VOLUME 17, NO. 9
SEPTEMBER 1985

THE SHOCK AND VIBRATION DIGEST

A PUBLICATION OF
THE SHOCK AND VIBRATION
INFORMATION CENTER
NAVAL RESEARCH LABORATORY
WASHINGTON, D.C.

OFFICE OF
THE UNDER
SECRETARY
OF DEFENSE
FOR RESEARCH
AND
ENGINEERING

THE SHOCK AND VIBRATION DIGEST

Volume 17, No. 9
September 1985

The **Shock and Vibration Digest** is a monthly publication of the Shock and Vibration Information Center. The goal of the Digest is to provide efficient transfer of sound, shock, and vibration technology among researchers and practicing engineers. Subjective and objective analyses of the literature are provided along with news and editorial material. News items and articles to be considered for publication should be submitted to:

Dr. R.L. Eshleman
Vibration Institute
Suite 206, 101 West 55th Street
Clarendon Hills, Illinois 60514
(312) 654-2254

Copies of articles abstracted are not available from the Shock and Vibration Information Center (except for those generated by SVIC). Inquiries should be directed to library resources, authors, or the original publishers.

This periodical is for sale on subscription at an annual rate of $200.00. For foreign subscribers, there is an additional 25 percent charge for overseas delivery on both regular subscriptions and back issues. Subscriptions are accepted for the calendar year, beginning with the January issue. Back issues are available -- Volumes 11 through 16 -- for $40.00. Orders may be forwarded at any time to SVIC, Code 5804, Naval Research Laboratory, Washington, D.C. 20375-5000. The Secretary of the Navy has determined that this publication is necessary in the transaction of business required by law of the Department of the Navy. Funds for printing of this publication have been approved by the Navy Publications and Printing Policy Committee.

A publication of

THE SHOCK AND VIBRATION INFORMATION CENTER

Code 5804, Naval Research Laboratory
Washington, D.C. 20375-5000
(202) 767-2220

SVIC NOTES

The Changing Trends in Shock and Vibration Meetings

During the past 20 years both the content and the nature of meetings on shock and vibration have changed noticeably. These changes are reflected in our Shock and Vibration Symposia and in other meetings on this topic.

One of the changes is in the orientation of the papers. A greater proportion of papers presented at the more recent meetings are case history or applications oriented, and I believe this reflects a feeling that many current shock and vibration problems can still be solved by using existing techniques. Budget limitations may also be a reason why fewer technique-oriented papers are presented. Less research of any kind is being performed, and relatively few technology development programs are being funded.

Many new developments, although they are useful, seem to be evolutionary rather than revolutionary. Unfortunately some feel a methods-oriented paper should only be presented if it represents a quantum jump in the technology. Could this attitude be another explanation for the reduced number of technique-oriented papers presented at today's meetings? But even when substantially new methods are developed, the ones who should write about them cannot do it because they do not have the time or the money.

The subjects that are discussed, or the session titles have significantly changed as well. These subject matter changes reflect the changing interests of the shock and vibration community. Subjects are discussed at meetings either because there are new developments or because they are controversial. But a subject may be actively discussed at meetings for several years, and then it might not be actively discussed again for many years. This often happens because significant changes might have occurred during the intervening years to make it necessary to discuss that particular subject again. Pyrotechnic shock is a good example. This subject was actively discussed during the early to mid 1960's; it was actively discussed again at a recent meeting this year; it will be emphasized at the 56th Shock and Vibration Symposium.

The "Short Discussion Topics" type of session is another change in meeting content that is often overlooked. These sessions are organized to deal with descriptions of "hints or kinks" or progress reports on on-going efforts; these presentations do no warrant writing a complete technical paper; so, ordinarily, nothing is published. These sessions are interesting because they provide insight into current work, and many useful "hints and kinks" are often disclosed in these sessions. But, because they are not published these "hints and kinks" are lost, except to those who attend these sessions. Perhaps some provision should be made for publishing these types of presentations.

The nature and the conduct of meetings on shock and vibration have also changed substantially during the past 20 years. Briefly, the changes concern the type of audio-visual equipment used in the meetings, the number of meetings on shock and vibration, and the growing degree of international participation.

EDITORS RATTLE SPACE

ABSTRACT CATEGORIES

The Abstracts from the Current Literature section of the DIGEST provides a monthly listing of journal articles, reports, and Ph.D. dissertations on shock and vibration technology. This listing of published material provides the reader with an objective view of the literature. In order to make maximum use of the literature and to effect an efficient transfer of information to the practicing engineer and/or scientist, some form of literature characterization must be used. Currently, twelve fundamental categories are used to separate the literature for the monthly review of the reader.

- Mechanical Systems
- Structural Systems
- Vehicle Systems
- Biological Systems
- Mechanical Components
- Structural Components
- Electric Components
- Dynamic Environment
- Mechanical Properties
- Experimentation
- Analysis and Design
- General Topics

These categories are further broken down into subgroups to allow easy access to discrete areas without burden on the reader. In recent issues of the DIGEST we have had a fairly even distribution of articles in most of these categories. This leads one to assume that the present categorization provides a reasonable density of articles in the categories and subcategories. If you the reader have comments on these categories or suggestions on refinement, I would like to hear from you.

R.L.E.

IMPACTOR INTERACTION WITH CONCRETE STRUCTURES — LOCAL EFFECTS

H. Adeli* and R.L. Sierakowski**

Abstract. **This paper focuses on the local effect of solid impactors acting on concrete structures. Available formulas for predicting the penetration depth, scabbing thickness, and perforation thickness of solid impactors acting on concrete structures are reviewed and compared.**

The general effects of impactors impinging on concrete structures can be classified as local or global response mechanisms. Local effects include such phenomena as penetration, scabbing, perforation, spalling, and richochet. Global effects can be considered related to flexural and shear behavior of a target. If the kinetic energy of an impactor missile is considerably smaller than the strain energy capacity of the structures or if a structure is sufficiently rigid, local effects can probably be considered the governing factor in structural response. This paper focuses on the local effects of solid impactors acting on concrete structures.

The problem of impact in relation to concrete structures is extremely complicated. A thorough theoretical analysis of the problem has yet to be developed. However, for design of concrete structures against impact, simple reliable equations are urgently needed. At present only empirical and semi-empirical equations seem to have been developed for design purposes. In this paper, available formulas for predicting penetration depth, scabbing thickness, and perforation thickness of solid impactors acting on concrete structures are reviewed and compared.

DEFINITION AND DELINEATION OF PHYSICAL PHENOMENA

Penetration is defined by the so-called wetted area of an impactor as it relates to the target or barrier; the impactor does not exit through the back face of the target (Figure 1). Penetration can be accompanied by back face scabbing of the concrete; however, the depth of scabbing is generally less than the thickness of the concrete cover -- the layer of concrete between the surface and first layer of reinforcement. Penetration depth is fundamentally independent of target thickness given a target of sufficient thickness.

Scabbing is the ejection of concrete pieces from the back face of a target (Figure 2). The thickness of ejected pieces is generally at least equal to the thickness of the concrete cover. Scabbing thickness for design purposes represents the minimum barrier thickness required to prevent scabbing. Scabbing generally leaves a crater on the back face of a target and is accompanied by penetration.

Perforation is the through-the-thickness entrance and exit of an impactor through a target (Figure 3). Perforation thickness in design is the barrier thickness required to prevent perforation. At this thickness, the impactor passes through the barrier and exits with a zero residual velocity.

Spalling is the ejection of concrete, generally from the front face (impact face) of a target or barrier. Spalling sometimes is associated with rear face fracture of concrete targets and barriers.

Ricochet is the rebound of an impactor interacting with a target at a nonzero incidence angle. The incidence angle is defined with respect to the normal impact plane, which is measured with respect to the impact surface.

*Associate Professor, **Professor and Chairman, Department of Civil Engineering, The Ohio State University, Columbus, OH 43210

PENETRATION DEPTH

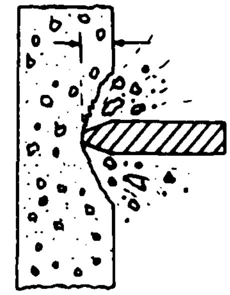

Figure 1. Penetration

A summary of available penetration equations along with their limitations are presented in Table 1. Included are the Modified Petry [1, 2]; Army Corps of Engineers, ACE [3]; Modified National Defense Research Committee, NDRC [4, 5]; Ammann and Whitney [6]; Kar [7]; Haldar and Miller [8]; Hughes [9]; and Adeli et al [10]. Certain of the penetration depth formulas [8-10] contain dimensionless parameters; others contain dimensional parameters. A list of nomenclature and appropriate units for the variables used in the dimensional equations are given in the Appendix.

The Petry formula, originally developed in 1910, represents one of the oldest recognized penetration formulas. It can be used to calculate penetration depth in terms of velocity of the impactor V, weight of impactor per unit of impacted area A_p, and type of concrete as represented by coefficient K_p. This coefficient was originally given values of 0.00284 for specially reinforced concrete, 0.00426 for normal reinforced concrete, and 0.00799 for massive concrete, independent of concrete strength. Amirikian [2] improved this equation by introducing a curve that expresses K_p as a function of concrete strength. This curve, however, is applicable for a particular case of reinforced concrete. The revised equation has become known in the literature as the Modified Petry penetration equation.

