Acoustics. The final paper in that session, by M. M. Nigm and M. M. Sadek, concerned the dynamic and acoustic analyses of forging hammer frames. The authors developed methods for predicting the dynamic characteristics of the forging hammer frame and the sound power emitted during forging operations. The authors then used their analytical techniques to investigate the effects of different frame design configurations on the noise emitted from the frame during forging operations. The titles of other papers presented in this session were:

1. "A New Look at Sound Generation by Blade/Vortex Interaction," by J. C. Hardin and J. P. Mason.

2. "Modeling and Analyses of Flow-Induced Vibration in Circular Saws," by M. Jiraponghan and M. C. Leu.

3. "Computation of Far Field Sound Generation in a Fluid-Structure Interaction Problem," by A. T. Conlisk.

4. "On the Application of the BIE Method in Studies of Acoustic Radiation from Vibrating Structures," by J. K. Jiang and M.G. Prasad.

R. H. Volin
Naval Research Laboratory

ASME SYMPOSIUM ON FLOW-INDUCED VIBRATION
December 9-13, 1984
New Orleans, Louisiana

The ASME Divisions of (i) Applied Mechanics, (ii) Heat Transfer, (iii) Noise Control and Acoustics, (iv) Nuclear Engineering, (v) Pressure Vessels and Piping, and (vi) Fluids Engineering sponsored a major joint Symposium on Flow-Induced Vibration at the 1984 ASME Winter Annual Meeting, which was held in New Orleans, Louisiana from December 9-13, 1984.

The Symposium consisted of ten technical sessions with sixty-eight papers in all. Developers for these sessions in their respective divisions, as above, were (i) A. J. Kalinowski, (ii) J. M. Chenoweth, (iii) M. Sevik, (iv) S.-S. Chen, (v) M. K. Au-Yang and (vi) O.M. Griffin. The principal organizer and overall coordinator of the Symposium was M. P. Paidoussis of McGill University.

This Symposium was a unique event in the annals of technical meetings organized by ASME. Apart from promising to be one of the most important meetings anywhere on this topic in recent years (only time will tell just how important), it was the first time that such a large symposium on the subject was organized by ASME. Also, it is the first time that as many as six divisions of the ASME have worked together in co-sponsoring a symposium on any subject.

The proceedings of the symposium were published in a series of ASME bound volumes with the following titles: Volume 1 - Excitation and Vibration of Bluff Bodies in Cross Flow; Volume 2 - Vibrations of Arrays of Cylinders in Cross Flow; Volume 3 - Vibration in Heat Exchangers; Volume 4 - Vibration Induced by Axial and Annular Flows; Volume 5 - Turbulence-Induced Noise and Vibration of Rigid and Compliant Surfaces; Volume 6 - Computational Aspects of Flow-Induced Vibration.

The ten technical sessions in the symposium program contained papers submitted from twelve countries. Three technical sessions with a total of twenty papers were devoted to the Vibration of Arrays of Cylinders in Cross Flow. These three sessions comprised the largest single technical area of the symposium.* The studies reported ranged from visualization of the flow in tube arrays to numerical modelling and comparison with experiments of the stability behavior of heat exchanger tube bundles. Other papers dealt with flow-induced noise, galloping of overhead line conductors, and fluid-elastic instabilities of arrays of cylinders in various arrangements. Twelve papers were presented in two sessions dealing with Vibration in Heat Exchangers. The majority of these papers dealt with problems associated with large power plant components such as steam generators and condensers. Other papers dealt with the flow-induced vibrations of shell-and-tube heat exchangers (experiments and prediction algorithms).

Two sessions were held to discuss the Excitation and Vibration of Bluff Bodies in Cross Flow. A total of fourteen papers were presented on subjects which ranged from fluid forces on isolated rigid cylinders in turbulent cross flows, to vortex-induced vibrations and to aeroelastic instabilities such as galloping of single cylinders. Nine papers were presented on Vibration Induced by Axial and Annular Flows. The problems discussed included unsteady forces and vibrations in annular diffusers, and the stability and vibration of cylinders of various configurations in annular flow.

Two single sessions were held on the topics of Computational Aspects of Flow-Induced Vibration and Turbulence-Induced Noise and Vibration of Rigid and Compliant Surfaces. The six computational studies mainly consisted of finite element analyses of fluid/-structure interactions and added mass predictions for single tubes and arrays of tubes in various arrangements. Seven papers were presented on turbulent boundary layer forcing of rigid and compliant surface motions, and flow effects on the pressure spectrum of the turbulent boundary layer.

The organization of a symposium of this size, with international scope and participation, was a challenging and rewarding experience for both organizers, contributors and participants. The results presented at the symposium hopefully have led to new and better understanding of a wide range of flow-induced vibration phenomena. This in turn should lead to new design guidelines and algorithms with diverse applications in manufacturing, power generation and distribution, and propulsion.

Owen M. Griffin
Naval Research Laboratory

ABSTRACTS FROM THE CURRENT LITERATURE

ABSTRACT CONTENTS

AVAILABILITY OF PUBLICATIONS ABSTRACTED

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

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

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

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

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

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

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

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

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

MECHANICAL SYSTEMS

ROTATING MACHINES

85-865
Pump Modifications Solve Complex Vibration Problems
R.E. Mondy, J.L. Suesli
Virginia Electric & Power Co.
Power, 129 (2), pp 41-43 (Feb 1985), 5 figs

KEY WORDS: Pumps, Vibration control, Structural modification techniques

Vibration in vertical multi-stage pumps can be caused by mechanical or flow-path problems. In this instance multiple modifications eliminated both possibilities.

85-866
Critical Speeds of Turbomachinery Computer Predictions vs Experimental Measurements
J.M. Vance, B.T. Murphy, H.A. Tripp
Texas A & M University, College Station, TX
Proc., 13th Turbomachinery Symp., Texas A&M Univ., College Station, TX, Nov 1984, pp 105-130, 35 figs, 20 tables, 10 refs

KEY WORDS: Turbomachinery, Critical speeds, Prediction techniques, Computer-aided techniques, Experimental data

Comparisons of state-of-the-art computer predictions of critical speeds are described; experimental measurements were made on shafts and rotors of varying complexity. The models investigated range from a precision uniform shaft in the laboratory to an eight-stage centrifugal compressor rotor. Modifications of existing computer programs to improve the accuracy of predicted critical speeds are also discussed.

85-867
Optimal Control of a Rotor Partially Filled with an Inviscid Incompressible Fluid
S.L. Hendricks, R.D. Klauber
Virginia Polytechnic Inst. and State Univ., Blacksburg, VA 24061
J. Appl. Mech., Trans. ASME, 51 (4), pp 863-868 (Dec 1984), 10 figs, 11 refs

KEY WORDS: Rotors, Fluid-filled containers

Optimal control theory is used to stabilize a rotating cylinder partially filled with an inviscid, incompressible fluid. The theory is used to control a rotor consisting of two discrete masses connected by a flexible shaft. The fluid is inside one mass; the control force is applied to the other. The rotor-fluid system that is unstable without controls is stable when acted upon by a feedback force designed to minimize a suitable performance index.

85-868
On Asynchronous Running of Synchronous Machines and Related Mechanical Stresses
M.A. Masrur
Ph.D. Thesis, Texas A & M Univ., 281 pp (1984), DA8419852

KEY WORDS: Shafts, Synchronous motors, Nonsynchronous vibrations, Fatigue life

Asynchronous operation of synchronous generators is considered during system disturbances, particularly to shaft stresses. Such abnormal operation can lead to mechanical stresses in the turbine-generator shaft system. These stresses can lead to shaft fatigue which can be evaluated by a proper fatigue model. Theoretical aspects of the parametric resonance phenomenon are also considered. Variation of certain parameters on asynchronous operation is also described. The safety factor during shaft specification are indicated.

85-869
Factors that Affect the Fatigue Strength of Power Transmission Shafting
S.H. Loewenthal

NASA Lewis Res. Ctr., Cleveland, OH
Rept. No. NASA-TM-83608, 28 pp (1984), N84-26029

KEY WORDS: Shafts, Fatigue life

One objective in the design of power transmission shafting is to eliminate excess shaft material without compromising operational reliability. This shaft design method accounts for variable amplitude loading histories and their influence on limited life designs. The effects of combined bending and torsional loading are considered along with a number of application factors known to influence the fatigue strength of shafting materials. Among the factors examined are surface condition, size, stress concentration, residual stress, and corrosion fatigue.

85-870
Synchronous and Self-Excited Rotor Vibrations Caused by a Full Annular Rub
A. Muszynska
Bently Rotor Dynamics Res. Corp., Minden, NV
Machinery Dynamics Seminar, Proc. of the 8th, Oct 1-2, 1984, Halifax, Canada. Spons. by National Res. Council Canada, NRC No. 23619, pp 21.1 -22.21, 22 figs, 1 table, 19 refs

KEY WORDS: Rotors, Rubs, Synchronous vibrations, Self-excited vibrations

This paper discusses dynamic effects during a rotor-to-stator or rotor-to-seal full annular rub (called a dry whip). Friction, modification of stiffness, and the effect or radial clearance are accounted for in the mathematical model of the rotor. The model allows for two solutions that describe two dynamic phenomena. Rotor synchronous precessional vibrations (due to a residual unbalance), modified by the rub, and rotor self-excited backward precessions with frequencies corresponding to the modified system natural frequencies are described. Results of the theoretical analysis agree well with experimental results.

85-871
Comparison of Instability Threshold Speed Predictions with Laboratory and Field Test Data
N.F. Rieger
Stress Technology, Inc., Rochester, NY
Machinery Dynamics Seminar, Proc. of the 8th, Oct 1-2, 1984, Halifax, Canada. Sponsor: National Res. Council Canada, NRC No. 23619, pp 21.1-21.33, 11 figs, 4 tables, 38 refs

KEY WORDS: Rotors, Whirling, Prediction techniques

This paper discusses the correlation between theoretical predictions of whirl instability threshold speed and the observed instability threshold speed for six rotor systems. The objective was to determine the accuracy with which the threshold speed can be predicted using linear bearing coefficients for symmetrical two-bearing rotors. These were compared with measured threshold speed values from tests on corresponding two-bearing rotor systems. The results are relevant for practical rotor systems of this type.

METAL WORKING AND FORMING

85-872
An Analysis of Cutting Surface Formation Under in-Process Measurement
Y.S. Liu, Z.H. Lin, X.Q. Hwong, C.H. Ku
Machine Tool Fundamentals Lab., Xi'an Jiaotong Univ. Xi'an, Shaanxi, Peoples Rep. of China
Intl. J. Mach. Tool Des. Res., 24 (4), pp 277-293 (1984), 15 figs, 6 tables, 5 refs

KEY WORDS: Machine tools, Cutting, Periodic vibration, Random vibration

The mechanism of cutting marks formation is used to establish mathematical expressions of turned surface and profiles of axial sections of workpiece under sinusoidal and random vibration. The rule and the characteristics of spiral direction of cutting marks are studied. The phenomenon of two or more spirals overlapping on the same turned surface is analytically clarified and experimentally proved. An effective criterion Q for indicating the dynamic quality of machine tools is suggested: a specially made in-process profilometer is introduced.

85-873

The Effect of Hob Wear on the Level of Vibration Generated in Hobbing

R. Galczynski
Inst. of Machine Tool Engrg., Technical Univ. of Lodz, Lodz, Poland

Intl. J. Mach. Tool Des. Res., 24 (4), pp 295-309 (1984) 9 figs, 5 tables, 14 refs

KEY WORDS: Machine tools, Hobbing, Wear, Vibration response

Results of an investigation of the effect of hob wear on the vibration of the tool post of a hobbing machine are described. The analysis was concentrated on applying the vibration signal for detecting hob wear. Analysis of the signal components showed that the z-direction component of a third-octave bandwidth and central frequency of 125 Hz had the most suitable characteristics. Of the basic process parameters analyzed only the value of feed had a significant effect on the parameters by which signal suitability is expressed. Suitability of the signal for tool wear detection is significantly reduced with the higher values of feed.

85-874

Feasibility of Applying Vibration Monitoring to High Volume, Multistation Transfer Machines

Jimi Sauw-Yoeng Tjong, Z. Reif
F. Jos. Lamb Co., Ltd., Windsor, Ontario, Canada

Machinery Dynamics Seminar, Proc. of the 8th, Oct 1-2, 1984, Halifax, Canada. Sponsor: National Res. Council Canada, NRC No. 23619, pp 7.1-7.16, 17 figs, 3 refs

KEY WORDS: Machine tools, Monitoring techniques, Automotive engines

A field study was undertaken to determine the feasibility of applying vibration monitoring to high-volume, multistation transfer machines installed in an automotive engine plant. An accelerometer, a vibration meter, and a tape recorder were used to obtain vibration data. Repeatable vibration measurements were possible, and future trends in both overall and spectral acceleration levels were apparent. For one machining station, prediction of bearing failure was illustrated.

85-875

Modal and Signature Analysis Methods Applied to the Cutting Noise and Vibration Problems of High Volume Transfer Machines

T. Moore, Z. Reif
F. Jos. Lamb Co., Ltd., Windsor, Ontario, Canada

Machinery Dynamics Seminar, Proc. of the 8th, Oct 1-2, 1984, Halifax, Canada. Sponsor: National Res. Council Canada, NRC No. 23619, pp 4.1-4.12, 6 figs, 4 refs

KEY WORDS: Machine tools, Noise reduction, Vibration control, Modal analysis, Forcing function

Signature and modal analysis techniques were used to investigate problems associated with the machining of an automotive transmission casing made of aluminum alloy. Significant variations of noise level and frequency spectrum occurred during the cutting sequence, apparently due to variations in width of cut and changes of local stiffness. The best potential for reduction was the unequal distribution of inserts on the milling cutter.

STRUCTURAL SYSTEMS

BRIDGES

85-876

Analysis of the Observed Earthquake Response of a Multiple Span Bridge

J.C. Wilson

Ph.D. Thesis, California Inst. of Technology, 167 pp (1984), DA8420842

KEY WORDS: Bridges, Earthquake response, Experimental data, Time domain method, Finite element technique

The structure studied is the San Juan Bautista 156/101 Separation Bridge. A time-domain technique of system identification was used to determine linear models. A three-dimensional finite element model that includes soil-structure interaction predicts several important features of the dynamic response of the bridge.

BUILDINGS

85-877
Three-Dimensional Response of a Pile-Supported Multistory Building to Seismic Disturbances
J.U. Khandoker
Ph.D. Thesis, Univ. of Missouri-Rolla, 179 pp (1984), DA8418565

KEY WORDS: Multistory buildings, Seismic response, Pile structures, Soil-structure interaction

An analytical model and the associated FORTRAN program for obtaining the seismic response of three-dimensional soil-structure and soil-pile-structure systems are presented. A generalized curve description model to describe the nonlinear stress-strain relation of soils and other similar materials is proposed. The seismic response of a ten-story building with different support conditions was investigated.

TOWERS

85-878
Stochastic Seismic Analysis of Offshore Towers
A. Cerami
Istituto di Scienza delle Costruzioni, Facoltà di Ingegneria, Universita di Palermo, V.le delle Scienze, 90128 Palermo, Italy
Meccanica, 19 (3), pp 234-241 (Sept 1984), 8 figs, 2 tables, 16 refs

KEY WORDS: Towers, Off-shore structures, Seismic response, Stochastic processes

Offshore towers submerged in water and subjected to strong earthquake motions is proposed. Nonlinear drag effects and stationary seismic excitations are considered by a linearization technique. Standard deviations of nodal displacements and velocities are evaluated. The probability of not exceeding a defined threshold of nodal displacements is computed.

FOUNDATIONS

85-879
Global-Local Finite Element Analysis of Steady Soil-Structure Interaction
V. Avanessian
Ph.D. Thesis, Univ. of California, Los Angeles, 114 pp (1984), DA8420143

KEY WORDS: Finite element technique, Soil-structure interaction

The global-local finite element method (GLFEM) is applied to the dynamic soil-structure interaction problem. The global functions are spherical wave functions. Integral constraints placed on the global functions were incorporated. Results compared favorably with available analytical solutions for a frictionless surface plate.

POWER PLANTS

85-880
Effect of Creep-Fatigue Damage Relationships Upon HTGR Heat Exchanger Design
M.M. Kozina, J.H. King, M. Basol

GA Technologies, Inc., San Diego, CA
Rept. No. GA-A-17460, CONF8404125-1, 13 pp (Apr 1984) DE84008856

KEY WORDS: Fatigue life, Heat exchangers, Nuclear reactors

Materials for heat exchangers in the high temperature gas-cooled reactor (HTGR) are subjected to cyclic loading. Therefore, fatigue life must be considered in terms of creep-fatigue interaction. The high-temperature components affected are the tubing and the superheated steam tubesheet of Alloy 800H. The effects of revised creep-fatigue damage relationships were evaluated.

85-881
Structural Reliability Analysis and Seismic Risk Assessment
H. Hwang, M. Reich, M. Shinozuka
Brookhaven National Lab., Upton, NY
Rept. No. BNL-NUREG-34502, CONF-840647-15, 6 pp (1984) DE84010891

KEY WORDS: Nuclear reactors, Seismic response

With this method it is possible to estimate the limit-state probability in the lifetime of structures and to generate analytically the fragility curves for PRA studies. Results of reliability analysis of a containment subjected to dead load, and ground earthquake acceleration are presented; a fragility curve for PRA studies is constructed.

85-882
Seismic Fluid-Structure Interaction Analysis of a Large LMFBR Reactor
D.C. Ma, J. Gvildys, Y.W. Chang
Argonne National Lab., IL
Rept. No. CONF-840647-5, 43 pp (1984) DE84006442

KEY WORDS: Fluid-structure interaction, Nuclear reactors, Seismic response

The seismic analysis includes fluid-structure interactions for a large LMFBR reactor with many internal components and structures. An axisymmetrical model was used for the vertical excitation analysis; a three-dimensional model was used for the horizontal excitation analysis. Important seismic effects such as fluid-structure interaction, free-surface sloshing and fluid coupling are included.

OFF-SHORE STRUCTURES

85-883
Elimination of Sub-Harmonic Resonances of Compliant Marine Structures
J.M.T. Thompson, J.S.N. Elvey
University College London, Gower St., London WCIE 6BT, UK
Intl. J. Mech. Sci., 26 (6-8), pp 419-426 (1984), 6 figs, 11 refs

KEY WORDS: Off-shore structures, Subharmonic oscillations, Damping effects

This paper shows how subharmonic resonances can be eliminated by increasing damping to a prescribed level or by varying other system parameters. The values of damping needed to eliminate all subharmonic motions are of the order of magnitude of those that could be achieved in realistic design situations.

VEHICLE SYSTEMS

GROUND VEHICLES

85-884
Noise Control of the Contemporary Transit Motorbus
M.C. Kaye
Tri-County Metropolitan Transportation District, Portland, Oregon
Rept. No. UMTA-OR-6-5-83-1, 131 pp (May 1984), PB84-212083

KEY WORDS: Buses, Noise control

This report summarizes work and finding of TRI-MET efforts. It contains information on pertinent noise sources and their control.

85-885
Aerodynamic Forces on Motor Vehicles. 1970-July 1984 (Citations from the NTIS Data Base)
NTIS, Springfield, VA
122 pp (Aug 1984), PB84-872712

KEY WORDS: Motor vehicles, Aerodynamic loads, Bibliograhies

Citations concern aerodynamic lift, drag, and side forces exerted on moving motor vehicles. Included are forces generated on moving motor vehicles by other vehicles. Many references pertain to drag reduction techniques. Aerodynamic forces include those exerted on the vehicle body, suspension system, steering and roadability factors, and air inlets for the engine.

85-886
A Hybrid Finite Element Method for Damage Tolerance Analysis
Pin Tong
Transportation Systems Ctr., DOT, Cambridge, MA 02142
Computers Struc., 19 (1/2), pp 263-269 (1984), 3 figs, 1 table, 9 refs

KEY WORDS: Finite element technique, Fracture properties, Transportation vehicles, Stiffened structures

This method is used to calculate crack tip stress intensity and stiffener stress concentration factors of a stiffened structure. The approach combines the versatility of the finite element method and the efficiency and accuracy of analytical solution.

SHIPS

85-887
Hamilton's Principle, Lagrange's Method, and Ship Motion Theory
T. Miloh
Tel-Aviv Univ., Tel-Aviv, Israel
J. Ship Res., 28 (4), pp 229-237 (Dec 1984), 54 refs

KEY WORDS: Lagrange equations, Ships

Lagrange's equations of motion, describing the motion of several bodies on or below a free surface, are derived from Hamilton's variational principle. The Lagrangian density is obtained by extending Luke's principle to the wave-radiation problem.

85-888
Dynamic Loads on Ship Hill and Internal Structure of Membrane Type LNGC
Mitsubishi Heavy Industries Ltd., Tokyo, Japan
Mitsubishi Juko Giho, 21 (2), pp 92-100 (1984), PB84-200401 (In PB84-200351) (In Japanese)

KEY WORDS: Ship hulls

This report outlines research on dynamic loads on ship hulls and internal structure of the membrane type LNGC. The contents include a general survey of dynamic loads, estimation of wave loads, hydrodynamic pressure and accelerations. Also included were consideration of the combined stress induced by hull girder wave bending moment, internal pressure and external pressure, and estimation of sloshing loads.

AIRCRAFT

85-889
Application of the Finite Element Technique to Aerodynamic Problems of Aircraft
M. Hashimoto, S. Suzuki, K. Nakamura

Mitsui Engrg. and Shipbuilding Co., Ltd., Tamano, Okayama, Japan
Computer Struc., 19 (1/2), pp 57-69 (1984), 21 figs, 25 refs

KEY WORDS: Aircraft, Aerodynamic analysis, Finite element technique

Finite element techniques combined with the collocation method are formulated used to obtain numerical solutions for the integral equation that determines the airload acting on the wings, body, and other components of an aircraft. Examples include not only the steady airload over a rectangular wing with partial-span flap but also the unsteady airload over a rectangular wing oscillating in the first bending mode.

85-890
Calculation of the Forces Acting Upon a Rigid Structure from an Aircraft Impact
J.W. Gardner
Safety & Reliability Directorate, Wigshaw Lane, Culcheth, Warrington, WA3 4NE, UK
Intl. J. Impact Engrg., 2 (4), pp 345-356 (1984), 8 figs, 7 refs

KEY WORDS: Crash research (aircraft)

This numerical method permits calculation of the loads produced by an aircraft impacting on a rigid structure at an arbitrary angle. Three flight trajectory distributions are studied that are relevant to crashes. It is concluded that the application of the normal load case in a design code is conservative in nature, corresponding to a 90% confidence level for the flight trajectory distributions likely to occur.

85-891
Application of an Adaptive Blade Control Algorithm to a Gust Alleviation System
S. Saito
NASA Ames Res. Ctr., Moffett Field, CA 94035
Vertica, 8 (3), pp 289-307 (1984), 13 figs, 4 tables, 19 refs

KEY WORDS: Helicopters, Wind-induced vibrations, Control simulation

This control system is based on discrete optimal control theory. It is composed of a set of measurements, an identification system using a Kalman filter, a control system based on the minimization of the quadratic performance function, and a simulation system of the helicopter rotor. The gust models are step and sinusoidal vertical gusts. The adaptive blade pitch control algorithm satisfactorily alleviates the hub gust response.

85-892
Automatic Generation of Helicopter Rotor Aeroelastic Equations of Motion
M.P. Gibbons, G.T.S. Done
The Florida State Univ., Tallahassee, FL 32306
Vertica, 8 (3), pp 229-241 (1984), 5 figs, 8 refs

KEY WORDS: Helicopters, Aeroelasticity, Equations of motion, Computer-aided techniques

The method allows much of the tedious algebraic manipulation required in formulating aeroelastic equations of motion to be effectively performed by the computer. The basic approach is outlined. Results for a simple rotor model allow assessment of the numerical accuracy.

85-893
Development of Basic Methods Needed to Predict Helicopter Aeroelastic Behaviour
R. Dat
ONERA, -B.P. 72 92322 Chattillon Cedex, France
Vertica, 8 (3), pp 209-228 (1984), 18 figs, 26 refs

KEY WORDS: Helicopter vibration, Aeroelasticity

The problems of structural dynamics, blade unsteady aerodynamic forces, stability, and forced vibrations of coupled rotor-fuselage structure are discussed. Peculiarities of the basic calculation methods developed at ONERA in cooperation with the Aerospatiale are shown. Some of the methods have been derived from formulations used by fixed wing specialists.

350 Ecureuil are presented. The reduction in vibration level is quite significant and weight saving.

85-894
Towards a Better Understanding of Helicopter External Noise
A. Damongeot, F. Dambra, B. Masure
Societe Nationale Industrielle Aerospatiale, Marignane, France
Rept. No. SNIAS-832-210-113, 15 pp (1983), N84-26388

KEY WORDS: Helicopter noise, Noise source identification

A survey of noise sources that contribute to total external noise of a helicopter is carried out. Noise sources considered are rotor rotational noise, engine noise, and rotor broadband noise. Noise source levels are assessed by band analysis of ground microphone recordings, ground measurements of engine noise, and theoretical means.

85-896
Design and Development of an Automatically Controlled Variable-Load Energy Absorber
J.C. Warrick, J.W. Coltman
Simula, Inc., Tempe, AZ
Rept. No. TR-83423, NADC-82025-60, 71 pp (Mar 1984), AD-A142 683

KEY WORDS: Energy absorption

This model contained an acceleration-sensing device capable of automatic control to compensate for different occupant weight. Crash tests were performed in which the hardware successfully decelerated weights representing those of the 5th through 95th percentile occupants to a predetermined constant acceleration.

MECHANICAL COMPONENTS

ABSORBERS AND ISOLATORS

85-895
SARIB Vibration Absorber
P. Jege, G. Genoux
Societe Nationale Industrielle Aerospatiale, Marignane, France
Rept. No. SNIAS-832-210-104, 13 pp (1983), N84-26058

KEY WORDS: Vibration absorption (equipment), Aircraft

Vibration absorber systems under study or installed on Aerospatiale's and other various aircraft are reviewed. Results of the flight tests performed on SARIB I and II vibration absorbers as mounted on the AS

85-897
Protecting Electronic Equipment from Shock and Vibration
D.T. Lilley
E-A-R Div. of Cabot Corp., Indianapolis, IN
Mach. Des., pp 70-73 (Jan 24, 1985), 7 figs

KEY WORDS: Electronic instrumentation, Material damping, Shock isolation, Vibration isolation

Space constraints in electronic equipment limit the amount of protection that elastomeric mounts can provide against shock and vibration. Usually, the most effective isolation is provided by highly damped materials.

TIRES AND WHEELS

85-898
Arbitrary Motions in Long Cylindrical Squeeze Films: Numerical Model and Experimental Validation
R.J. Rogers, A.C.M. Sousa, T.B. Qureshi

Univ. of New Brunswick, Fredericton, Canada
IMechE, Proc., 198 (12), pp 137-143 (1984), 6 figs, 2 tables, 16 refs

KEY WORDS: Squeeze film bearings, Transient excitation, Finite difference technique, Experimental data

Dynamically loaded cylindrical squeeze films are analyzed by a finite difference technique to predict transient fluid velocity, pressure fields, and the resulting squeeze force. Apart from neglecting axial flow, no assumptions are made with respect to the relative magnitudes of terms in the flow equations. Squeeze-force data show reasonable agreement with numerical results obtained for five orbit cases.

BLADES

85-899
Propeller Noise at Subsonic Blade Tip Speeds, Torque and Thrust Force
R. Stuff
European Space Agency, Paris, France
Rept. No. ESA-TT-821, DFVLR-MITT-82-17, 84 pp (Nov 1983), N84-26385

KEY WORDS: Propeller blades, Noise generation

A detailed investigation of the generation of sound and noise arising from propeller blade forces was made. An acceleration potential was used in the mathematical treatment. Analytical solutions were obtained for the sound field of a propeller in yaw with asymmetric disk loading.

BEARINGS

85-900
On the Role of a Compliant Surface in Long Squeeze Film Bearings
R.H. Buckholz
Columbia Univ., New York, NY 10027
J. Appl. Mech., Trans. ASME, 51 (4), pp 885-891 (Dec 1984), 2 figs, 13 refs

KEY WORDS: Squeeze film bearings, Elastomeric bearings

Compliant surface journal bearings with large slenderness ratio are analyzed for small journal eccentricities. The elastic circular cylinder has a large axial length compared to its diameter. Discrete distributions of singularities are used to represent the coupled fluid and elastic deformation. Surface stress traction vectors are matched at the liquid-solid interface. Explicit expressions for changes of the fluid-film gap due to rubber deformation and the associated change in fluid-film pressure are presented.

85-901
Effect of Outer Race Misalignment on the High Speed Performance of Ball Bearings
K. Seki
National Aerospace Lab., Tokyo, Japan
Rept. No. NAL-TR-786, 33 pp (Nov 1983), N84-26028 (In Japanese)

KEY WORDS: Ball bearings, Alignment

Experiments were conducted to determine the allowable limiting dn values and the running performance of deep-grove ball bearings (type 6220) operating at dn values ranging from .000005 to .0000025 under thrust load of 1,000 kgf. Frictional torque, temperature rise, and contact electric resistance were measured at various tilt angles of outer race with respect to inner race.

85-902
The Influence of Tilting Pad Bearing Clearance on Rotor Response of a Steam Turbine
B.C. Howes, D.D. Leung
Beta Machinery Analysis Ltd., Calgary, Alberta, Canada
Machinery Dynamics Seminar, Proc. of the 8th, Oct 1-2, 1984, Halifax, Canada. Spon-

sor: National Res. Council Canada, NRC No. 23619, pp 23.0-23.20, 14 figs

KEY WORDS: Tilt pad bearings, Ste- turbines

Field measurements of a steam turbine show responses during runup and coast-down. One bearing was destroyed due to prolonged operation close to the critical speed. In another case the unit was runup without damaging the bearing. Plots of vibration data including bode, Nyquist, waterfall spectra, orbit cascade, and speed vs time.

GEARS

85-903
Dynamics of Early Planetary Gear Trains
R. August, R. Kasuba, J.L. Frater, A. Pintz
Cleveland State Univ., Cleveland, OH
Rept. No. NASA-CR-3793, 233 pp (June 1984), N84-26027

KEY WORDS: Gears, Computer programs

A variable-variable mesh stiffness (VVMS) model was used to simulate the external and internal spur gear mesh behavior; an equivalent conventional gear train concept was adapted for dynamic studies. The method is incorporated into a computer program so that the static and dynamic behavior of individual components can be examined. The computer program was used to determine the effect of manufacturing errors, damping and component stiffness, and transmitted load on dynamic behavior.

COUPLINGS

85-904
Torsional Damping -- Transient and Steady State
R.N. Brown
Dow Chemical Co., Houston, TX
Proc., 13th Turbomachinery Symp., Texas A&M Univ., College Station, TX, Nov 1984, pp 203-208, 9 figs, 17 refs

KEY WORDS: Couplings, Torsional vibrations, Vibration damping, Tuning,

Many systems have torsional natural frequencies within the operating range, and operational problems often result. The coupling is a convenient location in the train to make torsional changes with a minimum effect on other system parameters. These modifications can incorporate a stiffness correction, the addition of damping, or both in order to torsionally tune the system for reliable operation.

85-905
The Manufacturer's World of Coupling Potential Unbalance
J.R. Mancuso
Zurn Industries, Inc., Erie, PA
Proc., 13th Turbomachinery Symp., Texas A&M Univ., College Station, TX, Nov 1984, pp 97-104, 11 figs, 5 tables, 4 refs

KEY WORDS: Couplings, Unbalanced mass response, Turbomachinery

Coupling balance is important to vibration-free operation of turbomachinery. Understanding the way a coupling affects vibration is the purpose of this paper. Topics include the basics of balancing, why a coupling is balanced, what contributes to unbalance in a coupling, and how to bring a coupling into balance. Also included are when to balance a coupling and to what level, coupling balance limits, the arbitrary balance criteria, and the various types of coupling balance.

LINKAGES

85-906
Steady-State Vibrational Response of High-Speed Flexible Mechanisms
W.L. Cleghorn, R.G. Fenton, B. Tabarrok
Univ. of Manitoba, Winnipeg, Manitoba, Canada R3T 2N2

Mech. Mach. Theory, 19 (4/5), pp 417-423 (1984), 9 figs, 16 refs

KEY WORDS: Mechanisms, Periodic response

This procedure is used to determine a steady state solution for governing finite element equations of high-speed flexible mechanisms, that operate with constant input rotational speed. Periodically-varying components of the governing equations are represented by truncated Fourier series. A system of linear equations is solved for the harmonic coefficients of the response. The procedure is tested by comparing calculated responses with previously published experimental results.

85-907
Material Selection: An Important Parameter in the Design of High-Speed Linkages.
C.K. Sung, B.S. Thompson
Michigan State Univ., East Lansing MI 48824
Mech. Mach. Theory, 19 (4/5), pp 389-396 (1984), 7 figs, 26 refs

KEY WORDS: Linkages, Design techniques, Materials

This parametric study demonstrates the advantages of using ultra-high-strength fiber-reinforced composites. Dynamic responses of flexible four-bar linkages manufactured in three different materials (steel, aluminum, and a graphite-epoxy laminate) are simulated. The mechanisms are analyzed using a displacement finite element model; the equations of motion are solved by numerical integration.

STRUCTURAL COMPONENTS

BARS AND RODS

85-908
Longitudinal and Torsional Oscillations on a Rod in a Non-Newtonian Fluid
K.R. Rajagopal
Univ. of Pittsburgh, Pittsburgh, PA 15261
Acta Mech., 49 (3/4), pp 281-285 (1983), 15 refs

KEY WORDS: Rods, Longitudinal vibration, Torsional vibration, Fluid-induced excitation

The problem of an infinite rod undergoing both torsional and longitudinal oscillations in an incompressible and homogeneous fluid of second grade is studied.

85-909
Oscillatory Structured Shock Waves in a Nonlinear Elastic Rod with Weak Viscoelasticity
N. Sugimoto, Y. Yamane, T. Kakutani
Osaka Univ., Toyonaka, Osaka 560, Japan
J. Appl. Mech., Trans. ASME, 51 (4), pp 766-772 (Dec 1984), 4 figs, 9 refs

KEY WORDS: Rods, Viscoelastic properties, Shock waves, Wave propagation

The approximate equation is derived by taking account of not only the finite deformation but also the lateral contraction or dilatation of rod. Structures of steady shock waves are investigated, one is the exponential function type and the other the power function type. The effect of geometrical dispersion is emphasized. A brief discussion is included on the simplified evolution equations for far field behavior.

BEAMS

85-910
Some Closed-Form Solutions in Random Vibration of Bernoulli-Euler Beams
I. Elishakoff, D. Livshits
Technion-Israel Inst. of Technology, Haifa, Israel
Intl. J. Engrg. Sci., 22 (11/12), pp 1291-1302 (1984), 9 refs

KEY WORDS: Beams, Bernoulli-Euler method, Random vibration

Closed-form solutions are found for uniform, simply-supported beams subjected to a stationary excitation that is white both in space and time. The beams possess either structural, Voigt, or rotary damping mechanisms. Expressions are obtained for the space-time correlation functions of displacement, velocity and stress. The closed form solution is obtained for the probabilistic characteristics of a beam under a number of separate or combined dampings.