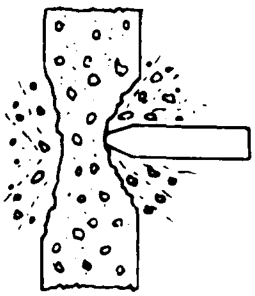

Figure 2. Scabbing

The ACE [3] penetration equation was developed in 1946 by curve fitting experimental data. For a number of years the National Defense Research Council (NDRC) penetration formula [4], developed and based on a large number of tests made during World War II, remained relatively unknown due to information restrictions. In recent years, however, it has become more widely used than the ACE [3] and other formulas. It was apparently the first penetration equation based upon theoretical modeling considerations; the principal premise is that the impact force increases linearly up to a constant terminal value. Experimental results, however, indicate that this assumption is not valid. The NDRC penetration formula was modified in 1966 to include a penetrability factor K as a direct

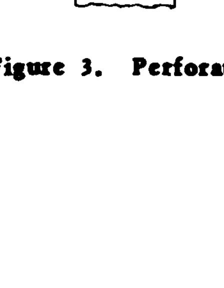

Figure 3. Perforation

Table 1. Penetration Formulas

	Formula	Theoretical basis	Limitations of applicability
Modified Petry (1910)	I. $X_p = 12\ K_p\ A_p\ \log[1 + V^2/215000]$ $K_p = 0.00426$ II. $X_p = 12\ K_p\ A_p\ \log[1 + V^2/215000]$ K_p is given as a function of concrete compressive strength by a curve.	Empirical	
ACE (1946)	$\frac{X_p}{D} = \frac{282\ W}{D^{2.785}\ f_c'^{\frac{1}{2}}}\left[\frac{V}{1000}\right]^{1.5} + 0.5$	Statistical fitting of experimental data	
Modified NDRC (1946)	$\frac{X_p}{D} = \left[\frac{4\ K\ K_1\ W}{D}\left[\frac{V}{10000}\right]^{1.8}\right]^{\frac{1}{2}}$ $\quad \frac{X_p}{D} \leq 2$ $\frac{X_p}{D} = 1 + \frac{K\ K_1\ W}{D}\left[\frac{V}{10000}\right]^{1.8}$ $\quad \frac{X_p}{D} > 2$ K = 0.72 for flat nosed missile. = 0.84 for blunt nosed missile. = 1.00 for average bullet nose (spherical end) = 1.14 for very sharp nose. $K_1 = 180 / \sqrt{f_c'}$	Penetration theory and experimental considerations	$3 \leq \frac{d}{D} \leq 18$ $V \geq 500$ ft/sec.
Ammann & Whitney	$\frac{X_p}{D} = \frac{282\ K\ W}{D^{2.8}\ f_c'^{\frac{1}{2}}}\left[\frac{V}{1000}\right]^{1.8}$		$V \geq 1000$ ft/sec.

Table 1 (continued)

	Formula	Theoretical basis	Limitations of applicability
Kar (1978)	$\frac{X_p}{D} = \{ \frac{4 K K_1 W}{D} [\frac{E}{E_m}]^{1.25} [\frac{V}{1000D}]^{1.8} \}^{1/2}$ $\frac{X_p}{D} \leq 2$ $\frac{X_p}{D} = 1 + \frac{K K_1 W}{D} [\frac{E}{E_m}]^{1.25} [\frac{V}{1000D}]^{1.8}$ $\frac{X_p}{D} > 2$ K = 0.72 for flat nosed missile. K = 0.72 + 0.25 (n - .25)$^{1/2}$ $\leq$ 1.17 for special nose. n = the ratio of the radius of the nose to the diameter of the missile.	Regression analysis	
Haldar & Miller (1982)	$\frac{X_p}{D} = -.02725 + .22024\ I$ $0.3 \leq I \leq 2.5$ (a) $\frac{X_p}{D} = -.592 + .446\ I$ $2.5 \leq I \leq 3.0$ (b) $\frac{X_p}{D} = .53886 + .06892\ I$ $3.0 \leq I \leq 21.$ (c) $I = K W V^2 / g f_c' D^3$	Regression analysis	$89 \leq V \leq 1023$ ft/sec. $0.7 \leq d/D \leq 18$, $D \leq 12$ $0.24 \leq W \leq 756$ lb $0.3 \leq I \leq 21$, $X/D \leq 2$
Hughes (1984)	$\frac{X_p}{D} = 0.19\ K'\ I' / S$ $I' = W V^2 / g f_r D^3$ K' = 1.0 for flat nosed missile. = 1.12 for blunt nosed missile. = 1.26 for average bullet nose (spherical end) = 1.39 for very sharp nose.	Physical model of the impact process and regression analysis	Targets with light reinforcement $I' < 3500$ ($I < 252$) $89 \leq V \leq 1023$ ft/sec. $0.7 \leq d/D \leq 18$, $D \leq 12$ $0.24 \leq W \leq 756$ lb.
Adeli et. al (1985)	I. $\frac{X_p}{D} = .0426 + .1698\ I - .0045\ I^2$ $\frac{X_p}{D} \leq 2$ II. $\frac{X_p}{D} = .012 + .196\ I - .008\ I^2 + .0001\ I^3$ $\frac{X_p}{D} \leq 2$	Quadratic and cubic regression analysis	same as Haldar's

function of the compressive strength of the concrete [5].

Among the older penetration formulas, the NDRC formula has been widely used and favored in the literature [11-13]. Sliter [13] has recently compared the NDRC formula with recent tests and found that, for impact velocities greater than 500 ft/sec, the NDRC formula gives the penetration depth within an error range of 25%, which represents the range of experimental scatter. For smaller velocities, however, he found that penetration depths calculated from the NDRC equation are as much as eight times greater than observed ones.

Kar [7] modified the NDRC equation by including a ratio of the modulus of elasticity of the impactor material to that of mild steel. He pointed out, however, that for most practical cases the ratio is approximately equal to one.

Haldar and Miller [8] determined penetration depth in terms of a dimensionless impact factor I with three linear equations (Table 1). Equations (a) and (c) are based upon a linear regression analysis. The range of applicability of equation (a) was initially selected to be from I = 0.3 to I = 3.0. There seems to be no strong argument, however, for the choice of an impact factor of 3 as a separating point between the two sets of experimental data. The arbitrary choice of 3.0 was troublesome, and they found a discontinuity, or jump, between the two regression lines at the point I = 3.0. In other words, for I = 3.0, equation (a) has a value of X_p/D = 0.63347; however, equation (c) is X_p/D = 0.74562, which is about 18 percent larger than the first value. Considering the relatively few data points used, there appears to be no physical reason for the existence of such a discontinuity. To overcome the difficulty, they drew a straight line between the point I = 3 and X_p/D = 0.74562 of equation (c) and an arbitrarily chosen point I = 2.5 and X_p/D = 0.52335 of equation (a). This line is represented by equation (b) in Table 2. This assumption is very conservative.

Haldar and Hamieh [14] in a recent paper extended the range of the linear penetration equations. They suggested three linear equations for use in the ranges 0.3 < I < 4.0, 4.0 < I < 21.0, and 21.0 < I < 455. However, they did not elaborate the rationale of their separation of ranges within the extended base.

Hughes [9] has also developed impact formulas; they assume the impact force-penetration depth relationship shown in Figure 4. He neglected the linear elastic portion of the curve, however, and assumed a parabola for the nonlinear portion. On the basis of this impact model and using dimensional analysis, he obtained the simple impact formulas given in Tables 1 through 3. He did not evaluate these equations using direct experimental results but used instead data points from the NDRC and ACE formulas.

Based upon quadratic and cubic regression analyses of existing U.S. and European data that have been summarized [13], two formulas have been derived for predicting penetration depth [10]. These new penetration equations are compared statistically with the NDRC penetration formula and two other recent penetration formulas -- the Haldar and Miller formula [8] proposed in 1982 and the Hughes formula [9] proposed in 1984 -- in Figure 5 and Table 4. In general, the variance and coefficient of variation of the new equations are smaller than those values of other formulas (Table 4). Furthermore, the new formulas are advantageous over the NDRC formula because the latter is a dimensional equation. When compared with the Haldar and Miller formula [8] the new equations give the penetration depth continuously in terms of the impact factor using only one equation.

SCABBING THICKNESS

The available scabbing equations are summarized in Table 2 and represent the Modified Petry [1, 2], ACE [3], NDRC [4, 5], Ballistic Research Laboratory (BRL) [15], Bechtel Corporation [16, 17], Stone and Webster [18], Kar [7], Chang [19], and Hughes [9] formulas. The Modified Petry, ACE, NDRC, BRL, and Hughes scabbing equations express scabbing thickness directly in terms of penetration depth.

In 1976 Kennedy [11] compared scabbing equations developed before that time with

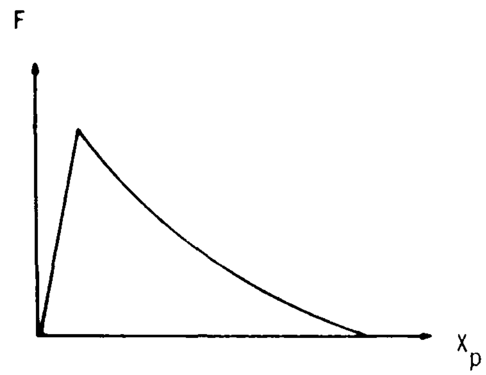

Figure 4. Impact-Force -- Penetration Depth Relationship Used by Hughes [9]