85-911

Dynamic Elasto-Plastic Response of Beams -- A New Model

D.Z. Yankelevsky, A. Boymel

Technion, Haifa 32000, Israel

Intl. J. Impact Engrg., 2 (4), pp 285-298 (1984), 8 figs, 3 tables, 13 refs

KEY WORDS: Beams, Elastic-plastic properties, Dynamic structural analysis

The model beam is composed of two rigid parts connected by a gap of zero width built of fibers having an imaginary length. Comparison of predicted final deflections with test results shows good correspondence. The model also calculates the time dependence of the dynamic reactions, being moment and membrane force, displacement, velocity and acceleration, and stress and strain distributions at selected times.

85-912

Dynamic Optimization of a Sandwich Beam

E.A. Sadek

Cairo Univ., Egypt

Computers Struc., 19 (4), pp 605-615 (1984), 8 figs, 4 tables, 4 refs

KEY WORDS: Beams, Sandwich structures, Minimum weight design, Frequency constraints

The approach is to modify an initial design by varying the thickness of each layer using gradient equations and minimizing weight. The gradient equations are derived in matrix notation suitable for digital computers. The equations of motion include all higher order effect. The method is convergent, and optimized configurations can be determined in a few redesign cycles.

85-913

Effects of Warping and Pretwist on Torsional Vibration of Rotating Beams

K.R.V. Kaza, R.E. Kielb

Lewis Res. Ctr., Cleveland, OH 44135

J. Appl. Mech., Trans. ASME, 51 (4), pp 913-920 (Dec 1984), 1 fig, 4 tables, 23 refs

KEY WORDS: Beams, Warping, Geometric imperfection effects, Torsional vibration

The equations of motion and the associated boundary conditions are derived. Results indicate the effects of warping, pretwist, and rotation on torsional vibration of beams as aspect ratio is varied. Results show that the structural warping and pretwist terms have a significant effect on torsional frequency and mode shapes of short-aspect-ratio blades.

CYLINDERS

85-914

Three-Dimensional Analysis of Axisymmetric Transient Waves in Hollow Elastic Cylinders

P. A. Svardh

Uttervagen 11, S-72242 Vasteras, Sweden

J. Appl. Mech., Trans. ASME, 51 (4), pp 792-797 (Dec 1984), 5 figs, 1 table, 30 refs

KEY WORDS: Cylinders, Wave propagation, Transient waves

The axially symmetric problem of a semi-infinite, hollow, linear-elastic circular cylinder with traction-free lateral surfaces initially at rest and subjected to transient end loadings is solved using three-dimensional theory. An axial pressure is applied to a radially clamped end, and a prescribed axial velocity is applied to an end that is free from shear stress. A double integral transform technique is used. Asymptotic solutions valid at large distances from the end are given for two time variations of the end loadings: step function and finite rise-time function.

FRAMES AND ARCHES

85-915
Asymmetrically Loaded Portal Frames
G.J. Simitses, J. Giri
Georgia Inst. of Technology, Atlanta, GA 30332
Computers Struc., 19 (4), pp 555-558 (1984), 4 figs, 1 table, 2 refs

KEY WORDS: Frames, Parametric excitation, Asymmetric excitation, Nonlinear theories

Nonlinear analysis of a symmetric portal frame, loaded asymmetrically by eccentric concentrated loads, is presented. Parametric studies include the effect of bar slenderness ratio and of load eccentricity (asymmetric) on the frame response characteristics. The effect of support rotational restraint stiffness on the sway buckling load is assessed. One important conclusion is that the effect of bar slenderness ratio on the nondimensionalized response is extremely small.

85-916
Vibration Analysis of Frames with Semi-Rigid Connections
S. Kawashima, T. Fujimoto
Kyushu Sangyo Univ., 327, Matsukadai 2-chome, Higashi-ku, Fukuoka City, 813, Japan
Computers Struc., 19 (1/2), pp 85-92 (1984), 7 figs, 3 tables, 7 refs

KEY WORDS: Frames, Joints (junctions), Natural frequencies, Mode shapes

Semi-rigid connections between members of frame structures are idealized as rotational and linear springs. The physical model representing each member is assumed to consist of a flexible beam with springs and dashpots attached at both ends. The dynamic stiffness matrix of a uniform beam element in bending is obtained. The direct stiffness method for vibration analysis of frames with rigid joints can be applied to those with semi-rigid joints. Computed natural frequencies and normal modes compare favorably with those obtained by experiments.

85-917
Dynamics of Trusses by Component-Mode Method
C.L. Loh
Ph.D. Thesis, Stanford Univ., 133 pp (1984) DA8420583

KEY WORDS: Trusses, Component mode synthesis, Flexural vibration

The purpose of this investigation is to examine the effects of flexure on the dynamic response of trusses. A component-mode analytical model for trusses is programmed for a digital computer. For plane and space trusses with only a few members, flexure plays an important role in the dynamic response of the structures. In trusses with many members this influence is not very important because the flexural effects in the members are localized.

PANELS

85-918
An Analytical Study of Nonlinear Response of Shear Buckled Rectangular Panels to Random Excitation
H. Suemasu, S. Kobayashi
Univ. of Tokyo, Komaba, Tokyo 153, Japan
Computers Struc., 19 (1/2), pp 213-223 (1984), 15 figs, 7 tables, 8 refs

KEY WORDS: Rectangular panels, Random excitation, Transverse shear deformation effects, Acoustic fatigue

A simulation method is used to determine the effects of shear buckling and antisymmetric mode on sonic fatigue. Simultaneous nonlinear equations are derived using a variational principle derived from the principle of virtual work and the Lagrange multiplier method. The plate is treated as a linear viscoelastic material for damping. Fatigue life is calculated with a cumulative damage rule. The larger the pressure the smaller the effect of shear buckling on the response of the deflection. However, the influence on the response of the strain does not become small. Fatigue life is shortened by shear buckling for each pressure level.

PLATES

85-919
Nonlinear Dynamic Buckling of Imperfect Rectangular Plates with Deformable Loaded Edges
H. Pasic, G. Herrmann
Stanford Univ., Stanford, CA 94305
Computers Struc., 19 (1/2), pp 155-164 (1984), 8 figs, 18 refs

KEY WORDS: Rectangular plates, Dynamic buckling, Nonlinear theories

This paper contains a solution for a rectangular plate for two different sets of boundary conditions. The exact solution for the in-plane displacements is found under the assumption that the system has only one degree of freedom. The deformability of the loaded edges should be taken into account for square-shaped plates; for long rectangular plates this effect can be disregarded.

85-920
Transverse Vibrations of Orthotropic, Nonhomogeneous Rectangular Plates
P.A.A. Laura, R.H. Gutierrez
Inst. of Applied Mechanics, 8111, Puerto Belgrano Naval Base, Argentina
Fibre Science Tech., 21, pp 125-133 (1984), 3 figs, 2 tables, 5 refs

KEY WORDS: Rectangular plates, Flexural vibration, Ritz method

Transverse vibrations of orthotropic, nonhomogeneous rectangular plates elastically restrained against rotation are studied in a symmetric fashion using the Ritz method and simple polynomial coordinate functions. The latter approximates the dynamic plate response. The same approach can be used to analyze a forced vibration situation.

85-921
Vibrations of Orthotropic Rectangular Plates
G.W. Caldersmith
48 Denny St., Latham, A.C.T., 2615, Australia
Acustica, 56 (2), pp 144-152 (Oct 1984), 1 fig, 4 tables, 15 refs

KEY WORDS: Rectangular plates, Flexural vibrations, Torsional vibrations

A practical theory of rectangular orthotropic plate vibrations is developed from an interpretation of the bending and twisting forces induced by certain vibrational mode displacements. The theory infers a unified method of gathering the data necessary to determine mode frequency and internal damping of any rectangular plate mode. It specifies the relative magnitude of bending and twisting forces occurring in the natural mode deformations of free and boundary-supported plates. A simple formula for calculating the plate twisting modulus is available. Interaction of free plate modes via the Poisson contraction is described.

85-922
Free Vibration of a Cantilever Folded Plate
T. Irie, G. Yamada, Y. Kobayashi
Hokkaido Univ., Sapporo, 060 Japan
J. Acoust. Soc. Amer., 76 (6), pp 1743-1748 (Dec 1984), 6 figs, 5 refs

KEY WORDS: Cantilever plates, Natural frequencies, Mode shapes, Cantilever beams

An analysis is presented for the free vibration of a cantilever folded plate. Deflection displacements of the plate are written in a series of products of eigenfunctions of a cantilever beam and a cranked free-free beam parallel to the clamped edge of the plate. Kinetic and strain energies of the plate are evaluated; frequency equations are derived by the Ritz method. The method is applied to cantilever folded plates with and without structural symmetry. The natural frequencies and mode shapes of vibration are calculated numerically.

85-923

The Generation of Waves in a Semi-Infinite Plate by a Smooth Oscillating Piston

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Univ. of Manchester, Manchester, England M13 9PL

J. Appl. Mech., Trans. ASME, 51 (4), pp 787-791 (Dec 1984), 6 figs, 7 refs

KEY WORDS: Wave generation, Plates, Pistons

The oscillating piston is in smooth contact with the edge of the plate. The exact (linearized) solution is obtained as a series expansion involving the Rayleigh-Lamb modes of the plate; the coefficients are determined by a biorthogonality relation. Amplitude of the resultant force exerted by the piston, mean total rate of working of the piston, and proportion of outgoing energy in each available propagating modes are computed. Resonances are observed at certain cut-off frequencies.

85-924

Nonlinear Vibration of Thin Elastic Plates, Part 1: Generalized Incremental Hamilton's Principle and Element Formulation

S.L. Lau, Y.K. Cheung, S.Y. Wu
Hong Kong Polytechnic, Hong Kong

J. Appl. Mech., Trans. ASME, 51 (4), pp 837-844 (Dec 1984), 4 figs, 4 tables, 16 refs

KEY WORDS: Plates, Nonlinear theories, Hamiltonian principle, Finite element technique

A simple triangular incremental modified Discrete Kirchhoff Theory plate element with 15 stretching and bending nodal displacements is derived. The accuracy of this element is demonstrated using typical examples of nonlinear bending and frequency response of free vibrations. Comparisons with previous results are made.

85-925

Nonlinear Vibration of Thin Elastic Plates, Part 2: Internal Resonance by Amplitude-Incremental Finite Element

S.L. Lau, Y.K. Cheung, S.Y. Wu
Hong Kong Polytechnic, Hong Kong

J. Appl. Mech., Trans. ASME, 51 (4), pp 845-851 (Dec 1984), 8 figs, 8 refs

KEY WORDS: Plates, Nonlinear theories, Internal resonance, Finite element technique

The simple amplitude-incremental triangular plate element is applied to the large-amplitude periodic vibrations of thin elastic plates with internal resonance. A simply supported rectangular plate with immovable edges and linear frequencies is used. The frequency responses of free vibration and forced vibration under harmonic excitation are computed. These results have not appeared previously. Considerations to simplify and speed up the numerical process are discussed.

85-926

A Variational Approach to the Dynamics of Structures Having Mixed or Discontinuous Boundary Conditions

P.J. Torvik
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J. Appl. Mech., Trans. ASME, 51 (4), pp 831-836 (Dec 1984), 4 figs, 19 refs

KEY WORDS: Plates, Boundary condition effects, Natural frequencies, Variational methods

The steady-state forced response and modes of free vibration for elastic systems

having mixed or discontinuous boundary conditions is determined. Approximate solutions are obtained as a superposition of a set of functions. The coefficients of this expansion are obtained through a variational principle developed from Hamilton's principle. The reduction from the general elastic solid to the elastic plate is given, as are results obtained for several natural frequencies of an elastic circular plate free on a portion of the boundary and clamped on the remainder.

85-927
Signaling Along Elastic Plates with Wide-band Acoustic Pulses
J.E. Barger
Bolt Beranek and Newman, Inc., Cambridge, MA 02139
J. Acoust. Soc. Amer., 76 (6), pp 1721-1730 (Dec 1984), 7 figs, 12 refs

KEY WORDS: Plates, Acoustic pulses

This paper derives analytical expressions for arrival times, peak envelope amplitudes, and center frequencies of arriving component pulses transmitted by wideband line forces acting normal to a plate surface. Each component pulse is the manifestation of a different mode of propagation. A series of photographs show transmitted Gaussian pulses when the pulse center frequency is picked to illustrate three regimes: the Rayleigh wave is not formed, is partially formed, and is fully formed.

85-928
Elasto-Plastic Analysis of Steel Plate Subjected to Irregularly Varying Cyclic Loads
J. Suhara
Kyushu Univ., Hakozaki, Higashiku, Fukuoka, 812, Japan
Computers Struc., 19 (1/2), pp 225-238 (1984), 20 figs, 1 table, 27 refs

KEY WORDS: Plates, Elastic-plastic properties, Discontinuity-containing media, Cyclic loading, Fatigue life

This paper reviews studies on elastoplastic analysis of steel plates subjected to varying cyclic loads. Constitutive equations are obtained using an anisotropic hardening model, the yield surface theory of plasticity, and a simulation algorithm for uniaxial loading tests. The theory is used to predict the low cycle fatigue endurance of notched and cracked plates. Possibility of extending this method to irregularly varying loads is investigated.

SHELLS

85-929
Systems Analysis of a Large Rotary Kiln Subject to Torsional Vibrations
D.A. Fenton
Vibratek Services, Inc.
Machinery Dynamics Seminar, Proc. of the 8th, Oct 1-2, 1984, Halifax, Canada. Sponsor: National Res. Council Canada, NRC No. 23619, pp 11.1-11.21, 12 figs, 1 table, 6 refs

KEY WORDS: Shells, Kilns, Driveline vibrations, Torsional vibrations, Elastomeric dampers

This paper describes problems of a drive train and kiln shell due to large amplifications of torque; excitations in the drive train coincided with natural frequencies of drive train and kiln shell. Drive train components were modified to produce optimum damping in the system. Natural frequencies were shifted by adding elastomeric couplings to the drive train and structurally reinforcing of the kiln shell.

85-930
Free Vibration of a Circular Cylindrical Double-Shell System Interconnected by Several Springs
T. Irie, G. Yamada, T. Tanaka
Hokkaido Univ., Sapporo, 060, Japan
J. Sound Vib., 95 (2), pp 249-259 (July 22, 1984), 6 figs, 2 tables, 15 refs

KEY WORDS: Cylindrical shells, Springs, Natural frequencies, Mode shapes

The governing equations of vibration of a circular cylindrical shell are written as a coupled set of first-order differential equations by using the transfer matrix of the shell. The entire structure matrix is obtained, and the frequency equation of the system is derived. The method is applied to free-clamped double-shell systems composed of two coaxial cylindrical shells. The natural frequencies and the mode shapes of vibration are calculated numerically.

85-931
Vibrations of Corner Point Supported Shallow Shells of Rectangular Planform
Y. Narita, A.W. Leissa
Computer Ctr., Hokkaido Inst. of Technology, Teine Maeda 419-2, Sapporo 061-24, Japan
Earthquake Engrg. Struc. Dynam., 12 (5), pp 651-661 (Sept/Oct 1984), 9 figs, 10 refs

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

The ritz method is used; algebraic polynomials form a set of trial functions. Convergence is relatively slow requiring more terms than for completely free shells. The class of problems studied includes independent, constant curvature in each of the directions parallel to the edges; vibration modes fall into one of four symmetry classes. Accuracy of results is partially established by comparison with other previously published results for the corner supported flat square plate.

85-932
Vibrations of a Combined System of Circular Plates and a Shell of Revolution
T. Kosawada, K. Suzuki, S. Takahashi
Yamagata Univ., Yonezawa, Japan
Bull. JSME, 27 (23), pp 1983-1989 (Sept 1984), 10 figs, 10 refs

KEY WORDS: Shells of revolution, Circular plates

The Lagrangian of the combined system is expressed in quadratic forms of boundary values. Frequency equations can be obtained from the minimum conditions of that Lagrangian with respect to unknown boundary values. Effects of the circular plate lids and the ratio of thickness of the circular plate to that of the shell of revolution are clarified. Transfer phenomena of the mode shapes are also investigated.

85-933
Dynamic Instability of Suddenly Heated, Thick, Composite Shells
H. Ray, C.W. Bert
North Carolina A & T State Univ., Greensboro, NC 27411
Intl. J. Engrg. Sci., 22 (11/12), pp 1259-1268 (1984), 6 figs, 17 refs

KEY WORDS: Shells, Composite structures, Parametric resonance, Temperature effects

Parametric resonance type of dynamic instability is investigated for suddenly heated, long circular cylindrical shells of composite material. Effects of thickness shear flexibility and mid-surface extensibility are studied. Both long-term and short-term responses are investigated.

85-934
On Finite Oscillations of a Gas-Filled Radially Isotropic Elastic Spherical Shell
K. Mukherjee, S.K. Chakrabarty
Univ. of Burdwan, Burdwan, India
Intl. J. Engrg. Sci., 22 (11/12), pp 1303-1313 (1984), 2 figs, 2 tables, 11 refs

KEY WORDS: Spherical shells

The periods of finite radial oscillations of a transversely isotropic gas-filled spherical shell are obtained. Numerical calculations are based on a particular form of strain energy function and compared with the isotropic case.

85-935
Dynamic Stability of a Nonlinear Cylindrical Shell

A. Tylikowski
Warsaw Technical Univ., Warszawa, Poland 02-524
J. Appl. Mech., Trans. ASME, 51 (4), pp 852-856 (Dec 1984), 3 figs, 12 refs

KEY WORDS: Cylindrical shells, Dynamic stability

The shell is subjected to a time-varying axial compression and a uniformly distributed time-varying radial loading. It is established that the linearized problem should be modified to ensure the stability of the nonlinear shell. The case when the shell is governed by the Ito stochastic nonlinear equations is also discussed.

85-936
Sloshing Behavior of Floating-Roof Oil Storage Tanks
F. Sakai, M. Nishimura, H. Ogawa
Kawasaki Heavy Industries Ltd., Minami-suna, Koto-ku, Tokyo 136, Japan
Computers Struc., 19 (1/2), pp 183-192 (1984), 10 figs, 3 tables, 9 refs

KEY WORDS: Storage tanks, Sloshing, Fluid-induced excitation

Theory of fluid-elastic vibration was used to study the interaction between a roof and the contained liquid. The finite element method was applied; a technique based on the variational principle of boundary integrals was used to simplify the solution. The theory was verified by shake table experiments. Conclusions are: floating roofs hardly affect first natural mode of sloshing, influence of higher modes should be used to determine stresses of double deck floating roofs, and local deformation of lower deck plays a role in sloshing behavior.

85-937
Computer Modeling of Static and Dynamic Behavior of Cylindrical Liquid Storage Tanks
M.A.H. Tayel
Ph.D. Thesis, Univ. of California, Irvine, 206 pp (1984) DA8420273

KEY WORDS: Storage tanks, Fluid-filled containers, Seismic response

Static analysis is accomplished using numerical and analytical techniques. Effects of variations of wall thickness and boundary conditions at the tank base are examined. Free axisymmetric vibrations of liquid-filled tanks are evaluated analytically and numerically. The response to vertical excitation is computed numerically. It is concluded that the effect of vertical excitation should not be discarded in the dynamic analysis.

85-938
Seismic Models for Buried Tanks
A.J. Philippacopoulos, C.J. Costantino, C.A. Miller
Brookhaven National Lab., Upton, NY
Rept. No. BNL-NUREG-34542, CONF-840647-16, 9 pp (June 1984) DE84010886

KEY WORDS: Storage tanks, Fluid-filled containers, Underground structures, Seismic response, Sloshing

Numerical models to evaluate the seismic response of partially-filled buried flexible tanks are presented. Approximate sloshing and finite element models are used to estimate the response of the fluid. Transfer functions associated with the soil/tank/fluid system obtained by alternate methods are presented. Effects of fluid discretization on the seismic stresses of the tank are examined.

RINGS

85-939
In-Plane Vibrations of Rotating Sectors and Rings With and Without Radial Supports by Finite Element Method
K. Singh, B.P. Singh
Indian Inst. of Technology, Kanpur 208016, India
Computers Struc., 19 (4), pp 545-554 (1984), 6 figs, 5 tables, 26 refs

KEY WORDS: Rings, Rotating structures, Finite element technique, Rotational speed effects

The governing differential equations of motion for a ring or sector are modified to include the effects of rotational speed. The finite element equations are derived using the Galerkin method. A quintic polynomial satisfies the compatibility of derivatives up to second order and has been used for the ring finite element. The efficiency of the formation is illustrated by the numerical results presented.

85-940
Assessment of Structural Computer Code Implementation of PVRC Recommended Piping Damping Values
A.G. Ware
EG and G Idaho, Inc., Idaho Falls, ID
Rept. No. EGG-EA-6550, 35 pp (Mar 1984)
DE84011886

KEY WORDS: Piping systems, Seismic response, Damping coefficients, Computer programs

The Pressure Vessel Research Committee of the Welding Research Council recommends that structural damping for seismic analyses of piping systems be modified from the constant damping to higher damping values at low response frequencies Appropriate methods are described.

PIPES AND TUBES

85-941
Finite-Element Analysis of the Marine Riser
M.H. Patel, S. Sarohia, K.F. Ng
London Centre for Marine Technology, Univ. College London, London, UK
Engrg. Struc., 6 (3), pp 175-184 (July 1984), 5 figs, 4 tables, 20 refs

KEY WORDS: Marine risers, Finite element technique

A two-dimensional finite-element computational method is presented. This method determined marine riser displacements and stresses due to self-weight, buoyancy, internal and external pressures, surface vessel motions, and environmental forces arising from currents and waves. Use is made of a substructuring technique to reduce the number of degrees of freedom and, therefore, achieve a substantial reduction in computer time and storage without a discernible performance penalty.

85-942
Computer Programs Describing the Motions and Loads of an OTEC Cold Water Pipe and Associated Platforms
T.C. Wolford
National Ocean Service, Rockville, MD
Mag Tape COM/DF 84/001 (1982) PB84-212661

KEY WORDS: Computer programs, Pipes, Drilling platforms, Offshore structures

A quasi-linear frequency domain analysis of the coupled OTEC CW pipe and platform system has been developed. A finite element model of pipe structural dynamics is employed; the platform is modeled by contemporary ship or stable platform motion theory. Nonlinear fluid forces are included by the method of equivalent linearization. The procedure is able to represent various platform configurations and realistic directional random sea states.

85-943
WIPS (Whip and Impact of Piping Systems) - Computer Code for Whip and Impact Analysis of Piping Systems. Summary Report
G.H. Powell
Lawrence Livermore National Lab., CA
Rept. No. UCRL-15597-SUMM, 15 pp (June 1984), NUREG/CR-3686-SUM

KEY WORDS: Computer programs, Pipelines, Whipping phenomena, Impact response

WIPS has been developed primarily to provide support for the pipe whip analysis procedures described in Section 3.6.2 of the U. S. Nuclear Regulatory Commission Standard Review Plan. This report summarizes the purpose and scope of the WIPS development effort.

85-944
Dynamic Stresses and Displacements in Buried Pipe
S.K. Datta, A.H. Shah, K.C. Wong
Univ. of Colorado, Boulder, CO 80309
ASCE J. Engrg. Mech., 110 (10), pp 1451-1466 (Oct 1984), 14 figs, 13 refs

KEY WORDS: Pipes, Underground structures, Cylindrical shells, Soil-structure interaction

The pipeline is modeled as a circular cylindrical shell of small thickness. The incident disturbances are assumed to be plane waves moving perpendicular to the axis of the pipeline. Two problems are considered. The pipe is surrounded by a homogeneous soft soil; and the pipe lies in a cylinder of soft soil surrounded by a rock-like material.

85-945
Damping in LMFBR Pipe Systems
M.J. Anderson, D.A. Barta, M.R. Lindquist, E.J. Renkey
Hanford Engrg. Development Lab., Richland, WA
Rept. No. HEDL-SA-2959, CONF-840647-4, 16 pp (June 1983) DE84006546

KEY WORDS: Piping systems, Nuclear reactors, Damping coefficients

This paper presents results of in-situ vibration tests conducted on FFTF pipe systems. Pipe damping values obtained at various excitation levels are presented. Effects of filtering data to provide damping values at discrete frequencies and the alternate use of a single equivalent modal damping value are discussed. These tests confirm that damping in typical LMFBR pipe systems is larger than presently used in pipe design.

85-946
Seismic Response and Damping Tests of Small Bore LMFBR Piping and Supports
D.A. Barta, M.J. Anderson, L.K. Severud, M.R. Lindquist
Hanford Engrg. Development Lab., Richland, WA
Rept. No. HEDL-SA-3050, CONF-840647-12, 11 pp (Jan 1984) DE84008498

KEY WORDS: Nuclear reactors, Piping systems, Seismic response, Damping

Seismic testing and analysis of a prototypical Liquid Metal Fast Breeder Reactor (LMFBR) small-bore piping system are described. Measured responses to simulated seismic excitations are compared with analytical predictions. The test specimen was representative of a typical LMFBR insulated small bore piping system. It was supported from a rigid test frame by prototypic dead weight supports, mechanical snubbers and pipe clamps.

DUCTS

85-947
Some General Properties of the Exact Acoustic Fields in Horns and Baffles
L.M.B.C. Campos
Cambridge Univ., Silver Street, Cambridge CB3 9EW, UK
J. Sound Vib., 95 (2), pp 177-201 (July 22, 1984), 1 fig, 110 refs

KEY WORDS: Ducts, Variable cross section, Sound waves, Wave propagation

The propagation of the fundamental, longitudinal acoustic mode in a duct of variable cross-section is considered. The Webster wave equations for sound pressure and velocity are used to establish general properties of exact acoustic fields. Elementary exact solutions of the Webster equation exist only for catenoidal, sinusoidal, and inverse ducts.

BUILDING COMPONENTS

85-948

Experimental Research of a Post-Tensioned Prefabricated Aseismic Roof Structure

Du Gongchen, et al

China Civ. Engrg. J., 17 (1), pp 1-6 (1984), CSTA No. 624-84.29

KEY WORDS: Roofs, Industrial facilities, Seismic design

This paper introduces an aseismic roof construction for single story factory buildings with column grids. The primary precast members are partially prestressed concrete channel slab (1.5 x 12)m, roof beam and periphery members. The continuity and integrity of the roof structure are obtained by post-tensioned tendons and ordinary reinforcing bars placed along the longitudinal and transverse joints between slabs.

85-949

Use of Recompressed Impulse Response to Identify Sources and Paths of Structure-Borne Noise in Wide Flange I-Beams and Pipes Conveying Fluid

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U. S. Naval Academy, Annapolis, MD 21402

J. Sound Vib., 95 (4), pp439-467 (Aug 22, 1984), 10 figs, 32 refs

KEY WORDS: Beams, Pipes, Fluid-filled containers, Noise source identification

The use of impulse response or modified impulse response to estimate time delays frequently is of little value because the wave propagation is dispersive. If one can establish the dispersion law, one can recompress the impulse response with respect to length of paths. Experimental results are given.

85-950

The Influence of Sills and Reveals on Sound Transmission Loss

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Appl. Acoust., 17 (6), pp 453-476 (1984), 13 figs, 1 table, 8 refs

KEY WORDS: Sound waves, Wave transmission, Windows, Panels

Effects of sills and reveals on the transmission of sound through windows and panels are reviewed. New data are presented; a sill and reveal design guide is proposed for the purpose of increasing the sound transmission loss of windows or light panels.

DYNAMIC ENVIRONMENT

ACOUSTIC EXCITATION

85-951

Acoustic Characteristics of Orifice Holes Exposed to Grazing Flow

S. Kaji, M. Hiramoto, T. Okazaki

Univ. of Tokyo, Bunkyo-ku, Tokyo, Japan

Bull. JSME, 27 (233), pp 2388-2396 (Nov 1984), 18 figs, 1 table, 16 refs

KEY WORDS: Acoustic properties, Hole-containing media, Fluid-induced excitation, Impedance technique

The impedance tube method was applied; grazing flow was given by an open jet to avoid standing wave effects in the radiation field. A potential flow theory was presented on the radiation impedance of a tube opening exposed to a grazing flow. The flow region and the tube region were connected to satisfy the coincidence conditions of displacement and pressure at the opening. This theory predicted fairly well the experimentally obtained impedance.

85-952

Noise Generated by a Propeller in a Wake

P.J.W. Block

NASA Langley Res. Ctr., Hampton, VA
Rept. No. NASA-TM-85794, 65 pp (May 1984), N84-26382

KEY WORDS: Propellers, Noise generation

Propeller performance and noise were measured on two model scale propellers operating in an anechoic flow environment with and without a wake. Wakes were generated by an airfoil that spanned the full diameter of the propeller. Noise measurements were made in the relative near field of the propeller. Data show that up to a 10 dB increase in the OASPL results when a wake is introduced into an operating propeller. Performance data are also presented.

85-953
Demonstration of Airport Noise Impact Mitigation
P. Schomer
Schomer and Associates, Champaign, IL
Rept. No. ILENR/RE-83/25, 230 pp (June 1983), PB84-211978

KEY WORDS: Airports, Noise control

The Decatur Airport in Decatur, Illinois, was selected for this demonstration. Baseline conditions in terms of noise and land use were established along with predictions for the year 2000. Noise monitoring and an attitudinal study were performed. Generalized state-wide recommendations for mitigating present or potential noise impact are made.

85-954
Noise Control in Plumbing Systems
L.F. Yerges
Yerges Consulting Engineers, Downers Grove, IL
Heating/Piping/Air Cond., 57 (1), pp 111-115 (Jan 1985), 4 figs

KEY WORDS: Hydraulic systems, Pipelines, Sound generation, Noise control, Water

The problems of noise and vibration control in plumbing systems is investigated.

85-955
Equivalent Absorption Coefficient: A Parameter for Room Sound Pressure Level Prediction
M.S. Hundal
Univ. of Vermont, Burlington, VT 05405
J. Sound Vib., 95 (1), pp 49-54 (July 8, 1984), 4 tables, 6 refs

KEY WORDS: Rooms, Sound pressure levels, Prediction techniques

An equivalent absorption coefficient facilitates calculation of A-weighted sound pressure levels in rooms. Thus, for modeling the acoustic field only one set of calculations need be performed rather than a separate one for each octave band and eventual A-weighted summation.

85-956
Finite-Amplitude Reflection Wave of Circular Piston Sound Sources
Qian Zu-wen, et al
Acta Physica Sinica, 32 (9), pp 1109-1117 (1983), CSTA No. 534-8:65

KEY WORDS: Pistons, Sound waves, Wave reflection

The boundary wall of a pool has been used for some experiments on second harmonic reflection. The average attenuation of harmonic pressure with distance is consistent with theory. According to theoretical evaluation the reflection results from a pool wall with thickness, a small angle between its two boundary surfaces, and a fixed beam width of the primary wave. The theoretical evaluation and the experiments are in agreement.

85-957
New Methodological Trials of Dynamical State Estimation for the Noise and Vibration Environmental System - Establishment of General Theory and Its Application to Urban Noise Problems
M. Ohta, H. Yamada
Faculty of Engrg., Hiroshima Univ., Japan
Acustica, 55 (4), pp 199-212 (July 1984), 3 figs, 11 refs

KEY WORDS: Urban noise, Stochastic processes

The so-called Bayesian point of view is employed. Three estimation methods of extending the well-known Kalman's filter are derived. The validity and the effectiveness of theoretical results are experimentally clarified through application to observed environmental noise data.

85-958
Measuring the Acoustic Intensity of Hydroacoustic Sources
G.C. Lauchle
Pennsylvania State Univ., State College, PA
Rept. No. ARL/PSU/TM-84-91, 23 pp (May 25, 1984), AD-A142 484

KEY WORDS: Acoustic intensity method, Two microphone technique, Underwater sound

The acoustic intensity generated by a hydrodynamic source is related solely to the pressure components that propagate. What influence does the non-propagating hydrodynamic pressure fluctuations have on an intensity probe used in the nearfield of the source? Can their effect be removed from a measured intensity spectrum? These two questions are addressed in this paper. Non-propagating pressure fields of a turbulent boundary layer flow can be accounted for approximately.

85-959
A Statistical Approach to Determining the Number Density of Random Scatterers from Backscattered Pulses
P. Wilhelmij, P. Denbigh
Central Acoustics Lab., Univ. of Cape Town, Rondebosch, 7700, Rep. of South Africa
J. Acoust. Soc. Amer., 76 (6), pp 1810-1818 (Dec 1984), 7 figs, 2 tables, 24 refs

KEY WORDS: Acoustic pulses, Wave scattering, Statistical analysis

The moments of the probability density function of the backscattered intensity depend on the scatterer number density. Expressions exist for these moments in terms of the number of scatterers contributing to the echo signal. A specific application suggested for this work is acoustic fish-stock assessment. Other possible applications are ultrasonic tissue characterization and acoustic ocean-bottom identification.

85-960
A Range Refraction Parabolic Equation
F.D. Tappert, D. Lee
Univ. of Miami, Miami, FL 33149
J. Acoust. Soc. Amer., 76 (6), pp 1797-1803 (Dec 1984), 6 figs, 3 tables, 6 refs

KEY WORDS: Underwater sound, Sound waves, Wave refraction

Application of the standard parabolic wave equation to real problems requires clever selection of the reference wave number. An extended parabolic equation with refraction capability is reintroduced so as to be totally independent of the reference wavenumber. An already existing implicit finite difference model was applied to test the range refraction parabolic equation. Results compare favorably with known solutions for weakly range-dependent environments, but yield significant corrections for propagation through strong oceanic fronts.

85-961
Undersea Acoustic Research
R.C. Spindel
Woods Hole Oceanographic Institution, MA
Rept. No. WHOI-84-4, 22 pp (Jan 1984), AD-A142 339

KEY WORDS: Underwater sound

This is the final report of Contract N00014-77-C-196 between the Woods Hole Oceanographic Institution and the Office of Naval Research for the contract period 1 January 1977 to 28 February 1983. This contract supported a broad program of research and development in underwater acoustics related to present and future Navy systems and requirements.

85-962
Analytical Modeling of Random Thermal Fluctuations in the NORDA (Naval Ocean Research and Development Activity) High-Frequency Sound Scattering Facility
A.D. Pierce
Pierce (Allan D.), Marietta, GA
79 pp (May 1984), AD-A142 520

KEY WORDS: Underwater sound, Sound waves, Wave scattering, Temperature effects

The report discusses the initially laminar thermal plume that rises from a line source of heat in water, the instability of this plume, the eventual turbulent form of the plume, plume-plume interactions, and the swaying of thermal plumes. An appendix gives a chronological bibliography of works on natural convection that might be pertinent to understanding turbulent flows created in situations analogous to the NORDA high-frequency scattering facility.

85-963
The Rational Approximation to the Acoustic Wave Equation with Bottom Interaction
R.R. Greene
Science Applications, Inc., 1710 Goodridge Dr., McLean, VA 22102
J. Acoust. Soc. Amer., 76 (6), pp 1764-1773 (Dec 1984) 3 figs, 6 tables, 20 refs

KEY WORDS: Sound waves, Wave propagation, Underwater sound

The rational-linear approximation to the wave equation is a full-wave approach to modeling range-dependent ocean acoustic propagation with bottom interaction. A one-way wave equation gives an accurate treatment of high-angle propagation to angles of about 40° with respect to the horizontal. Reflection from sound speed and density discontinuities is treated using the natural wave equation matching conditions. Bathymetry is allowed to vary in range. A tridiagonal implicit finite-difference solution of this equation has been implemented.