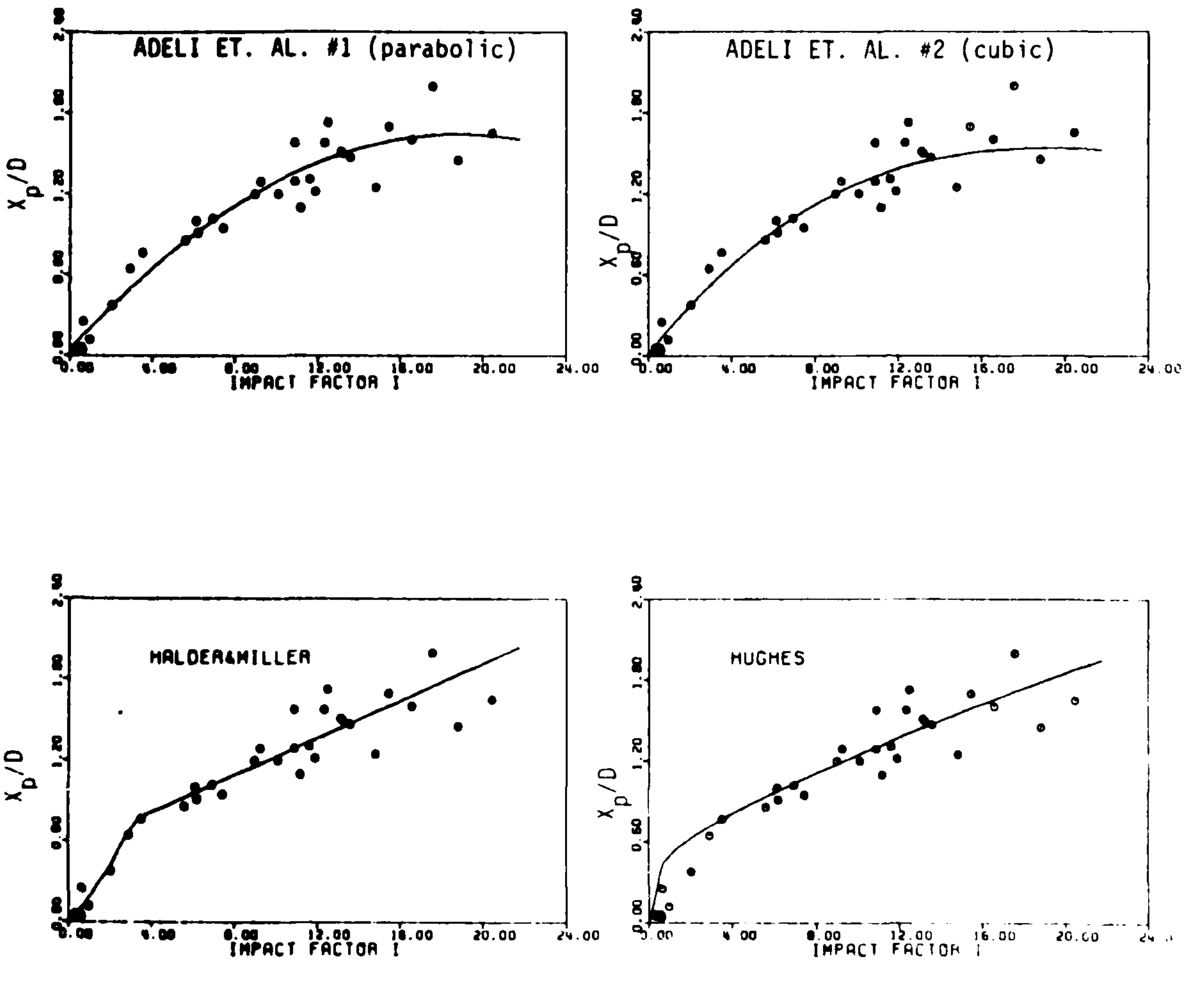

Figure 5. Comparison of Penetration Formulas

Table 2. Scabbing Formulas

	Formula	Theoretical basis	Limitations of applicability
Modified Petry (1910)	$d_s = 2.2\ X_p$	Empirical	
ACE (1946)	$\frac{d_s}{D} = 2.12 + 1.36\ [\frac{X_p}{D}]$ $\quad 0.65 \leq \frac{X_p}{D} \leq 11.75$	Statistical fitting of experimental data	
Modified NDRC (1946) (1966)	$\frac{d_s}{D} = 2.12 + 1.36\ [\frac{X_p}{D}]$ $\quad 0.65 \leq \frac{X_p}{D} \leq 11.75$ $\frac{d_s}{D} = 7.91\ [\frac{X_p}{D}] - 5.06\ [\frac{X_p}{D}]^2$ $\quad \frac{X_p}{D} \leq 0.65$	Penetration theory and experimental considerations	$3 \leqslant \frac{d}{D} \leqslant 18$ $V \geqslant 500$ ft/sec.
Ballistic Research Laboratory	$d_s = 2\ d_p$		
Bechtel Corpori .ion	$d_s = \frac{15.5\ W^{1/2}\ V^{1/2}}{f_c'^{1/2}\ D^{[illegible]}}$		

Table 2 (continued)

	Formula	Theoretical basis	Limitations of applicability
Stone & Webster	$d_s = [\frac{W V^2}{c}]^{1/3}$		$3000 \leq f_c' \leq 4500$ psi. $1.5 \leq \frac{d}{0} \leq 3.0$
Kar (1978)	$b [\frac{d_s - a}{D}] = 2.12 + 1.36 \frac{x_p}{D}$ $0.65 \leq \frac{x_p}{0} \leq 11.75$ $b [\frac{d_s - a}{D}] = 7.91 \frac{x_p}{D} - 5.06 [\frac{x_p}{D}]^2$ $\frac{x_p}{D} \leq 0.65$ b = coefficient of spalling , a = half of aggregate size	Regression analysis	
Chang (1981)	$d_s = 1.84 (\frac{200}{V})^{.13} \frac{(M V^2)^{.4}}{0^{.2} f_c'^{.4}}$	Bayesian analysis and some principles of mechanics	$55 \leq V \leq 1023$ ft/sec. $0.24 \leq W \leq 756$ lb. $2 \leq d \leq 24$ in. $0.79 \leq 0 \leq 24$ in. $3300 \leq f_c' \leq 6600$ psi.
Hughes (1984)	$\frac{d_s}{D} = 5.0 \frac{x_p}{D}$ $\frac{x_p}{D} < 0.7$ $\frac{d_s}{D} = 1.74 \frac{x_p}{D} + 2.3$ $\frac{x_p}{0} \geq 0.7$	Physical model of the impact process and regression analysis	Targets with light reinforcement 1' ≤ 3500 (I ≤ 252) $89 \leq V \leq 1023$ ft/sec. $0.7 \leq \frac{d}{0} \leq 18$, $D \leq 12$ $0.24 \leq W \leq 756$ lb.

available experimental data. He found that NDRC scabbing equation agreed with test results generally within $\pm$ 20 percent; these results are better than those provided using the other scabbing formulas.

The empirical scabbing equations of Kar [7] include the effects of aggregate size. However, his definition of aggregate size is unclear, and he does not describe the data base used. Data presented in his paper are for aggregate size of the order of only 1.5 in.

Sliter [13] compared NDRC, Bechtel, and Stone and Webster scabbing formulas with recent test results. He found that, except for relatively large-diameter nondeformable cylindrical impactors, all equations estimate the scabbing thickness equally well. He noted, however, that further experiments are needed for large-diameter missiles before the scabbing equations can be used with confidence.

Chang [19] has developed semi-analytical equations for scabbing thickness based upon simplifying assumptions and Bayesian statistics. He considered a circular region around an impact area to estimate the strain energy capacity corresponding to scabbing thickness. As pointed out by Haldar [20], this is in contrast to the experimental observation that cracks develop in an impacted region in all directions. He also derived his scabbing equations without taking into account the effect of missile penetration into a target.

The Petry, ACE, NDRC, BRL, Bechtel Corporation, Chang, and Hughes scabbing formulas have recently been compared [10] with data compiled by Sliter [13]. The following conclusions were made:

> The Modified Petry and BRL formulas have the worst fit with experimentally obtained scabbing thickness and underestimate scabbing thickness in many cases.
>
> The Hughes scabbing formula is the most conservative equation in predicting scabbing thickness and overestimates scabbing thickness, sometimes by a factor of three.
>
> The ACE, NDRC, Bechtel, and Chang formulas in general predict scabbing thickness safely with a few exceptions. The NDRC and ACE equations give more conservative results than the other two. In terms of closeness of fit, the Bechtel formula appears somewhat better than the others.

PERFORATION DEPTH

The available perforation equations are summarized in Table 3 and are represented by the Modified Petry [1, 2], ACE [3], NDRC [4, 5], BRL [15], CEA-DEF (Commissariat a l'Energie Atomique - Electricite de France) [21], Kar [7], Degen [22], Chang [19], and Hughes [9] formulas. The Modified Petry, ACE, NDRC, Degen, and Hughes perforation equations appear to give perforation thickness directly in terms of penetration depth.

The first NDRC perforation equation in Table 3 is due to Chelapati and Kennedy [23]. In 1976, Kennedy [11] compared the NDRC perforation equation with the Modified Petry, ACE, and BRL formulas and found better agreement with test data for the NDRC equation than other predictors. Sliter [13] in 1980 compared the NDRC and the CEA-DEF perforation formulas with recent test results and found that the latter estimates perforation thickness much more closely than the former.

The Modified Petry, ACE, NDRC, BRL, CEA-DEF, Degen, Chang, and Hughes perforation formulas were recently compared [10] with data compiled by Sliter [13]. The following conclusions were made:

> The Modified Petry and BRL formulas have the worst fit with the experimentally obtained data and underestimate perforation thickness in many cases.
>
> The Hughes perforation formula in general overestimates perforation thickness more than the other equations.
>
> The CEA-DEF, Degen, and Chang formulas have the best fit for perforation thickness; they are followed by the NDRC formula.

Table 3. Perforation Formulas

	Formula	Theoretical basis	Limitations of applicability
Modified Petry (1910)	$d_p = 2\, x_p$	Empirical	
ACF (1946)	$\frac{d_p}{D} = 1.24 \frac{x_p}{D} + 1.32 \qquad 1.35 \leq \frac{x_p}{D} \leq 13.5$	Statistical fitting of experimental data	
Modified NDRC (1946) (1966)	$\frac{d_p}{D} = 3.19 \frac{x_p}{D} - .718 \left[\frac{x_p}{D}\right]^2 \qquad \frac{x_p}{D} \leq 1.35$ $\frac{d_p}{D} = 1.24 \frac{x_p}{D} + 1.32 \qquad 1.35 \leq \frac{x_p}{D} \leq 13.5$	Penetration theory and experimental considerations	$3 \leq \frac{d}{D} \leq 18$ $V \geq 500$ ft/sec.
Ballistic Research Laboratory	$\frac{d_p}{D} = 7.8 \frac{W}{D^{2.8}} \left[\frac{V}{1000}\right]^{1.33}$ for $f'_c = 3000$ psi $\frac{d_p}{D} = \frac{427\, W}{D^{2.8} f_c'^{1/2}} \left[\frac{V}{1000}\right]^{1.33}$		
CEA-EDF (1977)	$d_p = 0.765\, [f'_c]^{-.375} \left[\frac{W}{D}\right]^{1/2} V^{.75}$	Least squares	Reinforcing steel 9.34 - 18.7 p/ft^3 $4300 \leq f'_c \leq 7300$ psi. $82 \leq V \leq 1476$ ft/sec. $0.345 \leq \frac{d}{D} \leq 4.17$

Table 3 (continued)

	Formula	Theoretical basis	Limitations of applicability
Kar (1978)	$\frac{d_p - a}{D} = 3.19 \frac{X_p}{D} - .718 \left(\frac{X_p}{D}\right)^2$ $\frac{X_p}{D} \leq 1.35$ $\frac{d_p - a}{D} = 1.24 \frac{X_p}{D} + 1.32$ $1.35 < \frac{X_p}{D} < 13.5$ a = half of aggregate size	Regression analysis	
Degen (1980)	$\frac{d_p}{D} = 2.2 \left(\frac{X_p}{D}\right) - 0.3 \left(\frac{X_p}{D}\right)^2$ $\frac{X_p}{D} < 1.52$ $\frac{d_p}{D} = 1.29 \left(\frac{X_p}{D}\right) + 0.69$ $2.65 < \frac{d}{D} < 18$	Statistical analysis	Reinforcing steel 9.97 - 21.8 p/ft³. $82 \leq V \leq 1023$ ft/sec. $33 \leq W \leq 756$ lb. $4116 \leq f'_c \leq 6245$ psi. $6 \leq d \leq 24$ in. $4 \leq D \leq 12$ in. $0.5 \leq d/D \leq 2.7$
Chang (1981)	$d_p = \left(\frac{200}{V}\right)^{1/4} \left(\frac{M V}{D f'_c}\right)^{1/2}$	Bayesian analysis and some principles of mechanics	$55 < V \leq 1023$ ft/sec. $0.24 \leq W \leq 756$ lb. $2 \leq d < 24$ in. $0.79 \leq D \leq 24$ in. $3300 \leq f'_c \leq 6600$ psi.
Hughes (1984)	$\frac{d_p}{D} = 3.6 \frac{X_p}{D}$ $\frac{d}{D} < 3.5$ $\frac{d_p}{D} = 1.58 \frac{X_p}{D} + 1.4$ $\frac{d}{D} > 3.5$	Physical model of the impact process and regression analysis	Targets with light reinforcement $I' < 3500$ ($I < 252$) $89 \leq V < 1023$ ft/sec. $0.7 \leq d/D < 18$, $D < 12$ $0.24 < W < 756$ lb.