85-964
Low-Frequency Grazing Propagation over Periodic Steep-Sloped Rigid Roughness Elements
H. Medwin, G.L. D'Spain, E. Childs, S.J. Hollis
Naval Postgraduate School, Monterey, CA 93943
J. Acoust. Soc. Amer., 76 (6), pp 1774-1789 (Dec 1984) 28 figs, 15 refs

KEY WORDS: Sound waves, Wave scattering

Experimental studies of coherently forward scattered sound at grazing incidence to low roughness rigid surfaces with periodic steep-sloped elements confirmed theoretical predictions of large boundary wave amplitude and subsonic dispersion. Results are presented for spheres, spaced and packed circular cylinders, and several wedge corrugated roughness elements. The boundary wave is also shown to diffract over a ridge in the same manner as the direct wave from a point source.

85-965
Modified Sound Refraction Near a Rough Ocean Bottom
H. Medwin, J.C. Novarini
Physics Dept., Naval Postgraduate School, Monterey, CA 93943
J. Acoust. Soc. Amer., 76 (6), pp 1791-1796 (Dec 1984) 6 figs, 9 refs

KEY WORDS: Sound waves, Underwater sound, Wave refraction

The case when source and receiver are near the ocean surface is considered. It is predicted that, under certain conditions of velocity gradient, frequency, and bottom roughness, the addition of the boundary wave mode to volume wave mode will change the path of the grazing specularly scattered ray above the rough bottom. As a result, an upward refracted ray will reach the surface at a skip distance significantly greater than for a smooth bottom. This modified refraction phenomenon should be detectable at sea under suitable experimental conditions.

85-966
Sound Propagation over Curved Boundary Surfaces
P.R. Brazier-Smith, J.F. Scott
Topexpress Limited, 13/14 Round Church St., Cambridge, UK
J. Sound Vib., 95 (2), pp 223-235 (July 22, 1984) 12 figs, 6 refs

KEY WORDS: Sound waves, Wave propagation

A model to determine variation in sound intensity due to a point source on a convex boundary surface, propagating over the surface, is described. Attenuation rates depend upon surface compliant properties and are much higher for a pressure release surface than for a rigid one. The possibility of a surface giving still higher attenuation rates is explored.

85-967
Surface Fields in Potential Theory and Acoustic Scattering
P.C. Waterman
Ctr. for Science and Technology, Ltd., 8 Baron Park Lane, Burlington, MA 01803
J. Acoust. Soc. Amer., 76 (4), pp 1215-1226 (Oct 1984) 8 figs, 4 tables, 7 refs

KEY WORDS: Sound waves, Wave scattering, Boundary value problems

Exterior boundary-value problems are considered for the class of cylinders. The results have significant impact on convergence for solutions to the infinite systems of equations involved. Potential theory for Dirichlet and Neumann boundary conditions and acoustic scattering in the Rayleigh limit are considered.

85-968
A Comparison of Acoustical Scattering from Fluid-Loaded Elastic Shells and Sound Soft Objects
M.F. Werby, L.H. Green
Naval Ocean Res. & Dev. Activity, NSTL Station, MS 39529
J. Acoust. Soc. Amer., 76 (4), pp 1227-1230 (Oct 1984) 3 figs, 9 refs

KEY WORDS: Sound waves, Wave scattering, Spheres, Shells, Fluid-induced excitation

Comparisons are presented for acoustical scattering from fluid-loaded prolate spheroidal sound soft scatterers and elastic shells of the same shape, ranging in thickness from 0.1% to 2.5% of the semi-major axis. Resonances are broad and tend to to dominate the form function plots. Of interest is the fact that, by the time the thickness reaches 2.5%, the background begins to appear rigid for suitably high Ka with a shift in resonance nulls.

SHOCK EXCITATION

85-969
Earthquake Damage and Insurance Risk
A.C. Boissonnade
Ph.D. Thesis, Stanford, Univ., 312 pp (1984) DA8420492

KEY WORDS: Earthquake damage

This dissertation includes the following: development of methods for determining vulnerability curves of structures under seismic loading, formulation of loss estimation procedures for specific structures and regions, use of pattern recognition and fuzzy set theory to evaluate seismic intensity and damage forecasting, and development of models to estimate earthquake insurance premium rates and insurance strategies.

85-970
Methods and Procedures to Specify Key-Worker Blast Shelter (KWBS) Location and Requirements. Volume 1. Main Report

M.J. Fischer, E.Z. Faby, R.T. Robinson, F.W. Leonard
Engrg. and Economics Res., Inc., Vienna, VA
Rept. No. EER-TR-9-84-VOL-1, 225 pp (May 1984) AD-A142 454

KEY WORDS: Protective shelters, Blast resistant structures

This report presents analyses and final results of a study conducted by Engineering and Economics Research to assist FEMA in development of the protection of industrial capability program. The study supports planning activities associated with the blast shelter component of the PIC program.

VIBRATION EXCITATION

85-971
High-Frequency Contact Mechanics: The Derivation of Frequency-Dependent Creep Coefficient
K. Knothe, A. Gross-Thebing
Inst. of Aeronautics and Astronautics, Tech. Univ. of Berlin, Salzufer 17-19, D-1000 Berlin, W. Germany
IMechE, Proc., 198 (12), pp 167-173 (1984) 7 figs, 11 refs

KEY WORDS: Contact vibration, Railroad trains

Kalker's creep coefficients for linear rolling contact problems are valid only in the steady-state case. An approximate method for extending linear contact mechanics to the high-frequency range is presented.

85-972
The Dynamic Response of Engineering Structures Subject to Excitation by Moving Mass Systems
D.P. Murphy
Ph.D. Thesis, Univ. of Wyoming, 275 pp (1984) DA8418782

KEY WORDS: Moving loads, Continuous systems, Mass coefficients, Damping effects, Stiffness effects

The analysis predicts the dynamic response of continuous flexible structures subject to live load excitation. The validity and accuracy of the approach are demonstrated in analyses of comparatively simple systems. The generality and versatility of the analytical method are further demonstrated by combining it with finite element techniques.

85-973
Shakedown Analysis of Limited-Ductility Structures
S. Rizzo, F. Giambanco
Istituto di Scienza delle costruzioni (091-427121/66/67), Viale delle Scienze, 90128 -Palermo (Italy)
Meccanica, 19 (2), pp 151-157 (June 1984) 6 figs, 19 refs

KEY WORDS: Shakedown theorem

The key concept of limited-ductility load amplifier is assessed; the problem is given a unified formulation as a nonlinear mathematical programming problem. Ductility constraints are obtained by a perturbation method that leads to a-priori upper bounds of relevant plastic deformation measures. Lower bounds are obtained. Three computational strategies are outlined.

85-974
Some Methods for the Analysis of Equipment-Structure Interaction
T.J. Ingham, J.L. Sackman
Univ. of California, Berkeley, CA
Intl. J. Earthquake Engrg. Struc. Dynam., 12 (5), pp 583-601 (Sept/Oct 1984) 6 figs, 7 refs

KEY WORDS: Equipment-structure interaction

An arbitrary number of natural frequencies of equipment and structure are nearly equal (or equal). This coincidence implies that the equipment-structure system will have several closely spaced natural frequencies. The essence is the formation of beats with slowly varying amplitude in each degree of freedom. Solutions of some differential equations are a slowly varying envelope function (a vector) that yields the slowly varying amplitudes.

85-975
Aeroelastic Stability Analysis with Interacting Structural Nonlinearities
C.L. Lee
Ph.D. Thesis, Southern Methodist Univ., 176 pp (1984) DA8415029

KEY WORDS: Flutter, Iteration, Frequency domain method, Nonlinear systems

Theoretical development of an iterative procedure in the frequency domain is presented that involves alignment of amplitudes in each nonlinear spring. Predictions of stiffness are described prior to computation of the final stability characteristics. The system is tuned to flutter frequency at the time of instability. Numerical simulations and experimental data are compared with iterative predictions.

85-976
Elastic Continua in High Frequency Excitation Field
M. Zak
Jet Propulsion Lab., California Inst. of Tech., Pasadena, CA 91009
Intl. J. Nonlin. Mech., 19 (5), pp 479-487 (1984) 3 refs

KEY WORDS: Elastic media, Vibration response

The response of an elastic continua to high-frequency excitations is decomposed in two parts, slow motion and fast motions. After decomposition the slow and fast motions become nonlinearly coupled by the corresponding governing equations. This coupling leads to an additional effective potential energy that changes the mean stiffness characteristics. The results can be used for dynamical stiffening of flexible structural elements to increase stiffness to prevent buckling or wrinkling.

85-977
Radiation Effects on Vibrational Heating of Polymers
I.S. Habib
Univ. of Michigan, Dearborn, MI
J. Spacecraft Rockets, 21 (5), pp 496-501 (Sept/Oct 1984) 5 figs, 10 refs

KEY WORDS: Heat generation, Cyclic loads, Polymers

Critical limits for the heat generation parameter Beta are obtained for various values of the radiation-conduction parameters. The effect of optically thin radiation is examined for a slab. The optically thick limit is analyzed for planar, cylindrical, and spherical geometries. An effective slip temperature coefficient is used for combined conduction and optically thick radiation. The effect of radiative interchange is to increase significantly the critical values of Beta above those obtained from analysis involving only conduction.

85-978
Dynamic Response of Linear Structures to a Stream of Random Impulses in a "Space-Time" System
P. Sniady
Technical Univ. of Wroclaw, Poland
J. Sound Vib., 95 (1), pp 41-47 (July 8, 1984) 7 refs

KEY WORDS: Continuous systems, Random excitation

Impulses reach a structure at random points on its surface and at random time intervals. It is assumed that the stream can be correlated with respect to space and time. Explicit expressions are given for the expected value and covariance of the structural deflection.

85-979
Resonances of 2 and 2/3 Order in a Parametrically Excited System Subjected to Self-Excitation
S. Yano
Fukui Univ., Fukui, Japan

Strojnícky Časopis, 35 (4), pp 419-435 (1984) 15 figs, 4 refs

KEY WORDS: Resonant response, Parametric excitation, Self-excited vibration

Nonlinear resonances in a parametrically excited system subjected to Van der Pol type self-excitation are investigated. Steady solutions in the regions of parametric resonance of second order, subsuperharmonic resonance of order 2/3, and beat vibrations in the neighborhood of resonances are approximately determined.

85-980

Unsteady Forces on a Body Immersed in Viscous Fluids (1st Report: For a Uniformly Accelerated Elliptic Cylinder)

T. Tanahashi, T. Sawada, A. Chino, S. Kawamoto
Keio Univ., 3-14-1 Hiyoshi, Kohoku-ku, Yokohama 223, Japan
Bull. JSME, 27 (230), pp 1598-1606 (Aug 1984) 9 figs, 15 refs

KEY WORDS: Submerged structures, Fluid-induced excitation

A numerical method for obtaining the forces on a body immersed in viscous fluids is derived for a uniformly accelerated elliptic cylinder. The coefficients of drag, lift, and moment exerted on a unit span length are obtained. They contain components due to pressure and viscous force. Distribution of vorticities on the surface is revealed. The separation time at the trailing edge has a larger error when the eccentricity of the elliptic cylinder goes to unity.

85-981

The Critical Condition for the Onset of Waves on the Free Surface of a Horizontal Liquid Layer under a Vertical Oscillation

E. Hasegawa, T. Umehara, M. Atsumi
Keio Univ., 3-14-1, Hiyoshi, Kohoku, Yokohama, Japan
Bull. JSME, 27 (230), pp 1625-1630 (Aug 1984) 11 figs, 9 refs

KEY WORDS: Fluid-filled containers, Vibration excitation, Fluid-structure interaction

The waves are governed by an ordinary differential equation with periodic coefficients. The curves, which envelope stability boundaries for various wave numbers, are obtained in the frequency-amplitude space. There is a minimum value in the critical amplitude above which a disturbance begins. Neutral stability curves are obtained experimentally. Experimental results are in good agreement with theoretical ones.

85-982

Fluid-Structure Coupling between a Finite Cylinder and a Confined Fluid

G. Garner, S. Chandra
The Charles Stark Draper Lab., 555 Technology Square, MS 60, Cambridge, MA 02139
J. Appl. Mech., Trans. ASME, 51 (4), pp 857-862 (Dec 1984) 4 figs, 2 tables, 12 refs

KEY WORDS: Fluid-structure interaction, Cylinders, Mode shapes, Natural frequencies

The dynamic behavior of a finite-length cylindrical rod in a fluid-filled annulus is considered. The fluid and structure equations are solved simultaneously. Coupled mode shapes and natural frequencies are obtained for various cases. For short lengths and/or higher modes the effect of the fluid on cylinder motion diminishes compared to the infinite cylinder case. Coupled and in-vacuum mode shapes can differ in certain cases.

85-983

Hydrodynamic Mass

H. Chung, S.S. Chen
Argonne National Lab., Argonne, IL
Rept. No. CONF-840647-9, 59 pp (1984) DE84009185

KEY WORDS: Fluid-induced excitation, Hydrodynamic excitation

The fluid moving with a vibrating structure has an effect on its dynamics. The effect of the fluid on natural frequencies can be accounted for using the hydrodynamic mass associated with the structure. This paper provides formulas, graphs, and computer programs for calculating hydrodynamic mass.

85-984
Propagation of Acoustic Waves in Partially Saturated Porous Media
R.K. Wilson, E.K. Walsh
Sandia National Labs., Albuquerque, NM
Rept. No. SAND-83-1522C, CONF-8405-04-2, 14 pp (May 10, 1984) DE84010536

KEY WORDS: Porous materials, Fluid-filled containers, Sound waves, Wave propagation

The continuum theory of mixtures is used. Three dynamic equations are obtained for the velocities of the liquid, gas, and solid phases. The coefficients have an explicit dependence on capillary pressure or surface tension. The resulting equations are discussed in the context of previous models.

85-985
On the Drag and Virtual Mass Coefficients in Biot's Equations
A. Bedford, R.D. Costley M. Stern
Applied Res. Labs., The Univ. of Texas at Austin, Austin, TX 78712-8029
J. Acoust. Soc. Amer., 76 (6), pp 1804-1809 (Dec 1984) 10 figs, 1 table, 21 refs

KEY WORDS: Porous materials, Fluid-filled media, Mass coefficients, Drag coefficients, Frequency dependent parameters

The determination of these coefficients can be reduced to the solution of a boundary value problem for a viscous, compressible fluid. Pores are assumed to be cylindrical. The motion of the fluid is determined theoretically. Motions parallel to and normal to the axis of the cylinder are considered.

MECHANICAL PROPERTIES

DAMPING

85-986
Design of Damped Structures Using Modal Analysis
M. Thomas
Centre de recherche industrielle du Quebec, Sainte-Foy, Quebec, Canada
Machinery Dynamics Seminar, Proc. of the 8th, Oct 1-2, 1984, Halifax, Canada. Spons. by National Res. Council Canada, NRC No. 23619, pp 5.1 -5.12, 14 figs, 6 refs

KEY WORDS: Viscoelastic damping, Design techniques, Modal analysis

Modal analysis allows rapid identification of resonant frequencies, mode shapes, and modal parameters. A designer can use modal analysis to optimize the application of viscoelastic damping materials to real structures.

85-987
Squeeze Film on Compliant Surface under Step Load (2nd Report, Spherical Thruster)
K. Ikeuchi, H. Mori
Kyoto Univ., Yoshida Hon-machi, Kyoto, 606, Japan
Bull. JSME, 27 (231), pp 2030-2035 (Sept 1984) 16 figs, 8 refs

KEY WORDS: Squeeze film dampers

Squeeze films between a spherical thruster and a compliant surface under step load are investigated. The thruster shows damping oscillation if its mass is large and the viscosity of the fluid is low. The film thickness increases in the early stage near the center; a concave face in which the fluid is trapped appears. A large step load results in a large film thickness until the final stage of transition.

85-988

Analysis of Damping Characteristics of Squeeze Films under Dynamic (Cyclic) Loading

Y.K. Younes, M.O.A. Mokhtar
Helwan Univ., Mataria, Cairo, Egypt
Trib. Intl., 17 (3), pp 139-145 (June 1984) 10 figs, 1 table, 9 refs

KEY WORDS: Squeeze film dampers, Disks, Cyclic loading

An analytical formulation to identify variation in oil-film thickness as a function of damping loads is proposed. The Reynolds equation in the discretized form is solved numerically using the Thomas algorithm. Such a direct technique has proved reliable in solving similar problems and minimizing computational time. Results indicate that micro- and macro-surface undulations play a major role in dictating squeeze-action damping characteristics.

85-989

A Discussion of Alternative Duncan Formulations of the Eigenproblem for the Solution of Nonclassically, Viscously Damped Linear Systems

J.A. Brandon
Dept. of Mech. Engrg., UMIST, Manchester, Manchester, England
J. Appl. Mech., Trans. ASME, 51 (4), pp 904-906 (Dec 1984) 11 refs

KEY WORDS: Viscous damping, Duncan method

This alternative statement of the problem is no better and is in fact potentially inferior to the standard method. A potentially important application removes a significant limitation in implementation of local modification procedures.

85-990

Study of Characteristics of Dry Friction Damping

A.V. Srinivasan, B.N. Cassenti, D.G. Cutts
United Technologies Corp., United Technologies Res. Ctr., Silver Lane, East Hartford, CT 01608
Rept. No. R84-956479-1, 45 pp (Mar 1984) 24 figs, 34 refs

KEY WORDS: Coulomb damping

This report pertains to the estimation of damping due to dry friction forces induced at interfaces of vibrating components. It includes a summary of literature survey and identifies the scope of research needed. The period covered was between March 1, 1983 and March 1, 1984.

85-991

Continuous Measurement of Material Damping During Fatigue Tests

P.W. Whaley, P.S. Chen, G.M. Smith
Univ. of Nebraska-Lincoln, 212 Bancroft Bldg., Lincoln, NE 68588-347
Exptl. Mech., 24 (4), pp 342-348 (Dec 1984), 8 figs, 1 table, 8 refs

KEY WORDS: Fatigue tests, Resonance tests, Beams, Material damping

An experimental procedure for continuously measuring strain level, temperature, and energy-dissipation rate during resonant fatigue tests is described. This procedure continuously measures energy-dissipation rate during fatigue-crack nucleation. It is the basis for experimental study of the hypothesis that the entropy gained during fatigue failure is a material constant.

85-992

Piping Dampers. No Chance for Vibrations (Rohrleitungsdampfer. Keine Schwingungen)

A. Winkler
Industrie Anzeiger, 106 (103/104), pp 64-65 (1984) (In German)

KEY WORDS: Dampers, Piping systems

The opening and closing of valves in a piping system produce changes in the mass of fluid that result in dynamic excitation of the system. The application of viscoelastic dampers is described. The damper consists of a housing, a viscous damping

medium, and a piston. The piston is free to move in all directions, thus enabling the damper to control motion in all directions.

FATIGUE

85-993

Fatigue Reliability of Parallel Member Systems

B. Stahl, J.F. Geyer
Amoco Production Co., P.O. Box 591, Tulsa, OK 74102

ASCE J. Struc. Engrg., 110 (10), pp 2307-2323 (Oct 1984) 8 figs, 8 refs

KEY WORDS: Fatigue life, Structural members, Exact methods

A method is developed for calculating the probability of progressive collapse due to fatigue for structural systems in which members are connected in parallel and for parallel member systems connected in series. Formulation of the method is based on the assumptions of equal member load sharing and identically distributed fatigue lives. The method can be useful in design criteria development. The method can be used as a test case for future work in the development of system reliability methods for more general applications.

85-994

Stochastic Fatigue Damage Accumulation

L.D. Lutes, M. Corazao, Sau-lon James Hu, J. Zimmerman
Rice Univ., P.O. Box 1892, Houston, TX 77251

ASCE J. Struc. Engrg., 110 (11), pp 2585-2601 (Nov 1984) 4 figs, 1 table, 8 refs

KEY WORDS: Fatigue life, Stochastic processes

A study is made of several aspects of the problem of predicting fatigue failure by the Palmgren-Miner (PM) approximation. PM analysis is consistent with theoretical models that give nonlinear growth of damage. Simulation results relate damage predicted from rainflow cycles to that predicted from narrowband analysis. Results are also presented for the effect of the stress process. Both analytical and simulation studies show that this effect can be significant.

85-995

Impact Torsional Fatigue Strength of Structural Carbon Steels

N. Okabe, T. Yano, T. Uchida, T. Mori
Heavy Apparatus Engrg. Lab., Toshiba Corp., 1, Toshiba-cho, Fuchu-shi, Tokyo, Japan

Bull. JSME, 27 (23), pp 1813-1820 (Sept 1984) 15 figs, 6 tables, 10 refs

KEY WORDS: Fatigue tests, Torsional excitation, Impact excitation, Steel

Impact torsional fatigue tests on four structural carbon steels were carried out in low cycle life region under both pulsating and completely reversed impact torsion. The relationship between pulsating and completely reversed torsional fatigue was based on the extended concept of endurance fatigue limit diagram. Impact torsional fatigue strength had a logarithmic normal distribution. Impact fatigue strength can be estimated from the statistics of static and tensile properties.

85-996

Rapid Estimation of Spectrum Crack-Growth Life Based on the Palmgren-Miner Rule

O. Orringer
U.S. DOT Transportation Systems Ctr., Cambridge, MA 02142

Computers Struc., 19 (1/2), pp 149-153 (1984) 4 figs, 6 tables, 10 refs

KEY WORDS: Crack propagation

This paper outlines a method based on the Palmgren-Miner Rule (linear damage summation), which was originally proposed for predicting crack-initiation life from empirical data. The Palmgren-Miner Rule is

exact for crack growth when stress and crack-length variables in the rate equation are separable. Such applications are limited, but the Palmgren-Miner Rule also produces acceptably accurate estimates in practical cases when the rate equation embodies commonly observed stress sequence effects. In its present state of development the method cannot be applied to interaction phenomena.

ELASTICITY AND PLASTICITY

85-997

Dynamic Stress Intensity Factors for an Inclined Subsurface Crack

W. Lin, L.M. Keer, J.D. Achenbach
Northwestern Univ., Evanston, IL 60201

J. Appl. Mech., Trans. ASME, 51 (4), pp 773-779 (Dec 1984) 11 figs, 9 refs

KEY WORDS: Cracked media, Stress intensity factors

The problem is analyzed by determining displacement potentials that satisfy reduced wave equations and specified boundary conditions. Curves are presented for the ratios of elastodynamic and corresponding elastostatic Mode-I and Mode-II stress intensity factors for various frequencies and various inclinations of the crack with the free surface.

85-998

Transient Stress Intensity Factors of an Interfacial Crack Between Two Dissimilar Anisotropic Half-Spaces, Part 2: Fully Anisotropic Materials

A.-Y. Kuo
Structural Integrity Assn., 3150 Almaden Expy., Ste. 226, San Jose, CA 95118

J. Appl. Mech., Trans. ASME, 51 (4), pp 780-786 (Dec 1984) 9 figs, 12 refs

KEY WORDS: Cracked media, Stress intensity factors

The mathematical problem is reduced to three coupled singular integral equations. Jacobi polynomials are used to obtain numerical solutions to the singular integral equations. The orders of stress singularity and stress intensity factors of an interfacial crack in a composite solid agree well with finite element solutions.

85-999

Finite Element Method: A Companion in Experimental Mechanics

A.S. Kobayashi
Univ. of Washington, Seattle, WA 98195

Computers Struc., 19 (1/2), pp 111-118 (1984) 11 figs, 27 refs

KEY WORDS: Fracture properties, Finite element technique, Testing techniques, Numerical analysis, Stress-intensity factors

The hybrid experimental-numerical procedure for structural analysis is described by its applications in fracture mechanics. The procedure was verified by excellent agreement between dynamic stress intensity factors obtained by dynamic photoelasticity and those generated by the hybrid procedure where a dynamic finite element code is executed in its generation mode. The hybrid procedure was then used to determine the dynamic fracture toughness of reaction bonded silicon nitride.

WAVE PROPAGATION

85-1000

Further Developments in Determining the Dynamic Contact Law

J.F. Doyle
Purdue Univ., West Lafayette, IN 47907

Exptl. Mech., 24 (4), pp 265-270 (Dec 1984) 8 figs, 4 refs

KEY WORDS: Beams, Impact response, Transverse shear deformation effects

A force/strain relation (incorporating shear effects) for the transverse impact of beams is established in the frequency domain. Inversion by use of a fast-Fou-

rier-transform (FFT) algorithm allows determination of the force history. Effects of sampling rate and size are considered when experimental data are analyzed.

EXPERIMENTATION

MEASUREMENT AND ANALYSIS

85-1001
On Seismic Waves
S. De
National Res. Inst., P.O. Bankisol, Bankura, W. Bengal, India
Shock Vib. Dig., 16 (11), pp 3-24 (Nov 1984) 281 refs

KEY WORDS: Elastic waves, Seismic waves, Reviews

This article deals with various aspects of the propagation of elastic waves on Earth, mathematical methods, waves due to explosion and oscillation of the Earth, seismic prospecting, seismic risk, ground motion and structures, and mechanisms and predictions of earthquakes.

85-1002
Dynamic Stresses and Displacements Around Cylindrical Cavities of Arbitrary Shape
S.K. Datta, K.C. Wong, A.H. Shah
Univ. of Colorado, Boulder, CO 80309
J. Appl. Mech., Trans. ASME, 51 (4), pp 798-803 (Dec 1984) 14 figs, 8 refs

KEY WORDS: Wave diffraction, Elastic waves, Cavities

Results are given for a pair of circular cavities of equal radii and a pair of circular and square cavities. These results are of interest in estimating the effects of corners and multiple scattering on the distribution of dynamic displacements and stresses around cylindrical holes or openings. A numerical technique combining the finite element method and the method of eigenfunction expansions is used.

85-1003
Measurement Technology and Signal Processing. Analog Measurement Technology and Signal Processing (Messtechnik und Messignalverarbeitung. Analoge Messtechnik u. Messignal verarbeitung)
H.R. Tränkler
Inst. f. Mess.- und Regelungstechnik, Hochschule der Bundeswehr München, Werner-Heisenberg-Weg 39, D8014 Neubiberg, Fed. Rep. Germany
Techn. Messen-TM, 51 (10), pp 375-378 (Oct 1984) 7 figs, 4 refs (continued from Nov. 1984) (In German)

KEY WORDS: Measuring instruments, Signal processing techniques

This section deals with the dynamic behavior of torsional measuring element and derives a general description of the time response of second order measuring element. When creep and vibration stop, the transient response (step function response) is investigated. Damping in torsional pulse measuring instruments is derived, and the characteristics of higher order measuring elements are defined.

85-1004
Application of Modal Analysis to the Design of a Large Fan-Foundation System
S.C. Ulm
Structural Dynamics Res. Corp., Milford, OH 45150
Machinery Dynamics Seminar, Proc. of the 8th, Oct 1-2, 1984, Halifax, Canada. Spons. by National Res. Council Canada, NRC No. 23619, pp 3.1 -3.18, 10 figs, 1 table, 3 refs

KEY WORDS: Modal analysis, Fans, Foundations, Design techniques

This paper describes the use of modal analysis to hasten on-line availability and minimize maintenance problems. The work demonstrates the use of modal analysis in a production environment. The software is commercially available to the engineering community.

85-1005

The Adaptive Spectrum Analyser

P.A. Baudrenghien

Ph.D. Thesis, Stanford Univ., 287 pp (1984)
DA8420488

KEY WORDS: Spectrum analyzers

This thesis introduces a new method for the analysis of signals whose power spectral density is located in a set of narrow bands on the frequency axis. The adaptive spectrum analyser models the narrow-band signal as a linear combination of sinusoids. The ASA achieves very fine frequency resolution. The major problem is that convergence is not completely global.

85-1006

A New Method for Measuring Impulsive Force at Contact Parts

S. Tanimura
Univ. of Osaka Prefecture, Mozu, Sakai, Osaka 591, Japan

Exptl. Mech., 24 (4), pp 271-276 (Dec 1984) 12 figs, 10 refs

KEY WORDS: Impact force, Measurement techniques

Sensing plates produce an effect equivalent to the embedment of small strain gages in a solid. This method is effective for measuring the impulsive force directly and sensitively; it is almost entirely free from the disturbance caused by interference with reflected waves. It is even effective for the case in which an elastic-plastic deformation occurs at a contact part and the contact area varies with time.

85-1007

Photoelastic-Coating Analysis of Dynamic Stress Concentration in Composite Strips

K. Kawata, N. Takeda, S. Hashimoto
Science Univ. of Tokyo, 2641 Yamazaki, Noda City, Chiba 278, Japan

Exptl. Mech., 24 (4), pp 316-327 (Dec 1984) 19 figs, 3 tables, 24 refs

KEY WORDS: Testing techniques, Photoelastic analysis, Dynamic stress concentration, Hole-containing media, Fiber composites

Dynamic stress concentration in high-velocity tension is investigated for fiber-reinforced composite strips with a central circular hole. An excellent reflective plane is the key to clear isochromatic-fringe patterns. Dynamic-stress and strain distribution around a hole varied remarkably with change in anisotropy of each composite.

85-1008

Dynamic Analysis of Nonlinear Structures by Psuedo-Normal Mode Superposition Method

A.R. Kukretti, H.I. Issa
Univ. of Oklahoma, Norman, OK 73019

Computers Struc., 19 (4), pp 653-663 (1984) 3 figs, 5 tables, 26 refs

KEY WORDS: Modal superposition method, Nonlinear systems

The analytical formulation is based on finite element theory for spatial dependence; both geometric and material nonlinearities are considered. For a geometrically nonlinear beam problem, comparison of results with a linear approximation of pseudo-load and the Park Stiffly-Stable method, show the algorithm presented gives more accurate, efficient, and stable solutions.

85-1009

Modal Analysis and Its Application to Machine Vibration Problems

D.J. Ewins
Imperial College, London, UK

Machinery Dynamics Seminar, Proc. of the 8th, Oct 1-2, 1984, Halifax, Canada. Spons. by National Res. Council Canada, NRC No. 23619, pp 1.1 -1.25, 13 figs, 9 refs

KEY WORDS: Modal analysis, Machinery vibration

An overview of current modal analysis methodology is presented together with a discussion of major application areas. The main features of modal testing and the skills required for its implementation are described. The variety of methods available and the need to use an appropriate option are emphasized. The applicability of modal analysis methods in solving machine vibration problems is described. Different classes of structure are identified, their vibration characteristics are summarized, and typical applications for modal analysis are given.

85-1010
Frequency Response Function for Modal Analysis of Rotor Systems
M. Massoud
Univ. of Sherbrooke, Sherbrooke, Quebec, Canada
Machinery Dynamics Seminar, Proc. of the 8th, Oct 1-2, 1984, Halifax, Canada. Spons. by National Res. Council Canada, NRC No. 23619, pp 2.1 -2.21, 15 figs, 19 refs

KEY WORDS: Modal analysis, Rotors, Frequency response function

The merits of this type of analysis in a broad spectrum of industrial rotor applications are briefly reviewed. Commercially available systems are briefly pointed out. Emphasis is given to the mathematical background of the software. Recent trends in modal analysis are outlined. The presentation is intended for the practicing engineer who would like to know about the potentials of the modal analysis.

85-1011
Development and Calibration of a Dynamic-Contact-Force Transducer
D. Goldar, V.S. Sethi, O.P. Khurana, S.R. Verma
Delhi College of Engrg., Delhi-110 006, India
Exptl. Mech., 24 (3), pp 187-190 (Sept 1984) 3 figs, 1 table, 5 refs

KEY WORDS: Transducers

A dynamic-contact-force transducer was developed using a pair of quartz crystals as the sensing element. Calibration involved comparing experimental results with the numerical solution of the Timoshenko-beam equation. The transducer was used to study transverse impact on a simply-supported beam.

85-1012
Force Transducers Accurately Sense Process Line Tension
W.H. Compton
Comptrol Inc., Cleveland, OH
Power Transm. Des., 26 (7), pp 21-24 (July 1984) 10 figs

KEY WORDS: Transducers

Force transducers installed on new and modernized systems can accurately measure forces in webs and strands.

85-1013
Problems of System Identification in Flight Vibration Testing
K. Koenig
AGARD, Neuilly-sur-Seine, France
Rept. No. AGARD-R-720, 29 pp (Apr 1984) AD-A142 556

KEY WORDS: Flight test data, System identification techniques, Modal analysis, Flutter

The accuracy of modal-data analysis was studied. The state of the art is poor and insufficient to deal with critical flutter cases. Improvements are possible and should be sponsored.

85-1014

Noise Measurement, Noise Assessment (Annual Survey) (Geräuschmessung, Geräuschbeurteilung)

R. Martin

VDI-Z., 126 (14), pp 539-545 (July 1984) 10 figs, 1 table, 70 refs (In German)

KEY WORDS: Noise measurement, Instrumentation, Measurement techniques, Standards

General, standards, and recommendations are given. Noise measuring instruments, noise measurement procedures, and noise assessment are surveyed.

85-1015

Modal Parameter Identification in Rotors Supported on Hydrodynamic Bearings

R. Subbiah, R.B. Bhat, T.S. Sankar

Concordia Univ., Montreal, Quebec, Canada

Machinery Dynamics Seminar, Proc. of the 8th, Oct 1-2, 1984, Halifax, Canada. Spons. by National Res. Council Canada, NRC No. 23619, pp 6.1 -6.21, 23 figs, 1 table, 6 refs

KEY WORDS: Rotors, Hydrodynamic bearings, Modal analysis, Parameter identification techniques, Frequency response functions

Frequency response functions for the rotor are obtained experimentally and are used in a modal model to extract modal parameters of the structure. Configurations of rotor systems studied include a rotor supported on dissimilar bearings.

DIAGNOSTICS

85-1016

On-Line Diagnostics of Rear Axle Transmission Errors

V. Milenkovic, S. Shmuter, N. Field

Ford Motor Co., Detroit, MI

J. Engrg. Indus., Trans. ASME, 106 (4), pp 331-338 (Nov 1984) 12 figs, 7 refs

KEY WORDS: Diagnostic techniques, Driveline vibrations, Torsional vibrations, Gear-induced vibrations

This paper describes a methodology that is suitable for measuring gear-induced vibrations in assembled axle carriers outside a vehicle. The dynamic approach to computerized axle testing has resulted in a machine capable of testing more than 100 axle carriers per hour. Three tasks are addressed: development of an angular sensor; synthesis of a dynamic drive train; and configuration of a data processing system.

85-1017

Design for Testability Techniques Using Signature Analysis

S.Z. Hassan

Ph.D. Thesis, Stanford Univ., 233 pp (1984) DA8420544

KEY WORDS: Signature analysis, Failure analysis

The focus of this work is to enhance the fault coverage obtained from signature analysis testing techniques. The application of signature analysis has been broadened; factors that influence fault coverage have been analyzed. Specific schemes have been devised for testing different circuits by signature analysis techniques.

85-1018

Drive Belt Vibrations -- A Case Study

L.P. Tessier, A.C. Coulton

Esso Resources Canada Ltd., Alberta, Canada

Machinery Dynamics Seminar, Proc. of the 8th, Oct 1-2, 1984, Halifax, Canada. Spons. by National Res. Council Canada, NRC No. 23619, pp 10.2 -10.20, 2 figs, 2 tables, 3 refs

KEY WORDS: Belt drives, Failure analysis, Equations of motion, Forcing function, Case histories

The belt natural frequency coincided with compressor speed; the belt was thus subjected to a resonant excitation. A theoretical equation derived for the natural frequency of a belt did not correlate well with the experimental data taken during the site study. An empirically derived forcing function was added to the theoretically derived equation to describe the natural frequency of a vibrating belt. With these equations it is now possible to determine if a given belt drive system will be prone to a resonant vibration condition prior to packaging of the equipment. If a potential problem exists the appropriate changes can be made at the design stage.