Table 4. Comparison of Penetration Equations

	NDRC	Halder & Miller	Hughes	Adeli et al #1	Adeli et al #2
Variance	0.03607	0.02515	0.04242	0.02280	0.02315
Coefficient of Variation	0.18035	0.15061	0.19560	0.14339	0.14449

FUTURE RESEARCH

The effect of reinforcement on damage prediction equations (penetration depth, scabbing thickness, and perforation thickness) should be investigated. Surprisingly, researchers report that the effect of reinforcement is negligible. However, very low percentage of steel (0.3 - 1.5 percent) has usually been used in experiments. Actual reinforced concrete structures usually have reinforcement of the order of 1.5 - 3 percent. Two-way reinforcement behaves as a mesh and can substantially enhance impact resistance. Therefore, further experiments are needed with slabs or other types of structural elements with a high degree of reinforcement.

Little is known about the influence of aggregate size and texture on local impact effects. Experiments performed in Great Britain [25] in which the ratio of impactor diameter to maximum aggregate size varied from 0.5 to 50 indicated a weak dependence of penetration depth on aggregate size. This aspect of the impact problem, however, needs further investigation. Aggregate interlocking behavior and bond slip characteristics should be explored to improve the impact resistance of concrete structures.

Constitutive laws for the high strain rate regime and a proper description of material failure are urgently needed. Failure models for multiaxial short time loadings are practically nonexistent. Such models should inevitably be evolved based upon the physical arguments of micromechanics for the various classes of materials used [26].

Available penetration depth, scabbing thickness, and perforation thickness formulas are basically only for normal impact. This is due to the fact that practically all experiments now performed are for concrete targets subjected to normal impact. Research is needed to develop formulas for oblique incidence impacts.

Properly reinforced concrete has substantial ductility and is deformable. Neglecting the deformability of reinforced concrete results in gross overestimation of local effects. The effect of deformability of reinforced concrete structures should be included in damage prediction formulas.

Local and global effects have traditionally been treated independently [27]. A unified treatment of local effects and dynamic structural response would be more appropriate. For such a unified treatment, impact force-time history curves consistent with barrier penetration, scabbing, and perforation must be developed. Sensitivity of structural response to shape, maximum impact force, and duration of impact should be investigated.

The problem-dependence of local impact effects needs to be studied. A majority of experimental results reported in the literature have been performed on concrete walls or slabs. Different results should be expected for such structures as beams and shells.

REFERENCES

1. Samuely, F.J. and Hamann, C.W., Civil Protection, The Architectural Press (1939).

2. Amirikian, A., "Design of Protective Structures," Report NT-3726, Bureau of Yards and Docks, Department of the Navy (Aug 1950).

3. ACE, "Fundamentals of Protective Design," Report AT1207821, Army Corps of Engineers, Office of the Chief of Engineers (1946).

4. NDRC, "Effects of Impact and Explosion," Summary Tech. Rept. Division 2, National Defense Research Committee, Vol. 1, Washington, D.C. (1946).

5. Kennedy, R.P., "Effects of an Aircraft Crash into a Concrete Reactor Containment Building," Holmes & Narver Inc., Anaheim, CA (July 1966).

6. "Structures to Resist the Effects of Accidental Explosions," Rept. No. TM 5-1300, Dept. of the Army, Washington, D.C. (July 1965).

7. Kar, A.K., "Local Effects of Tornado-Generated Missiles," ASCE J. Struc. Div., 104 (ST5), pp 809-816 (May 1978).

8. Haldar, A. and Miller, F.J., "Penetration Depth in Concrete for Nondeformable Missiles," Nucl. Engrg. Des., 71, pp 79-88 (1982).

9. Hughes, G., "Hard Missile Impact on Reinforced Concrete," Nucl. Engrg. Des., 77, pp 23-35 (1984).

10. Adeli, H., Amin, A.M., and Sierakowski, R.L., "Damage Prediction for Impacted Concrete Structures," Proc. 2nd Symp. Interaction Non-Nuclear Munitions Struc., Panama City Beach, FL, pp 326-332 (Apr 15-19, 1985).

11. Kennedy, R.P., "A Review of Procedures for the Analysis and Design of Concrete Structures to Resist Missile Impact Effects," Nucl. Engrg. Des., 37, pp 183-203 (1976).

12. Stephenson, A.E., "Full-Scale Tornado-Missile Impact Tests," Electric Power Research Institute, Final Rept. NP-440 (July 1977).

13. Sliter, G.E., "Assessment of Empirical Concrete Impact Formulas," ASCE J. Struc. Div., 106 (ST5) (May 1980).

14. Haldar, A. and Hamieh, H.A., "Local Effect of Solid Missiles on Concrete Structures," J. Struc. Div., 110 (5), pp 948-960 (May 1984).

15. Gwaltney, R.C., "Missile Generation and Protection in Light Water-Cooled Reactor Power Plants," CRNL NISC22, Oak Ridge Natl. Lab., Oak Ridge, TN (Sept 1968).

16. Rotz, J.V., "Results of Missile Impact Tests on Reinforced Concrete Panels," 2nd ASCE Specialty Conf. Struc. Des. Nucl. Plant Facil., New Orleans, LA (Dec 1975).

17. Rotz, J.V., "Results of Tornado Missile Impact Effects on Structures," Proc. Symp. Tornadoes, Assessment of Knowledge and Implications for Man, Texas Tech Univ., Lubbock, (June 1976).

18. Jankov, Z.D., Shanahan, J.A., and White, M.P., "Missile Tests of Quarter-Scale Reinforced Concrete Barriers," Proc. Symp. Tornadoes, Assessment of Knowledge and Implications for Man, Texas Tech Univ., Lubbock (June 1976).

19. Chang, W.S., "Impact of Solid Missiles on Concrete Barriers," ASCE J. Struc. Div., 107 (ST2), pp 257-271 (Feb 1981).

20. Haldar, A., "Impact of Solid Missiles on Concrete Barriers -- Discussion," ASCE J. Struc. Div., 107 (ST11), pp 2307-2309 (Nov 1981).

21. Berriaud, C., Sokolovsky, A., Gueraud, R., Dulac, J., and Labrot, R., "Local Behavior of Reinforced Concrete Walls under Missile Impact," Nucl. Engrg. Des., 45, pp 457-470 (1978).

22. Degen, P.P., "Perforation of Reinforced Concrete Slabs by Rigid Missiles," ASCE J. Struc. Div., 106 (ST7), pp 1623-1642 (July 1980).

23. Chelapati, C.V. and Kennedy, R.P., "Probabilistic Assessment of Aircraft Hazard for Nuclear Power Plants," Nucl. Engrg. Des., 19, pp 333-364 (1972).

24. Milton, J.E., Sierakowski, R.L., Bobbitt, C.W., and Schauble, C.C., "Studies on Symmetric and Unsymmetric Body Penetration into Soil/Concrete," Tech. Rep. prepared for U.S. Air Force Office of Sci. Res., Univ. Florida (Oct 1980).

25. Proctor, J.F., "A Review of Methods of Predicting Concrete Penetration by Postulated Reactor Plant Missiles," Naval Surface Weapons Ctr. Rept. NSWC/WOL/X147 (July 1975).

26. Sierakowski, R.L. and Adeli, H., "The Dynamic Behavior of Concrete Materials," Proc. Intl. Conf. Mech. Phys. Behavior Matls. Dynam. Loading, Paris (Sept 2-5, 1985).

27. Buyukozturk, O. and Connor, J., "Nonlinear Dynamic Response of Reinforced Concrete under Impulsive Loading: Research Status and Needs," Nucl. Engrg. Des., 50, pp 83-92 (1978).

APPENDIX — NOTATIONS

a - Half the aggregate size in concrete (in.)

A_p - Weight of impactor per unit project area (lb/ft^2)

d - Thickness of the slab or target (in.)

d_p - Perforation thickness (in.)

d_s - Scabbing thickness (in.)

D - Diameter of the impactor (cylinder) (in.)

E - Modulus of elasticity of impactor material

E_m - Modulus of elasticity of mild steel

f_c - Ultimate concrete compressive strength (psi)

f_t - Tensile strength of concrete (psi)

I - Impact factor WV^2/gD^3f_c

K - Nose shape factor

K_1 - Concrete penetrability

M - Mass of the impactor

n - Ratio of the radius of the nose to the diameter of the impactor

S - Strain-rate factor

V - Impact velocity (ft/s)

W - Weight of the impactor (lb)

X_p - Penetration depth (in.)

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.

RECENT RESEARCH IN NONLINEAR ANALYSIS OF BEAMS

M. Sathyamoorthy*

Abstract. This literature survey deals with the static and dynamic nonlinear analysis of beams. Also included are papers about arches, cables, frames, strings, and trusses. Papers reviewed are limited to those published between 1982 and 1984. Geometric and material type nonlinearities are included. Analytical, experimental, and numerical methods are reviewed.

Nonlinear methods of analysis are becoming popular for finding solutions to beam problems. Various types of nonlinearities are usually included in the analysis of nonlinear problems. Geometric nonlinearities arise as a result of large deformations in beams; such nonlinearities are accounted for by considering nonlinear strain-displacement relations. Geometric nonlinearities also arise due to a nonlinear curvature-displacement relationship. Combinations of the two types of nonlinearities also occur.