85-1019

Fault Diagnosis Method for a Vibration Phenomenon on an Exciter for a Turbo-Alternator, through a Vibration Analysis Discrete Instant Motion Study Using Accelerometers and a Supporting Instrumentation System

W.I. Quigley
Marine Systems Engrg. Div. of Naval Engrg. Unit Atlantic, Halifax, N.S., Canada
Machinery Dynamics Seminar, Proc. of the 8th, Oct 1-2, 1984, Halifax, Canada. Spons. by National Res. Council Canada, NRC No. 23619, pp 9.0 -9.18, 5 figs

KEY WORDS: Diagnostic techniques, Generators

The problem was addressed by designing and installing an instrumentation system comprising accelerometers on various structural parts and bearing housings of the turbo-alternator. Reproduction and analysis of data indicated an out-of-phase relationship in waveforms at the exciter and led to a diagnosis of internal misalignment in the generator/exciter coupling.

85-1020

Dynamic Analyses of an Over-Running Clutch Vibration Problem on a Gas Turbine Generator Set

D.E. Franklin, J.C. Van Horne
B.C. Hydro and Power Authority, 970 Burrard St., Vancouver, B.C. V6Z 1Y3, Canada
Machinery Dynamics Seminar, Proc. of the 8th, Oct 1-2, 1984, Halifax, Canada. Spons. by National Res. Council Canada, NRC No. 23619, pp 8.1 -8.21, 12 figs

KEY WORDS: Clutches, Gas turbines, Diagnostic techniques, Modal analysis

Modal analysis was used to define the structural characteristics of a clutch and power turbine section. Spectral mapping of the vibration patterns characterized the operating mode dynamics. The problem was a rotating unbalance possibly caused by asynchronous oil flow in the overhung section of the clutch.

85-1021

Application of Intensity Measuring Technique to Vibration Diagnostics in Machinery

G. Rasmussen
Bruel & Kjaer, 18 Naerum Hovedgade, 2850 Naerum, Denmark
Machinery Dynamics Seminar, Proc. of the 8th, Oct 1-2, 1984, Halifax, Canada. Spons. by National Res. Council Canada, NRC No. 23619, pp 14.1 -14.10, 12 figs, 2 refs

KEY WORDS: Diagnostic techniques, Machinery vibration, Sound intensity, Measurement techniques

An improved analysis technique using frequency analysis can be important. This technique does not account for the complexity of structural motion. The energy is related to the real part of vibratory motion. The imaginary part is determined by structural masses and stiffnesses; the real part depends on damping and nonlinearities, and is closely related to work processes such as fatigue, wear, and breakdown.

85-1022

Pumpset Commissioning at Nuclear Power Plants

T. Loewen, F. Perricone
Ontario Hydro Res. Div., Ontario, Canada
Machinery Dynamics Seminar, Proc. of the 8th, Oct 1-2, 1984, Halifax, Canada. Spons. by National Res. Council Canada, NRC No. 23619, pp 13.0 -13.20, 21 figs

KEY WORDS: Pumps, Nuclear power plants, Diagnostic techniques

This paper outlines objectives, vibration tests, and diagnoses performed as part of the commissioning program at Ontario Hydro Nuclear Plants. Case histories illustrate the application of various tests and analyses.

85-1023
Vibration in Centrifugal Pumps - Their Causes and Cure
H. Samarasekera
Bingham-Williamette Ltd.
Machinery Dynamics Seminar, Proc. of the 8th, Oct 1-2, 1984, Halifax, Canada. Spons. by National Res. Council Canada, NRC No. 23619, pp 12.0 -12.14, 6 figs, 10 refs

KEY WORDS: Diagnostic techniques, Centrifugal pumps

Mechanical and hydraulic factors that influence the vibration of a pump are reviewed. Criteria employed in the design stage to avoid vibration during subsequent operation are presented. Techniques to eliminate problems in operating equipment are described. Vibration diagnostic techniques that can be used to detect causes of vibration are demonstrated with signatures taken during actual pump tests.

85-1024
Analysis of Service Failures
P.S. Gupton
Monsanto Co., Texas City, TX
Proc., 13th Turbomachinery Symp., Texas A&M Univ., College Station, TX, Nov 1984, pp 75-86, 34 figs, 12 refs

KEY WORDS: Diagnostic techniques, Failure analysis, Case histories

When a component fails prematurely, it is important that an engineering evaluation be made. A comprehensive failure analysis enables the engineer to predict future problems, establish inspection criteria and intervals, improve safety, refine operating procedures, and correct equipment specifications. The necessary requirements of a comprehensive failure analysis are presented.

BALANCING

85-1025
Balancing of Finite Element Modelled Rotor-Disks Using Dynamic Matrix Reduction Technique in Conjunction with Modal Analysis and Least Square Analysis
S. Ahuja, A.M. Sharan
Memorial Univ., St. John's, Newfoundland, Canada A1B 3X5
Machinery Dynamics Seminar, Proc. of the 8th, Oct 1-2, 1984, Halifax, Canada. Spons. by National Res. Council Canada, NRC No. 23619, pp 20.1 -20.12, 1 fig, 1 table, 5 refs

KEY WORDS: Balancing techniques, Rotors, Condensation method, Modal analysis, Least squares method

A mathematical technique for balancing rotor-disks supported on fluid-film bearings is presented. System inertia and damping and stiffness matrices are condensed. This condensation technique leads to considerable savings in CPU time and computer memory storage.

85-1026
A Computational Model to Aid the Balancing of Turbo-Generator Sets
A. Craggs, F. Ellyin, R. Pelot
Univ. of Alberta, Edmonton, Alberta T6G 2G8, Canada
Machinery Dynamics Seminar, Proc. of the 8th, Oct 1-2, 1984, Halifax, Canada. Spons. by National Res. Council Canada, NRC No. 23619, pp 19.1 -19.15, 7 figs, 4 refs

KEY WORDS: Balancing techniques, Finite element techniques, Rotors, Computer-aided techniques

A finite-element model for a turbogenerator rotor is developed for balancing rotating machinery. The model is based on an axisymmetric shaft of variable diameter rotating in a flexible asymmetric fluid bearing resting on a rigid foundation. A computational model based on a finite element discretization can thus be used to identify unbalance forces without the numerous trial runs presently used to establish the influence coefficient matrix of the system.

MONITORING

85-1027
Guidelines for Machinery Data Logging
J.M. Cummings
Roy M. Huffington, Inc., Bontang, Indonesia
Hydrocarbon Processing, 64 (1), pp 61-65 (Jan 1985) 2 figs, 2 refs

KEY WORDS: Monitoring techniques, Machinery

This article outlines a simple, inexpensive but effective way -- data logging -- to assure that major machinery trains are operating reliably. Shortcomings are also discussed.

85-1028
The Development of Vibration and Rundown Time Norms as a Quality Control Tool for Overhauled Electric Motors
C.A.W. Glew, W.A. Reinhardt
Naval Engrg. Test Establishment
Machinery Dynamics Seminar, Proc. of the 8th, Oct 1-2, 1984, Halifax, Canada. Spons. by National Res. Council Canada, NRC No. 23619, pp 18.1 -18.21, 12 figs, 5 refs

KEY WORDS: Monitoring techniques, Motors

The quality of mechanical overhaul of the motors was gauged by the octave band vibration spectrum and rundown time measurements during post overhaul motor tests. A vibration control specification is a significant improvement over those presently used commercially.

85-1029
The Evolution of Octave Band Vibration Severity Zones for Naval Machinery
G.D. Xistris, J.M. Lowe
Concordia Univ., Montreal, Quebec, Canada
Machinery Dynamics Seminar, Proc. of the 8th, Oct 1-2, 1984, Halifax, Canada. Spons. by National Res. Council Canada, NRC No. 23619, pp 17.1 -17.11, 6 figs, 3 refs

KEY WORDS: Monitoring techniques, Shipboard machinery

This paper describes the evolution of a vibration monitoring program and its gradual acceptance as a reliable quality assurance indicator. Yearly variation of both overall and octave band vibration severity zones computed on a moving 48 month cycle are described. Use of such variations in assessing the effectiveness of maintenance policies and procedures are shown.

85-1030
The Application of Vibration Analysis in Canadian Forces Aircraft Maintenance
F. Dube
Nondestructive Testing Branch, Aircraft Maintenance Development Unit, Canadian Forces Base Trenton, Astra, Ontario K0K 1B0, Canada
Machinery Dynamics Seminar, Proc. of the 8th, Oct 1-2, 1984, Halifax, Canada. Spons. by National Res. Council Canada, NRC No. 23619, pp 16.1 -16.11, 6 figs

KEY WORDS: Monitoring techniques, Aircraft

This paper outlines the philosophy behind the use of vibration analysis as an aircraft maintenance troubleshooting tool. Steps needed for a successful implementation of the program include establishing guidelines, gathering data, developing troubleshooting guides, and program review. Equipment used to record vibration signatures, analyze data and produce guidelines are described.

85-1031
Vibration Analysis Programs for Shipboard Machinery
J.A. Gruber

Maritime Engrg. and Maintenance, National Defence Headquarters, Ottawa, Ontario, Canada
Machinery Dynamics Seminar, Proc. of the 8th, Oct 1-2, 1984, Halifax, Canada. Spons. by National Res. Council Canada, NRC No. 23619, pp 15.1 -15.14

KEY WORDS: Monitoring techniques, Shipboard machinery, Machinery vibration

This paper describes the evolution of a vibration analysis program and the gradual acceptance of equipment health monitoring techniques as reliable indicators of satisfactory operation. On the basis of an assessment of program results to date, a supposition is made for developments during the next decade.

ANALYSIS AND DESIGN

ANALYTICAL METHODS

85-1032
Development of a Solid Hexahedron Finite Dynamic Element
K.K. Gupta
NASA Ames Res. Ctr., Dryden Flight Res. Facility, Edwards, CA
Intl. J. Numer. Methods Engrg., 20 (11), pp 2143-2150 (Nov 1984) 3 figs, 1 table, 7 refs

KEY WORDS: Finite element technique, Structural response

This newly developed solid rectangular hexahedron finite dynamic element involves derivation of higher order stiffness and inertia dynamic correction matrices. Numerical results of a test case indicate that adoption of the dynamic elements significantly improves the solution convergence when compared with the related performance of the corresponding finite elements.

85-1033
Oscillations of a Self-Excited, Nonlinear System
S.A. Hall, W.D. Iwan
International Business Machines Corp., Yorktown Heights, NY 10598
J. Appl. Mech., Trans. ASME, 51 (4), pp 892-898 (Dec 1984) 11 figs, 8 refs

KEY WORDS: Equations of motion, Vortex-induced vibration

A system of self-excited, nonlinear differential equations exhibiting frequency entrainment is studied. The results apply specifically to a model for the vortex-induced oscillation of linear structures. Partial nonlinear coupling and full nonlinear coupling are identified. The partially coupled case describes a structure with a single mode of oscillation; the fully coupled case approximates continuous systems, such as undersea cables. Solutions for each case are examined for stability. Results reveal several new types of behavior.

85-1034
Dynamics of Constrained Multibody Systems
J.W. Kamman, R.L. Huston
Univ. of Notre Dame, Notre Dame, IN 46556
J. Appl. Mech., Trans. ASME, 51 (4), pp 899-903 (Dec 1984) 5 figs, 27 refs

KEY WORDS: Equations of motion

A new automated procedure for obtaining and solving the governing equations of motion of constrained multibody systems is presented. The procedure is applicable when the constraints are either geometric or kinematic. Examples of a constrained hanging chain and a chain whose end has a prescribed motion are presented. Applications are suggested in robotics, cable dynamics, and biomechanics.

85-1035
Implementation and Accuracy of Mixed-Time Implicit-Explicit Methods for Structural Dynamics

Wing Kam Liu, T. Belytschko, Yi Fei Zhang
Technological Inst., Northwestern Univ., Evanston, IL 60201
Computers Struc., 19 (4), pp 521-530 (1984) 4 figs, 5 tables, 15 refs

KEY WORDS: Dynamic structural analysis, Numerical analysis

Three topics are discussed: computer implementation of mixed-time procedures; hourglass control for bilinear quadrilaterals using one-point quadrature and its effect on numerical stability in the explicit partition; and spurious oscillations in solutions. Two numerical examples examine the accuracy and effectiveness of mixed-time formulations.

85-1036
Complementary Variational Principles in Elastodynamics
B. Tabarrok
Univ. of Toronto, Toronto, Canada
Computers Struc., 19 (1/2), pp 239-246 (1984) 31 refs

KEY WORDS: Elastodynamic response, Variational methods

Hamilton's principle and its complementary form are derived for discrete systems. Hamilton's principle is applied to the elastodynamic problem of continuous media. This principle can be modified to yield the generalizations of some variational principles of elastostatics to the dynamic regime. Application of the complementary energy procedure is illustrated. Sal' .nt features for the free vibration eigenvalue problem are discussed.

85-1037
A Perturbation Method for Certain Non-Linear Oscillators
T.D. Burton
Washington State Univ., Pullman, WA 99164-2920
Intl. J. Nonlin. Mech., 19 (5), pp 397-407 (1984) 5 figs, 21 refs

KEY WORDS: Perturbation theory

A perturbation method for the analysis of single degree of freedom nonlinear oscillation phenomena governed by an equation of motion containing a parameter ε which need not be small is presented. The approach is to define a new parameter $\alpha = \alpha(\varepsilon)$ so that asymptotic solutions in power series in α converge more quickly than do standard perturbation expansions in power series in ε. Phenomena considered are free vibration of strongly nonlinear conservative oscillators and steady-state response of strongly nonlinear oscillators subject to weak harmonic excitation.

85-1038
The Gate Function Response Method in Analysis of Linear Systems
Du Qingxuan
J. China Railway Soc., 5 (4), pp 22-29 (1984) CSTA No. 625.1-83.34

KEY WORDS: Time domain method

The unit gate function is defined. The gate function response method in the time-domain analysis of linear systems is introduced. The convolution integral can thus be converted into ordinary integrals.

85-1039
Recursive Covariance of Structural Responses
M. Hoshiya, K. Ishii, S. Nagata
Musashi Inst. of Tech., Tokyo, Japan
ASCE J. Engrg. Mech., 110 (12), pp 1743-1755 (Dec 1984) 10 figs, 10 refs

KEY WORDS: Recursive methods, Nuclear power plants, Seismic response, Torsional vibration

This paper describes an effective method of obtaining covariance responses in recursive form for a multi-degree-of-freedom linear structural system subjected to nonstationary random excitations. Earthquake excitations are expressed as a multiply-correlated nonstationary autoregressive process model. A BWR type nuclear power plant building is used as an example.

85-1040
Spectral Model and Time-Varying Covariance Functions for the Nonstationary Processes
Y.H. Tsao
Intercole Systems Ltd., Avenger Close, Changlers Ford, Eastleigh, Hants, S05 3YU, UK
J. Acoust. Soc. Amer., 76 (5), pp 1422-1426 (Nov 1984) 40 refs

KEY WORDS: Stochastic processes, Covariance function, Power spectral density

The paper reviews a spectral description for a nonstationary process and models it as the output from a white-noise excited time-variant shaping filter. The new relationship has generalized the W-K theorem in a special way, that is efficient and accurate to synthetic signals and to practical signals.

85-1041
Range and Frequency Dependence of Transfer Function Phase
R.H. Lyon
Massachusetts Inst. of Tech., Cambridge, MA
J. Acoust. Soc. Amer., 76 (5), pp 1433-1437 (Nov 1984) 9 figs, 7 refs

KEY WORDS: Phase methods

The phase trend in multi-degree-of-freedom systems can be determined by an algorithm that tracks relative signs of adjacent resonances in a modal expansion of transfer functions. This algorithm is expressed in analytical form for two-dimensional systems. The expression shows the transition from input function phase to reverberant phase limit. The phase trend for two-dimensional systems exceeds that of the average response of such systems. The reason for this difference is discussed.

85-1042
Reduction and Condensation of Dynamic Systems
O. Daněk
Inst. of Thermomechanics, Czechoslovak Academy of Sciences, Prague, Czechoslovakia
Strojnícky Časopis, 35 (4), pp 437-448 (1984) 7 refs (In Czech)

KEY WORDS: Reduction methods, Condensation method, Dynamic systems

Possibilities of reduction are investigated and conditions of condensation are derived. Reduction is understood as the transformation of a mathematical model from an n-dimensional space P^n to P^m, where $m < n$. Condensation is thus spectrally and modally true reduction.

85-1043
Time-Variant Filtering for Nonstationary Random Processes
Y.H. Tsao
Inst. of Sound Vib. Res., Univ. of Southampton, Southampton S09 5NH, UK
J. Acoust. Soc. Amer., 76 (4), pp 1098-1113 (Oct 1984) 4 figs, 3 tables, 60 refs

KEY WORDS: Random response, Frequency domain method, Modulation functions

This paper is concerned with the effects of time-variant linear systems upon the nonstationarity of an acquired random process. The basis approach is the frequency domain description. A general series form of the input-output relationship is expressed in terms of relevant modulation functions of the processes. Two approximations: the system iterative method and the power series method might be usefully applied to certain nonstationary problems.