One type of nonlinearity that is attributed to material behavior is called material or physical nonlinearity. Nonlinear stress-strain relationships give rise to this type of nonlinearity. A combination of geometric and physical nonlinearities is also possible. Governing equations corresponding to each nonlinearity can be derived following a procedure outlined in previous reviews [1, 2].

This literature survey deals with the static and dynamic nonlinear analyses of beams, rods, and columns. Papers dealing with arches, cables, frames, strings, and trusses are included, as are nonlinear effects due to large deformations and stress-strain behavior. Nonlinear methods of analysis including analytical, experimental, and numerical methods are also reviewed. Papers published since 1892 are surveyed; most of the papers are in English.

ARCHES, CABLES, FRAMES, STRINGS, AND TRUSSES

Literature on nonlinear static and dynamic analyses of arches, cables, frames, strings, and trusses published since 1982 is summarized in this section. A geometrically nonlinear analysis of circular and arbitrary arches has been carried out using the finite element method [3]. Postbuckling behavior of plane arches, rings, and frames has been investigated [4]. Dynamic problems of arches including the effects of geometric nonlinearities have been reported [5, 6], as has nonlinear stability of tapered prebuckled arches [7]. Static nonlinear analysis of cable type structures has been studied [8, 9]. In one case only geometric nonlinearity was considered [8]; both geometric and material nonlinearities were included in the other [9]. Dynamic problems of cables have been treated [10-12]. Luongo, Rega, and Vestroni [10] considered the planar nonlinear free vibration behavior of elastic cables; large amplitude free vibrations of a suspended cable have also been considered [11]. Fried [12] used finite element analysis procedures to study the static and dynamic behaviors of extensible cables during deformation.

In the area of frames, almost all investigations since 1982 have been concerned with static nonlinear problems. The influence of discretization density has been examined [13]. Nonlinear analyses of unbraced frames, large deflections of portal frames, large deflection and stability of rigid frames, nonlinear behavior of nonintegral in-filled frames, optimization of frame type structures using nonlinear analysis procedures, large displacement in-plane analysis of elasto-plastic frames, application of the finite element analysis procedure to the nonlinear analysis of elastic-plastic frames, and postbuckling behavior of frames have been reported [14-24, 98].

*Associate Professor, Department of Mechanical and Industrial Engineering, Clarkson University, Potsdam, New York 13676

Static nonlinear problems concerning elastic strings have been solved [25, 26]. Nonlinear free vibration of a damped elastic string has been considered [27], as has a nonlinear generation method for finding missing modes of a vibrating string [28]. Planar response and stability of strings under narrow-band random excitation has been studied [29].

Recent developments in the nonlinear static and dynamic analyses of trusses have been reported [30-38]. Large displacement analyses of elastic and elastic-plastic trusses are available [30-32]; geometrically nonlinear dynamic analysis methods have been used to solve problems of trusses and truss type structures [33-36]. Theoretical and experimental results concerning trusses are available [37, 38].

BEAMS, RODS, AND COLUMNS

Recent investigations dealing with nonlinear static and dynamic behaviors of beams, rods, and columns have been reported [39-119]. Geometrically nonlinear static problems have been treated [39-72]. A variational method for finite deformation of prismatic beams is available [41, 42]. Pleus and Sayir [44] presented a second order nonlinear theory for large deflections of slender beams; a similar higher order theory applicable to beams has also been derived from three-dimensional elasticity [46]. Curved beams have been treated [49, 50], and a finite strip method has been used [56] in the nonlinear analysis of thin-walled structures. Effects of thermal stresses and high temperatures [55, 61] and various boundary conditions, orthotropy, and transverse shear [70] have been considered.

Nonlinear beam problems with material nonlinearity have been studied [73-80]. Large deflections of nonlinearly elastic beams with various boundary conditions and loading have been considered [74-77]. The material nonlinearity in these cases is represented by a Ludwick type nonlinear stress-strain relationship. Papirno [73] conducted an experimental investigation to check the validity of the Ramberg-Osgood type nonlinear stress-strain relationship to various materials. He found that the Ramberg-Osgood analytic approximation is an excellent fit to experimental stress-strain data from the proportional limit to 0.2 percent offset yield stress.

Nonlinear dynamic cases of beams in which geometric nonlinearities are considered have been treated [81-102]. Both free and forced vibrations were studied. Transient response of nonlinear beam vibration problems subjected to pulse loading have been considered using a numerical approach [85]. Vibration response of geometrically nonlinear beams subjected to pulse and impact loadings have been investigated using a finite difference method [92]. Gutierrez and Laura [97] studied the effect of concentrated mass on the large amplitude free flexural vibration of beams and plates; Adami [101] presented theoretical and experimental results for the nonlinear response of buckled beams under random excitation. Nonlinear vibrations of rotating shafts [81-83], vibrations of rotating blades [84], nonlinear studies of rotating cantilever beams [99], and nonlinear vibrations of homogeneous viscous beams [98] have been reported.

Postbuckling analyses of elastic and elasto-plastic beams and columns have been published [41, 103-115, 127, 140]. In most of the investigations only geometric nonlinearities are included. Monasa and Lewis [106] considered material nonlinearity in an analysis of the stability behavior of uniformly loaded flexible bars of elasto-plastic material. The finite element method was used in an investigation of thermal post-buckling behavior of tapered columns [108, 109]. The problem of nonlinear bending and collapse of long, thin, open section beams has been solved using microcomputers for a closed, convergent sequence of algebraic and integral equations that are tractable [112]. Anifantis and Dimarogonas [114-115] investigated the postbuckling behavior of cracked columns. Dynamic stability of columns has been considered [116-119, 139]. The effects of transverse shear deformation and rotatory inertia were included in a study of the dynamic stability of bars [116]; bucked beams have also been studied [117]. Braced columns and columns subjected to axial excitation have also been included [118-119].

During the period 1982-1984, advances in the computational methods of nonlinear analysis were made concerning beams and beam-type structures. Use of the finite element method for large deflection, large amplitude vibration, and postbuckling behaviors of beams has been illustrated [40, 70, 108, 109, 117, 121-140]. General purpose nonlinear finite element programs have been developed [121, 126]. Both geometric and material type nonlinearities were considered in nonlinear formulations of problems. Nonlinear vibration problems have been treated [129-138]. Sarma, Prathap, and Varadan [133, 134] studied the applicability of the Ritz finite element method to the solution of nonlinear structural problems with application to beams. The formulation and the solution of the problem of finite elastic-viscoplastic transient deformation of thin beams has been treated [40].

ACKNOWLEDGMENTS

The author is grateful to Mrs. Linda Newtown, Senior Secretary of the Mechanical and Industrial Engineering, Clarkson University, for carefully typing this paper.

REFERENCES

1. Sathyamoorthy, M., "Nonlinear Analysis of Beams; Part I: A Survey of Recent Advances," Shock Vib. Dig., 14, pp 19-35 (Aug 1982).

2. Sathyamoorthy, M., "Nonlinear Analysis of Beams; Part II: Finite Element Methods," Shock Vib. Dig., 14, pp 7-18 (Sept 1982).

3. Calhoun, P.R., "Geometrically Nonlinear Finite Element Analysis of Circular and Arbitrary Arches," Ph.D. Thesis, The University of Arizona (1980).

4. Batoz, J.L., "Buckling and Postbuckling of Plane Arches, Rings and Frames," ASME Summer Meeting, San Antonio, Texas (1984).

5. Crespo Da Silva, M.R.M., "Vibrations of Shallow Arches, Including the Effect of Geometric Non-linearities," J. Sound Vib., 84, pp 161-172 (1982).

6. Pilipchuk, V.N., "On Essentially Nonlinear Dynamics of Arches and Rings," PMM J. Appl. Math. Mech., 46, pp 360-364 (1983).

7. Tinsae, A.M.W. and Assaad, M.C., "Nonlinear Stability of Prebuckled Tapered Arches," ASCE J. Engrg. Mech., 110, pp 84-94 (1984).

8. Lewis, W.J., Jones, M.S., and Rushton, K.R., "Dynamic Relaxation Analysis of the Nonlinear Static Response of Pretensioned Cable Roofs," Computers Struc., 18, pp 989-997 (1984).

9. Pietrzak, J., "Static Analysis of Geometrically and Physically Nonlinear Cable-Beam Structures," Rev. Romaine Sci. Tech., 28, pp 45-53 (1983).

10. Luongo, A., Rega, G., and Vestroni, F., "Planar Nonlinear Free Vibrations of an Elastic Cable," Intl. J. Nonlin. Mech., 19, pp 39-52 (1984).

11. Rega, G., Vestroni, F., and Benedettini, F., "Parametric Analysis of Large Amplitude Free Vibrations of a Suspended Cable," Intl. J. Solids Struc., 20, pp 95-106 (1984).

12. Fried, I., "Large Deformation Static and Dynamic Finite Element Analysis of Extensible Cables," Computers Struc., 15, pp 315-319 (1982).

13. Saran, M., "On the Influence of the Discretization Density in the Nonlinear Analysis of Frames," Computer Methods Appl. Mech. Engrg., 43, pp 173-180 (1984).

14. Simitses, G.J. and Giri, J., "Nonlinear Analysis of Unbraced Frames of Variable Geometry," Intl. J. Nonlin. Mech., 17, pp 47-61 (1982).

15. Raphanel, J.L. and Symonds, P.S., "The Estimation of Large Deflections of a Portal Frame under Asymmetric Pulse Loading," J. Appl. Mech., Trans. ASME, 51, pp 494-500 (1984).

16. Qashu, R.K. and DaDeppo, D.A., "Large Deflection and Stability of Rigid Frames," ASCE J. Engrg. Mech., 109, pp 765-780 (1983).

17. Liauw, T.C. and Kwan, K.H., "Nonlinear Behavior of Non-Integral Infilled Frames," Computers Struc., 18, pp 551-560 (1984).

18. Kwan, K.H. and Liauw, T.C., "Nonlinear Analysis of Integral Infilled Frames," Engrg. Struc., 6, pp 223-231 (1984).

19. Khot, N.S., Kamat, P., and Watson, L.T., "On Optimizing Frame Type Structures in Nonlinear Response," ASME Appl. Mech., Bioengrg. Fluids Engrg. Conf., Univ. of Houston (1983).

20. Kounadis, A.N. and Avraam, T.P., "Linear and Nonlinear Analysis of a Nonconservative Frame of Divergence Instability," AIAA J., 19, pp 761-765 (1981).

21. Cichon, C., "Large Displacements In-plane Analysis of Elastic-Plastic Frames," Computers Struc., 19, pp 737-746 (1984).

22. Argyris, J.H., Boni, B., et al., "Finite Element Analysis of Two and Three Dimensional Elasto-plastic Frames -- The Natural Approach," Computer Methods Appl. Mech. Engrg., 35, pp 221-248 (1982).

23. Andreaus, U., "A Finite Element Model for Geometrically Nonlinear Analysis of Elastic-Plastic Frames," Intl. Symp. Current Theories Plasticity Their Applic., Univ. of Oklahoma (1984).

24. Pignataro, M. and Rizzi, N., "The Effect of Multiple Buckling Modes on the Postbuckling Behavior of Plane Elastic Frames; Part I: Symmetric Frames," J. Struc. Mech., 10, pp 437-458 (1982); "Part II: Asymmetric Frames," pp 459-474 (1982).

25. Schmidt, U. and Weinitschke, H.J., "Some Static Problems for the Nonlinear Elastic String," J. Engrg. Math., 17, pp 149-189 (1983).

26. Luning, C.D. and Perry, W.L., "Iterative Solution of a Nonlinear Boundary Value Problem for a Rotating String," Intl. J. Nonlin. Mech., 19, pp 83-92 (1984).

27. Gough, C., "The Nonlinear Free Vibration of a Damped Elastic String," J. Acoust. Soc. Amer., 75, pp 1770-1776 (1984).

28. Legge, K.A. and Fletcher, N.H., "Nonlinear Generation of Missing Modes on a Vibrating String," J. Acoust. Soc. Amer., 76, pp 5-12 (1984).

29. Richard, K. and Anand, G.V., "Nonlinear Resonance in Strings under Narrow Band Random Excitation; Part 1: Planar Response and Stability," J. Sound Vib., 86, pp 85-98 (1983).

30. Hodge, P.G., "Simple Examples of Nonlinear Truss Behavior," Dept. Aerospace Engrg. Mech., Univ. Minnesota, Rept. No. AEM-H2-2 (1983).

31. Eckhardt, V. and Semenov, B.N., "Geometrically Nonlinear Trusses," Ing.-Arch., 52, pp 229-236 (1982).

32. Cichon, C. and Corradi, L., "Large Displacement Analysis of Elastic-Plastic Trusses with Unstable Bars," Engrg. Struc., 3, pp 210-218 (1981).

33. Utku, S., Shoemaker, W.L., and Salama, M., "Nonlinear Equations of Dynamics for Spinning Paraboloidal Antennas," Computers Struc., 16, pp 361-370 (1983).

34. Abrate, S. and Sun, C.T., "Dynamic Analysis of Geometrically Nonlinear Truss Structures," Computers Struc., 17, pp 491-498 (1983).

35. Hanna, S.Y., Mangiavacchi, A., and Suhendra, R., "Nonlinear Dynamic Analysis of Guyed Tower Platforms," J. Energy Resources Tech., Trans. ASME, 105, pp 205-211 (1983).

36. Housner, J.M. and Belvin, W.K., "On the Analytical Modeling of the Nonlinear Vibrations of Pretensioned Space Structures," Computers Struc., 16, pp 339-352 (1983).

37. Purasinghe, R. and Mueller, W., "Post Buckling Behavior of Indeterminate Trusses -- Experimental Investigation," Proc. 26th AIAA Struc., Struc. Dynam. Matls. Conf., Orlando, FL (1985).

38. Noor, A.K. and Peters, J.M., "Instability Analysis of Space Trusses," Computer Methods Appl. Mech. Engrg., 40, pp 199-218 (1983).

39. Roberts, T.M. and Azizian, Z.G., "Nonlinear Analysis of Thin Walled Bars of Open Cross-Section," Intl. J. Mech. Sci., 25, pp 565-577 (1983).

40. Rodal, J.J.A., Steigmann, D.J., and Witmer, E.A., "Numerical Simulation of Transient Finite Deformations of Thin Beams," ASME Paper No. 83-WA/APM-21 (1983).

41. Reissner, E., "On a Variational Analysis of Finite Deformations of Prismatical Beams and on the Effect of Warping Stiffness on Buckling Loads," Z. angew. Math. Phys., 35, pp 247-251 (1984).

42. Reissner, E., "On a Simple Variational Analysis of Small Finite Deformations of Prismatical Beams," Z. angew. Math. Phys., 34, pp 642-648 (1983).

43. Panayotounakos, D.E. and Theocaris, P.S., "The Arbitrary Co-Planar Concentrated Force in the Problem of Nonlinear Elastic Analysis in Thin Cantilever Rods," Res Mechanica, 6, pp 1-14 (1983).

44. Pleus, P. and Sayir, M., "A Second Order Theory for Large Deflections of Slender Beams," Z. angew. Math. Phys., 34, pp 192-217 (1983).

45. Peyrot, A.H., "Large Deflection Analysis of Beams, Pipes, or Poles," Engrg. Struc., 4, pp 11-16 (1982).

46. Parker, D.F., "On the Derivations of Nonlinear Rod Theories from 3-Dimensional Elasticity," Z. angew. Math. Phys., 35, pp 833-847 (1984).

47. Maewal, A., "A Set of Strain-Displacement Relations in Nonlinear Theories of Rods and Shells," J. Struc. Mech., 10, pp 393-401 (1982-83).

48. Lau, J.H., "Large Deflection of Curved Beams with Combined Loads," ASCE J. Engrg. Mech., 108, pp 180-185 (1982).

49. Lau, J.H., "Large Deflection of Curved Beams under Combined Loading," Modeling and Simulation Conf., Univ. Pittsburgh (1983).

50. Lau, J.H. and Hu, C.K., "Nonlinear Stress Analysis of Curved Bars," 5th ASCE Engrg. Mech. Specialty Conf., Univ. Wyoming (1984).

51. Kooi, B.W. and Kuipers, M., "Unilateral Contact Problem with the Heavy Elastica," Intl. J. Nonlin. Mech., 19, pp 309-321 (1984).

52. Kurajian, G.M. and Na, T.Y., "Single-Loaded Elastic Beams on Nonlinear Continuous Foundations," J. Vib., Acoust., Stress Rel. Des., Trans. ASME, 105, pp 192-199 (1983).

53. Kowalczyk, K. and Krasinski, M., "The Extensible Elastica of a Prestressed Beam with Arbitrary Boundary Conditions," Intl. J. Mech. Sci., 25, pp 387-396 (1983).

54. Huang, T., "On Large Displacement Analysis of a Class of Beams," Proc. 5th ASCE Engrg. Mech. Specialty Conf., Univ. Wyoming (1984).

55. Hopkins, D.A. and Chamis, C.C., "Nonlinear Analysis for High-Temperature Composites: Turbine Blades/Vanes," Nonlin. Struc. Anal., NASA, pp 131-147 (1984).

56. Gierlinski, J.T. and Smith, T.R.G., "The Geometric Nonlinear Analysis of Thin-Walled Structures by Finite Strips," Thin-Walled Struc., 2, pp 27-50 (1984).

57. Golley, B.W., "Large Deflections of Bars Bent through Frictionless Supports," Intl. J. Nonlin. Mech., 19, pp 1-9 (1984).

58. Fujii, F., "A Simple Mixed Formulation for Elastica Problems," Computers Struc., 17, pp 79-88 (1983).

59. Buesking, K.W. and Chatterjee, S.N., "Bending of Orthotropic Beams Which are Nonlinear in Shear and Compression," Thermomech. Behavior High-Temp. Composites, ASME, pp 111-122 (1982).

60. Yu, T.X. and Johnson, W., "The Plastica: The Large Elastic-Plastic Deflection

of a Strut," Intl. J. Nonlin. Mech., 17, pp 195-210 (1982).

61. Varadan, T.K., Dilip, V.R., and Prathap, G., "Nonlinear Analysis of a Thermally Restrained Beam," Mech. Res. Commun., 11, pp 61-66 (1984).

62. Varadan, T.K. and Rajendran, V.K.T.P., "A Note on Nonlinear Analysis of Clamped-Clamped Beams," Aeronaut. Soc. India, 33, pp 89-92 (1981).

63. Teodorescu, P.P. and Toma, I., "Two Fundamental Cases in the Nonlinear Bending of a Straight Bar," Meccanica, 9, pp 52-60 (1984).

64. Theocaris, P.S. and Panayotounakos, D.E., "The Problem of Elastica of a Thin Straight and Prismatic Rod with Constant Initial Twist," Res Mechanica, 6, pp 105-118 (1983).

65. Theocaris, P.S. and Panayotounakos, D.E., "Exact Solution of the Nonlinear Differential Equation Concerning the Elastic Line of a Straight Rod due to Terminal Loading," Intl. J. Nonlin. Mech., 17, pp 395-402 (1982).

66. Stern, J., "The Hinged Strut with Initial Curvature," (in German), Ingen.-Arch., 54, pp 152-160 (1984).

67. Seide, P., "Large Deflections of a Simply Supported Beam Subjected to Moment at One End," J. Appl. Mech., Trans. ASME, 51, pp 519-525 (1984).

68. Schrefler, B.A., Odorizzi, S., and Wood, R.D., "A Total Lagrangian Geometrically Nonlinear Analysis of Combined Beam and Cable Structures," Computers Struc., 17, pp 115-128 (1983).

69. Sutyrin, V.G., "Helican Lines: Exact Solutions of the Nonlinear Theory of Inextensible Rods," Mechanics of Solids, 18, pp 174-178 (1983).

70. Noor, A.K., Peters, J.M., and Anderson, C.M., "Mixed Models and Reduction Techniques for Large-Rotation Nonlinear Problems," Computer Methods Appl. Mech. Engrg., 44, pp 67-89 (1984).

71. Surana, K.S., "Geometrically Nonlinear Formulation for Two Dimensional Curved Beam Elements," Computers Struc., 17, pp 105-114 (1983).

72. Shield, R.T., "Equilibrium Solutions in Finite Elasticity," J. Appl. Mech., Trans. ASME, 50, pp 1171-1180 (1983).

73. Papirno, R., "Goodness-of-Fit of the Ramberg-Osgood Analytic Stress-Strain Curve to Tensile Test Data," J. Testing Eval., ASTM, 10, pp 263-268 (1982).