STATISTICAL METHODS

85-1044
Oscillator Response to Nonstationary Excitation

G.P. Solomos, P.-T.D. Spanos
Rice Univ., P.O. Box 1892, Houston, TX 77521
J. Appl. Mech., Trans. ASME, 51 (4), pp 907-912 (Dec 1984) 4 figs, 17 refs

KEY WORDS: Oscillators, Probability theory

Analytical solutions are presented for probability density distributions of various response parameters of a lightly damped oscillator. The oscillator is subjected to a broad-band stochastic excitation with a time-variant power spectrum. Analytical solutions are derived by utilizing appropriate Fokker-Planck equations. The reliability of the approximate analytical solution is tested by using pertinent data generated by a digital Monte Carlo study.

PARAMETER IDENTIFICATION

85-1045
Experimental Parameter Determination of Industrial Robots (Praktische Erfahrungen bei der experimentellen Parameterbestimmung an Industrierobotern)
C. Dietrich, U. Monczkowski
Technische Universität Dresden, German Dem. Rep.
Maschinenbautechnik, 33 (6), pp 249-252 (1984) 6 figs, 5 tables, 5 refs (In German)

KEY WORDS: Parameter identification techniques, Robots

Methods for the determination of static and dynamic parameters are presented. The advantages and disadvantages of their application are discussed. Selected results for natural frequencies, damping ratio, mass moment of inertia, static total clearance, and overshooting behavior are explained.

OPTIMIZATION TECHNIQUES

85-1046
An Optimality Criterion Method for Structures with Stress, Displacement and Frequency Constraints
A. Zacharopoulos, K.D. Willmert, M.R. Khan
Clarkson Univ., Potsdam, NY
Computers Struc., 19 (4), pp 621-629 (1984) 1 fig, 7 tables, 40 refs

KEY WORDS: Minimum weight design, Frequency constraints, Aircraft wings

The technique is a combination of a previously developed method for stress and displacement constraints alone and one for frequency limited structures. The method is applied to a delta-wing. It is capable of obtaining the optimal design in a small number of iterations, without significant calculations beyond a standard analysis.

COMPUTER PROGRAMS

85-1047
Shock Wave Modelling and the Hull Computer Code Formation of Mach Stems
J.A. Waschl
Materials Res. Labs., Melbourne, Australia
Rept. No. MRL-R-907, AR-3-803, 29 pp (Nov 1983) N84-25942

KEY WORDS: Shock waves, Wave propagation, Computer programs

The HULL code was modified to run on an Australian computer system to examine its capabilities. The HULL was used to simulate the collision of a traveling shock wave with an oblique ramp within a shock tube. The resultant Mach stem formation and growth and the triple point trajectory were analyzed and their validity verified.

85-1048
Computer Code EURDYN-1M (Release 2): User's Manual
S. Giuliani
Commission of the European Communities, Ispra, Italy
Rept. No. EUR-8220-EN, 85 pp (1982) PB84-212570

KEY WORDS: Computer programs, Structure-fluid interaction

EURDYN-1M is a finite element computer code developed at JRC Ispra to compute the response of two-dimensional, coupled fluid-structure configurations to transient dynamic loading. Instructions are given for preparing input data to EURDYN-1M, release 2. A test problem on water hammer illustrates input and output of the code.

85-1049
Computer Codes for Fluid-Structure Interactions
W.H. McMaster
Lawrence Livermore National Lab., CA
Rept. No. UCRL-89724, CONF-840647-14, 16 pp (Apr 1984) DE84011068

KEY WORDS: Fluid-structure interaction, Computer programs

Three fluid dynamics codes are available to analyze fluid-structure interactions when fluid motion is drastic enough to cause difficulties in the Lagrangian formulation. The fluid-structure interaction algorithms have been developed to analyze the dynamic response of coupled fluid-structure systems.

85-1050
Dynamic Stress Analysis of Smooth and Notched Fiber Composite Flexural Specimens
P.L.N. Murthy, C.C. Chamis
NASA Lewis Res. Ctr., Cleveland, OH
Rept. No. E-2152, NASA-TM-83694, 27 pp (1984) N84-25770

KEY WORDS: Fiber composites, Transient response, Computer programs

The analysis is performed using a direct transient response analysis solution sequence of MSC/NASTRAN. Three unidirectional composites were chosen. The specimens were subjected to an impact load. The results are compared with those of static analysis of specimens subjected to a peak load of 2000 lb.

85-1051
Experimental Modal Analysis
Societe Nationale Industrielle Aerospatiele, Marignane, France
Rept. No. SNIAS-832-210-110, 8 pp (1983) N84-25655

KEY WORDS: Experimental modal analysis, Computer programs, Helicopter rotors, Helicopter vibrations

An experimental software program for analyzing the dynamic behavior of structural vibration is examined. Helicopter rotor vibrations are analyzed for shape animation, damping methods, and general model refinement.

85-1052
Mathematical Modeling of a Continuum. Related Modal Analysis. Volume 1: Problem Analysis
M. Davies
Surrey Univ., Guildford, England
Rept. No. ESA-CR(P)-1862-V-1, 122 pp (Nov 1983) N84-26376

KEY WORDS: Modal analysis, Computer programs

A mathematical analysis of methods forming the basis of the modal analysis software package written for ESTEC is given. Details are given of two fundamental algorithms for finding modal values. Linear algebra procedures for generating modal vectors and gains matrices are presented.

85-1053
Mathematical Modelling of a Continuum. Related Modal Analysis. Volume 2: User's Manual
Surrey Univ., Guildford, England
Rept. No. ESA-CR(P)-1862-V-2, 70 pp (Nov 1983) N84-26379

KEY WORDS: Modal analysis, Computer programs

A brief resume of the basic characteristics of the two packages is given. Sections cover the operation and presentation of user-application subroutines required by the system. Input data handling and intermediate data transfers, output information, scaling, debugging, and diagnostic facilities are described.

GENERAL TOPICS

CONFERENCE PROCEEDINGS

85-1054
INTERNOISE 84 -- International Cooperation for Noise Control
Proc. 1984 Intl. Conf. on Noise Control Engrg., Honolulu, Hawaii, Dec 3-5, 1984

KEY WORDS: Noise control, Proceedings

A number of papers have to do with physical aspects of environmental noise, especially community noise control. A second group of 37 papers deals with sound intensity. Other areas include noise emission of sources, active sound attenuation, and noise reduction by barriers.

CRITERIA, STANDARDS, AND SPECIFICATIONS

85-1055
Recommendations for On-Site Vibration Standards
G.E. Fischer
Stanford Linear Accelerator Ctr., CA
Rept. No. SLAC-CN-236, 12 pp (June 1983)
DE84011756

KEY WORDS: Ground vibration, Vibration control, Standards

Unless certain common sense precautions are observed, the luminosity of the Collider may be adversely affected by otherwise preventable ground vibrations. The order of magnitude of amplitudes and frequencies of known noise polluters is described in relation to naturally occurring distances and to the tolerances required for successful Collider operation. A vibration tolerance level specification is recommended.

AUTHOR INDEX

TECHNICAL NOTES

S.A. Paipetis
A Note on the Approximate Determination of Equal Eigenfrequencies in Elastic Systems
Acustica, 56 (1), pp 53-56 (Sept 1984) 5 figs, 2 tables, 15 refs

B.B. Aalami
Large-Amplitude Vibrations of Rectangular Plates
J. Appl. Mech., Trans. ASME, 51 (4), pp 953-937 (Dec 1984) 3 figs, 11 refs

A.K. Chattopadhyay and B.C. Majumdar
Dynamic Characteristics of Finite Porous Journal Bearings Considering Tangential Velocity Slip
J. Tribology, Trans. ASME, 106 (4), pp 534-536 (Oct 1984) 1 fig, 3 tables, 12 refs

Shyi-Yaung Chen and Jon-Shen Fuh
Application of the Generalized Inverse in Structural System Identification
AIAA J., 22 (12), pp 1827-1830 (Dec 1984) 2 figs, 2 tables, 4 refs

J.E. Cole, III
Membrane Damping by a Constrained Layer
J. Acoust. Soc. Amer., 76 (4), pp 1250-1251 (Oct 1984) 1 fig, 2 refs

M. Tajuddin and A.A. Moiz
Rayleigh Waves on a Convex Cylindrical Poroelastic Surface. Part II
J. Acoust. Soc. Amer., 76 (4), pp 1252-1254 (Oct 1984) 1 fig, 9 refs

T. Mizusawa and T. Kajita
Vibration of Continuous Skew Plates
Earthquake Engrg. Struc. Dynam., 12 (6), pp 874-850 (Nov/Dec 1984) 2 figs, 2 tables, 16 refs

J.D. Smith
Energy Loss in Gear Tooth Impact
IMechE, Proc., 198 (12), pp 205-208 (1984) 6 figs, 2 refs

M. Greenhow
A Note on the High-Frequency Limits of a Floating Body
J. Ship Res., 28 (4), pp 226-228 (Dec 1984) 4 tables, 6 refs

K.W. Yeow
Penetration of Aircraft Noise into an Open Configuration Airport Terminal Building
J. Sound Vib., 95 (2), pp 291-294 (July 22, 1984) 2 figs

K. Kanaka Raju and G. Venkateswara Rao
Vibration, Stability and Frequency-Axial Load Relation of Short Beams
J. Sound Vib., 95 (3), pp 426-429 (Aug 8, 1984) 2 tables, 5 refs

G. Yamada, T. Irie, and I. Yoshioka
Equations of Vibration and Sectional Constants of Thin-Walled Beams with Alphabet-Shaped Cross-Section
J. Sound Vib., 95 (3), pp 423-425 (Aug 8, 1984) 2 figs, 1 table, 4 refs

B.L. Ly
A Computation Technique for the Response of Linear Systems
J. Sound Vib., 95 (3), pp 435-438 (Aug 8, 1984) 6 refs

S.T. Wu
Frequencies of Coupled Translational-Rotational Systems Including the Effects of the Impedance Functions for the Foundations
J. Sound Vib., 95 (4), pp 561-564 (Aug 22, 1984) 2 figs, 1 table, 10 refs

F.M. Kessler, E.J. DiPolvere, M. van Ouwerkerk
Highway Identification of Potential Exhaust System Noise Problems
Noise Control Engrg. J., 23 (1), pp 40-43 (July/Aug 1984) 4 figs, 1 table, 3 refs

CALENDAR

JUNE

3-5 **NOISE-CON 85** [Inst. Noise Control Engrg./Ohio State Univ.] Columbus, OH (NOISE-CON 85, Dept. of Mech. Engrg., Ohio State Univ., 206 W. 18th Ave., Columbus, OH 43210 - (614) 422-1910)

19-21 **American Control Conference** [ASME] Boston, MA (ASME)

24-26 **2nd National Conference and Workshop on Tailoring Environmental Standards to Control Contract Requirements** [IES] Leesburg, VA (IES)

24-26 **Mechanics Conference** [ASME/-ASCE] Albuquerque, NM (ASME/ASCE)

JULY

2-4 **Ultrasonics International '85,** Kings College, London (Z. Novak, Ultrasonics, P.O. Box 63, Westbury House, Bury St., Guildford, Surrey GU2 5BH, England)

11-13 **International Compressor Engineering Conference,** Lafayette, IN (Purdue Univ., W. Lafayette, IN - (317) 494-2132)

AUGUST

4-8 **International Computers in Engineering Conference and Exhibition** [ASME] Boston, MA (ASME)

5-10 **SAE West Coast International Meeting** [SAE] Portland, OR (SAE)

SEPTEMBER

2-7 **International Gas Turbine Symposium and Exposition** [Gas Turbine Div., ASME; Chinese Natl. Aero-Technology Import and Export Corp.; Chinese Soc. of Aeronautics and Astronautics] Beijing, People's Rep. China (Intl. Gas Turbine Ctr., 4250 Perimeter Park South, Suite 108, Atlanta, GA 30341 - (404) 451-1905)

9-11 **19th Midwestern Mechanics Conference** [Ohio State Univ.] Columbus, OH (Dept. of Engrg. Mech., Ohio State Univ., 155 W. Woodruff Ave., Columbus, OH 43210 - (614) 422-2731)

10-13 **Design Automation Conference** [ASME] Cincinnati, OH (ASME)

10-13 **Failure Prevention and Reliability Conference** [ASME] Cincinnati, OH (ASME)

10-13 **Vibrations Conference** [ASME] Cincinnati, OH (ASME)

16-20 **DIAGNOSTICS - 85** [Technical Univ. Poznan / Polish Academy Sciences] Leszno, Poland (Diagnostics -85, Prof. C. Cempel, Tech. Univ. Poznan, Piotrowo 3, P.O. Box 5, 60-695 Poznan, Poland)

18-20 **INTER-NOISE '85** [Intl. Inst. Noise Control Engrg.] Munich, Fed. Rep. Germany (E. Zwicker, Institut f. Elektroakustik, TU Munchen, Arcisstr. 21, 8000 Munchen 2, Fed. Rep. Germany)

OCTOBER

6-8 **Diesel and Gas Engine Power Technical Conference** [ASME] Grove City, PA (ASME)

8-10 **Lubrication Conference** [ASLE/-ASME] Atlanta, GA (ASLE/ASME)

8-11 **Stapp Car Crash Conference** [SAE] Arlington, VA (SAE)

14-17 **Aerospace Congress and Exposition** [SAE] Los Angeles, CA (SAE)

20-24 **Power Generation Conference** [ASME] Milwaukee, WI (ASME)

22-24 14th Turbomachinery Symposium [Turbomachinery Labs] Houston, TX (Dara Childs, Turbomachinery Labs., Dept. of Mech. Engrg., Texas A&M Univ., College Station, TX 77843)

22-24 56th Shock and Vibration Symposium [Shock and Vibration Information Ctr., Washington, D.C.] Monterey, CA (Dr. J. Gordan Showalter, Acting Director, SVIC, Naval Res. Lab., Code 5804, Washington, D.C. 20375-5000 - (202) 767-2220)

NOVEMBER

4-8 Acoustical Society of America, Fall Meeting [ASA] Nashville, TN (ASA)

11-14 Truck and Bus Meeting and Exposition [SAE] South Bend, IN (SAE)

17-22 American Society of Mechanical Engineers, Winter Annual Meeting [ASME] Miami Beach, FL (ASME)

DECEMBER

11-13 Western Design Engineering Show [ASME] Anaheim, CA (ASME)

CALENDAR ACRONYM DEFINITIONS AND ADDRESSES OF SOCIETY HEADQUARTERS

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

AIAA American Institute of Aeronautics and Astronautics
1633 Broadway
New York, NY 10019

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

ASCE American Society of Civil Engineers
United Engineering Center
345 E. 47th St.
New York, NY 10017

ASLE American Society of Lubrication Engineers
838 Busse Highway
Park Ridge, IL 60068

ASME American Society of Mechanical Engineers
United Engineering Center
345 E. 47th St.
New York, NY 10017

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

ICF International Congress on Fracture
Tohoku University
Sendai, Japan

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

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

IMechE Institution of Mechanical Engineers
1 Birdcage Walk, Westminster
London SW1, UK

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

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

ISA Instrument Society of America
67 Alexander Dr.
Research Triangle Pk., NC 27709

SAE Society of Automotive Engineers
400 Commonwealth Dr.
Warrendale, PA 15096

SEE Society of Environmental Engineers
Owles Hall, Buntingford, Hertz.
SG9 9PL, England

SESA Society for Experimental Mechanics (formerly Society for Experimental Stress Analysis)
14 Fairfield Dr.
Brookfield Center, CT 06805

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

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

SVIC Shock and Vibration Information Center
Naval Research Laboratory
Code 5804
Washington, D.C. 20375-5000

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PUBLICATION POLICY

Unsolicited articles are accepted for publication in the **Shock and Vibration Digest.** Feature articles should be tutorials and/or reviews of areas of interest to shock and vibration engineers. Literature review articles should provide a subjective critique/summary of papers, patents, proceedings, and reports of a pertinent topic in the shock and vibration field. A literature review should stress important recent technology. Only pertinent literature should be cited. Illustrations are encouraged. Detailed mathematical derivations are discouraged; rather, simple formulas representing results should be used. When complex formulas cannot be avoided, a functional form should be used so that readers will understand the interaction between parameters and variables.

Manuscripts must be typed (double-spaced) and figures attached. It is strongly recommended that line figures be rendered in ink or heavy pencil and neatly labeled. Photographs must be unscreened glossy black and white prints. The format for references shown in **Digest** articles is to be followed.

Manuscripts must begin with a brief abstract, or summary. Only material referred to in the text should be included in the list of References at the end of the article. References should be cited in text by consecutive numbers in brackets, as in the following example:

> Unfortunately, such information is often unreliable, particularly statistical data pertinent to a reliability assessment, as has been previously noted [1].
>
> Critical and certain related excitations were first applied to the problem of assessing system reliability almost a decade ago [2]. Since then, the variations that have been developed and practical applications that have been explored [3-7] indicate . . .

The format and style for the list of References at the end of the article are as follows:

-- each citation number as it appears in text (not in alphabetical order)
-- last name of author/editor followed by initials or first name
-- titles of articles within quotations, titles of books underlined
-- abbreviated title of journal in which article was published (see Periodicals Scanned list in January, June, and December issues)
-- volume, issue number, and pages for journals; publisher for books
-- year of publication in parentheses

A sample reference list is given below.

1. Platzer, M.F., "Transonic Blade Flutter -- A Survey," Shock Vib. Dig., 7 (7), pp 97-106 (July 1975).

2. Bisplinghoff, R.L., Ashley, H., and Halfman, R.L., Aeroelasticity, Addison-Wesley (1955).

3. Jones, W.P., (Ed.), "Manual on Aeroelasticity," Part II, Aerodynamic Aspects, Advisory Group Aeronaut. Res. Dev. (1962).

Articles for the **Digest** will be reviewed for technical content and edited for style and format. Before an article is submitted, the topic area should be cleared with the editors of the **Digest**. Literature review topics are assigned on a first come basis. Topics should be narrow and well-defined. Articles should be 3000 to 4000 words in length. For additional information on topics and editorial policies, please contact:

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