74. Monasa, F. and Lewis, G., "Large Deflections of Point Loaded Cantilevers with Nonlinear Behaviour," Z. angew. Math. Phys., 34, pp 124-130 (1983).

75. Monsasa, F. and Lewis, G., "Large Deflections of Nonlinear Elastic Beams under Uniformly Distributed Loads," ASCE Engrg. Mech. Specialty Conf., Purdue Univ., pp 455-458 (1983).

76. Lewis, G. and Monasa, F., "Large Deflections of Nonlinear Elastic Beams under Combined Loading," Modeling Simulation Conf., Univ. Pittsburgh (1983).

77. Lewis, G. and Monasa, F., "Large Deflections of Cantilever Beams of Nonlinear Material of the Ludwick-Type Subjected to an End Moment," Intl. J. Nonlin. Mech., 17, pp 1-6 (1982).

78. Ditcher, A.K. and Webber, J.P.H., Non-linear Stress-Strain Effects in the Flexural Wrinkling of Carbon Fibre Honeycomb Sandwich Beams," Aeronaut. Quart., 33, pp 1-24 (1982).

79. Cinquini, C., "Optimality Criteria for Materials with Nonlinear Behavior: Application to Beams in Bending," Engrg. Struc., 6, pp 61-64 (1984).

80. Bert, C.W., "Simple Method to Determine Nonlinear Compressive and Tensile Stress-Strain Curves Using a Sandwich Beam," J. Matl. Sci. Letters, 1, pp 247-248 (1982).

81. Yamamoto, T. and Ishida, Y., "Vibrations of Rotating Shaft with Nonlinear Spring Characteristics and Unsymmetry," Memoirs, 35, pp 131-204 (1983).

82. Yamamoto, T., Ishida, Y., et al, "Nonlinear Forced Oscillations of a Rotating Shaft Carrying an Unsymmetrical Rotor at the Critical Speed," Bull. JSME, 25, pp 1969-1976 (1982).

83. Vassilopoulos, L. and Ghosh, P.K., "Simplified Techniques for Studying Nonlinear Shaft Vibration Problems," VIII Cong. Pan-American Inst. Naval Engrg., Washington, DC (1983).

84. Venkatesan, C. and Nagaraj, V.T., "Nonlinear Flapping Vibrations of Rotating Blades," J. Sound Vib., 84, pp 549-556 (1982).

85. Moyer, Jr., E. Thomas, "Energy Conservation in the Transient Response of Nonlinear Beam Vibration Problems Subjected to Pulse Loading -- A Numerical Approach," Computers Struc., 19, pp 339-344 (1984).

86. Tiersten, H.F. and Ballato, A., "Nonlinear Extensional Vibrations of Quartz Rods," J. Acoust. Soc. Amer., 73, pp 2022-2033 (1983).

87. Sunakawa, M. and Higuchi, K., "Nonlinear Behavior of Thin Columns under Parametrically Excited Load," Proc. 24th AIAA Struc., Struc. Dynam. Matls. Conf., Lake Tahoe, NV, pp 215-223 (1983).

88. Raju, K.K. and Rao, G.V., "A Note on Large Amplitude Vibrations," Computers Struc., 18, pp 1189-1191 (1984).

89. Moon, F.C. and Shaw, S.W., "Chaotic Vibrations of a Beam with Nonlinear Boundary Conditions," Intl. J. Nonlin. Mech., 18, pp 465-478 (1983).

90. Malik, S.K. and Singh, M., "Nonlinear Longitudinal Waves in Bars," Intl. J. Nonlin. Mech., 19, pp 187-194 (1984).

91. Miloserdova, I.V. and Potanov, A.I., "Vibrations in Nonlinear Rods in the Presence of Internal Resonances," Soviet Machine Sci., 4, pp 16-22 (1983).

92. Liebowitz, H., "Vibration Response of Geometrically Nonlinear Elastic Beams to Pulse and Impact Loading," NASA-CR-174495 (1983).

93. Kanaka Raju, K. and Venkateswara Rao, G., "A Note on Large Amplitude Vibrations," Computers Struc., 18, pp 1189-1192 (1984).

94. Kukreti, A.R. and Issa, Hadi I., "Dynamic Analysis of Nonlinear Structures by Pseudo-Normal Mode Superposition Method," Comptuers Struc., 19, pp 653-664 (1984).

95. Kopackova, M., "On Periodic Solution of a Nonlinear Beam Equation," Aplikace Matematkiy, 28, pp 108-115 (1983).

96. Kojima, H. and Saito, H., "Forced Vibrations of a Beam with a Nonlinear Dynamic Vibration Absorber," J. Sound Vib., 88, pp 559-568 (1983).

97. Gutierrez, R.H. and Laura, P.A.A., "Effect of a Concentrated Mass on Large Amplitude, Free Flexural Vibrations of Elastic Plates and Beams," Appl. Acoust., 17, pp 135-151 (1984).

98. Griffin, P.D. and Martin, J.B., "Geometrically Nonlinear Mode Approximations for Impulsively Loaded Homogeneous Viscous Beams and Frames," Intl. J. Mech. Sci., 25, pp 15-26 (1983).

99. El-Essawi, M., "A Discrete Model for Nonlinear Structural Dynamics of Rotating Cantilevers," Ph.D. Thesis, Duke University (1982).

100. Desilva, C.N. and Chen, H.Y., "Dynamic Nonlinear Response of Beams Subjected to Impact Loads," J. Sound Vib., 93, pp 489-502 (1984).

101. Adami, C., "Theoretical and Experimental Investigation of the Nonlinear Response of the Buckled Beam under Random Excitation," Ph.D. Thesis, University of Southern Calilfornia (1982).

102. Buchholdt, H.A. and Moossavinejad, S., "A Review of Nonlinear Methods of Dynamic Analysis - I," Intl. J. Struc., 2, pp 1-35 (1982).

103. Wang, C.Y., "Buckling and Postbuckling of a Long-Hanging Elastic Column Due to a Bottom Load," J. Appl. Mech., Trans. ASME, 50, pp 311-314 (1983).

104. Theocaris, P.S., "Instability of Cantilever Beams with Nonlinear Elements: Butterfly Catastrophe," Intl. J. Mech. Sci., 26, pp 265-276 (1984).

105. Pignataro, M. and DiCarlo, A., et al, "On Nonlinear Beam Models from the Point of View of Computational Post-Buckling Analysis," Intl. J. Solids Struc., 18, pp 327-347 (1982).

106. Monasa, F. and Lewis, G., "Stability Behavior of Uniformly Loaded Flexible Bars of Elasto-Plastic Materials," Proc. 5th ASCE Engrg. Mech. Specialty Conf., Univ. Wyoming (1984).

107. Maddocks, J.H., "Stability of Nonlinearly Elastic Rods," Arch. Rational Mech. Anal., 85, pp 311-354 (1984).

108. Kanaka Raju, K. and Venkateswara Rao, G., "Finite Element Analysis of Thermal Postbuckling of Tapered Columns," Computers Struc., 19, pp 617-620 (1984).

109. Kanaka Raju, K. and Venkateswara Rao, G., "Thermal Postbuckling Behavior of Tapered Columns," AIAA J., 22, pp 1499-1501 (1984).

110. Han, D.J. and Chen, W.F., "Buckling and Cyclic Inelastic Analysis of Steel Tubular Beam-Columns," Engrg. Struc., 5, pp 119-132 (1983).

111. Cheatham, Jr., J.B. and Pattillo, P.D., "Helical Postbuckling Configuration of a Weightless Column under the Action of an Axial Load," Soc. Petrol. Engr. J., 24, p 467 (1984).

112. Benson, R.C., "Nonlinear Bending and Collapse of Long, Thin, Open Section Beams and Corrugated Panels," J. Appl. Mech., Trans. ASME, 51, pp 141-145 (1984).

113. Ascione, L. and Grimaldi, A., "On the Stability and Postbuckling Behavior of Elastic Beams," Thin-Walled Struc., 1, pp 325-351 (1983).

114. Anifantis, N. and Dimarogonas, A., "Postbuckling Behavior of Transverse Cracked Columns," Computers Struc., 18, pp 351-356 (1984).

115. Anifantis, N. and Dimarogonas, A., "Imperfection Post-Buckling Analysis of Cracked Columns," Engrg. Fracture Mech., 18, pp 693-702 (1983).

116. Sastry, B.P. and Venkateswara Rao, G., "Dynamic Stability of Bars Considering Shear Deformation and Rotatory Inertia," Computers Struc., 19, pp 823-828 (1984).

117. Seide, P., "Dynamic Stability of Laterally Loaded Bucked Beams," ASCE J. Engrg. Mech., 110, pp 1556-1572 (1984).

118. Huang, J.S. and Hung, L.H., "Dynamic Stability for a Simply Supported Beam under Periodic Axial Excitation," Intl. J. Nonlin. Mech., 19, pp 287-301 (1984).

119. Balendra, T. and Tay, C.H., "Dynamic Instability of Braced Columns," Intl. J. Struc., 4, pp 13-26 (1984).

120. Besseling, J.F., "Nonlinear Theory for Elastic Beams and Rods and Its Finite Element Representation," Computer Methods Appl. Mech. Engrg., 31, pp 205-220 (1982).

121. Bathe, K.J., "Nonlinear Finite Element Analysis and ADINA," Computers Struc., 17, p 311 (1983).

122. Brockman, R.A., "Economical Stiffness Formulations for Nonlinear Finite Elements," Computers Struc., 18, pp 15-22 (1984).

123. Chebl, C. and Neale, K.W., "A Finite Element Method for Elastic-Plastic Beams and Columns at Large Deflections," Computers Struc., 18, pp 255-261 (1984).

124. Hsu, M.B., "Finite Element Analysis of Beam Type Structures with Geometric and Material Nonlinearities," Modeling Simulation Conf., Univ. Pittsburgh (1983).

125. Murase, K., Katori, H., and Nishimura, T., "Visco-Plastic and Large Deformation Analysis by FEM," Bull. JSME, 26, pp 1696-1702 (1983).

126. Whitcomb, J.D. and Dattaguru, B., "User's Manual for GAMNAS: Geometric and Material Nonlinear Analysis of Struc-

tures," NASA Langley Res. Ctr., Rept. No. NASA-TM-85734 (1984).

127. Yang, T.Y. and Berry, D.T., "Simplified Lattice Beam Finite Elements for Nonlinear Static, Dynamic and Postbuckling Analysis," Proc. 26th AIAA Struc., Struc. Dynam. Matls. Conf., Orlando, FL (1985).

128. Noor, A.K. and Peters, J.M., "Penalty Finite Element Formulation for Curved Elastica," ASCE J. Engrg. Mech., 110, pp 694-712 (1984).

129. Fried, I., "Nonlinear Finite Element Computation of the Equilibrium, Stability and Motion of the Extensional Beam and Ring," Computer Methods Appl. Mech. Engrg., 38, pp 29-44 (1983).

130. Yang, T.Y. and Saigal, S., "A Simple Element for Static and Dynamic Response of Beams with Material and Geometric Nonlinearities," Intl. J. Numer. Methods Engrg., 20, pp 851-867 (1984).

131. Yang, T.Y., Berry, D.T., and Skelton, R.E., "Simplified Lattice Beam Finite Elements for Feedback Control and Nonlinear Vibration Analysis," Proc. 25th AIAA Struc., Struc. Dynam. Matls. Conf. (1984).

132. Sarma, B.S. and Varadan, T.K., "Lagrange-Type Formulation for Finite Element Analysis of Nonlinear Beam Vibrations," J. Sound Vib., 86, pp 61-70 (1983).

133. Sarma, B.S., Prathap, G. and Varadan, T.K., "Influence of the Order of Polynomial on the Convergence in Ritz Finite Element Formulation to Nonlinear Vibrations of Beams," Computers Struc., 18, pp 667-671 (1984).

134. Sarma, B.S. and Varadan, T.K., "Ritz Finite Element Approach to Nonlinear Vibrations of Beams," Intl. J. Numer. Methods Engrg., 20, pp 353-367 (1984).

135. Sato, H., "Nonlinear Free Vibration Analysis of Stepped Beams under Gravity by Transfer Matrix Method," Bull. JSME, 24, pp 2115-2121 (1981).

136. Sarma, B.S. and Varadan, T.K., "Certain Discussions in the Finite Element Formulation of Nonlinear Vibration Analysis," Computers Struc., 15, pp 643-646 (1982).

137. Mei, C., "Comments on Lagrange-Type Formulation for Finite Element Analysis of Nonlinear Beam Vibrations," J. Sound Vib., 94, pp 445-452 (1984).

138. Kanaka Raju, K. and Venkateswara Rao, G., "A Note on Large Amplitude Vibrations," Computers Struc., 18, pp 1189-1191 (1984).

139. Datta, P.K. and Chakraborty, S., "Parametric Instability of Tapered Beams by Finite Element Method," J. Mech. Engrg. Sci., 24, pp 205-208 (1982).

140. Sundararamaiah, V. and Venkateswara Rao, G., "Stability of Short Beck and Leipholz Columns on Elastic Foundation," AIAA J., 21, pp 1053-1054 (1983).

BOOK REVIEWS

DIGITAL FILTERS

R.W. Hamming
Prentice-Hall Inc., Englewood Cliffs, NJ
1983, 257 pages, $28.95

As stated by the author, "This text includes an accurate (but not rigorous) introduction to the necessary mathematics . . . I have become increasingly convinced of the need for an elementary treatment of the subject of digital filters." Digital filtering involves differentiation, integration, smoothing, and removal of noise from a signal.

The book consists of 14 chapters and 256 pages. Chapter 1 introduces digital filters and explains their use. Chapter 2 considers the frequency approach, including aliasing, invariance under translation, and a definition of an eigenfunction and its use in equally spaced sampling.

Chapter 3 uses the frequency approach in a number of classical applications. The least squares fitting of polynomials, including quadratics and quartics, is described and extended to a modified least squares approach. A method for compensating some faults of the least square methods is suggested. Differences and derivatives, a procedure for supplying missing values by a method of interpolation, an explanation of filter operation, an attempt to smoothing non-recursive filters, and numerical integration applied in recursive filter design are also discussed.

The next chapter discusses Fourier series for a continuous case in terms of orthogonality, odd and even functions expressed by Fourier series, the use of Fourier series in least squares, convergence of a point of continuity and discontinuity, and the relationship of complex Fourier series and phase form. Chapter 5 focuses on windows and presents a good explanation of the Gibbs phenomenon. The author shows how the convolution theorem can generate new Fourier series.

Chapter 6 considers non-recursive filters, including the design of a low pass filter, a differentiation filter, sharpening of a filter, and band pass differentiators. The next chapter is concerned with smooth non-recursive filters. Dr. Hamming discusses the objection to ripples with a transfer function; he shows how a smooth transfer function can be obtained. He describes the filter, design of a smooth filter, and its extension to a smooth band pass filter.

Chapter 8 contains a mathematical explanation of the Fourier integral and the sampling theorem. Included are a derivation of the Fourier integral, an introduction of some transform pairs, and application of the convolution theorem to the Fourier integral. The effect of a finite sample size, the application of Fourier integral to window design, and the uncertainty principle conclude the chapter.

The next chapter describes the shape of the window and its use in truncating the Fourier series. Professor Kaiser suggests that the weights of Fourier coefficients of the rectangular window be supplanted by his function, which contains a factorial representation. It resembles the Hamming window at the ends of the nonzero terms but has a finite value at the middle. The author uses the same procedure to design a non-recursive filter as was used with the Hamming window. Chapter 10 describes finite Fourier series, the relationship between discrete and continuous expansions, and the fast Fourier transform (FFT). The reviewer believes that the discussion of the FFT is too short.

Chapter 11 reviews the spectrum, aliasing effects, and computation of a spectrum from an FFT. The next step is removal of the mean from the data. Dr. Hamming explains that removal of the mean affects the appearance of the spectrum; resulting data should be carefully scrutinized. A too brief discussion of the phase spectrum concludes the chapter.

Chapter 12 considers recursive filters, which have more memory than non-recursive filters. A recursive filter is a formula for integration that must remember all values back to and including the value at the lower limit of integration. Linear differential and difference equations are then reviewed. Difference equations lead to the Z transform, which is used in the design of the recursive filter. The chapter concludes with an interesting discussion of the Butterworth filter, which is a recursive filter.

The 13th chapter focuses on Chelychev approximation and Chelychev filters. The approximation is probably the most popular for measuring how close a designed filter is to an original transfer function. In a Chelychev fit the sum of the squares of the error is larger than the corresponding least squares fit; conversely, the least squares fit has a larger maximum error than does the Chelychev fit. Consequently, in filter design the Chelychev fit is frequently preferred. The author introduces Chelychev polynomials and the Chelychev criterion, which he uses to derive Chelychev filters, types 1 and 2. An example of the design of an integrator is given. The closing chapter is a short discussion of different types of filters.

This interesting book is kept at an elementary level. The reviewer believes that some computer programs should have been included. A table of nomenclature would help the reader. However, the book is readable and could be used as a text for a beginner interested in filter design.

H. Saunders
1 Arcadian Drive
Scotia, NY 12302

ACOUSTICAL IMAGING, VOLUME 12

E.A. Ash & C.R. Hills, Eds.
Plenum Publishing Corp., New York, NY
1982, 776 pages, $95.00
ISBN 0-306-41247-0

This book is part of an annual review series begun in 1969. It reports the latest information on acoustical holography and imaging and is the proceedings of the Twelfth International Symposium on Acoustical Imaging held during July, 1982, in London, England. The symposium emphasized the study of acoustical visualization and its applications to medical diagnostics and welds and flaws in industrial products and underground structures. A total of 66 papers are included.

Several of the papers on acoustic microscopes concentrate on applications. These include material structure examinations, wear and fracture assessment in silicon nitrides, the structures of semiconductor chips and films, and human tissue characterization. Three papers cover photoacoustic effects; for example, Rayleigh wave imaging and imaging using water jet coupling.

Most of the nine papers grouped under signal processing address computer reconstruction and the range of signal processing techniques available to enhance imaging. Topics include self-focusing algorithms, pulse echo techniques, and optical techniques. Six papers on transducers cover optically-scanned acoustic imaging transducers and the use of axicons; i.e., devices for imaging and amplitude shading. Four papers on multi-element arrays address behavior and characterization of ultrasonic transducers.

Six papers on scattering and propagation emphasize nonhomogeneous, attenuating, and multi-layered media. The 15 papers on applications to medicine cover topics in tissue characterization, doppler imaging, and the use of tomography as a diagnostic technique. Ten papers on imaging systems cover holographic aperture analytical expansions, imaging with arrays, holographic scans, and underwater applications.

A list of attendees includes participants from the United States, Canada, and several European countries and the Far East. This book will be of value to those engaged in the field of acoustic holography and will be a handy reference.

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

UNDERWATER ACOUSTIC SYSTEM ANALYSIS

W.S. Burdic
Prentice-Hall, Inc., Englewood Cliffs, NJ
1984, 445 pages, $49.95

This text is part of a Prentice Hall series on signal processing. It presents the fundamentals of underwater acoustics, signal generation, and signal processing used by the analyst to study and optimize the performance of underwater acoustic systems.

Chapter one contains a historical review of fundamental discoveries and accomplishments, many of which are from diverse fields and seemingly unrelated technical areas. The following four chapters cover material on the generation and propagation of acoustic waves in the ocean, including effects at surface and bottom boundaries. Acoustic transducers and their operation are also discussed. Chapters six through nine can be considered a review of Fourier methods, correlation functions, and random processes.

Types and properties of ambient noise, including sources and directional characteristics in the ocean, are covered in Chapter 10, as is the effect of the spatial correlation function in calculations. The subject of acoustic beam forming and its use as a filtering operation to improve signal detection in the presence of ambient noise is covered in Chapter 11. The next chapter is concerned with important target characteristics for passive and active underwater acoustic detection systems. A definition of system performance relative to the objectives of acoustic systems is used in Chapter 13 to provide estimates of certain parameters (size, bearing, velocity); statistical hypothesis testing is required. The last chapter uses target characteristics, ocean medium, and detection/estimation theory developed earlier in the book to present examples of system performance analysis.

Each chapter except the first contains problems for the interested reader to test his understanding of the material. It is unfortunate that answers are not included somewhere within the text. All chapters contain a suggested reading list for further study. Because of the coverage material, this book will be compared to Urick's Principles of Underwater Sound.

Those who want or need an introduction to underwater acoustic system analysis will be interested in this book. It is also appropriate for advanced undergraduate or graduate students in this area.

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

STRUCTURAL MODELING AND EXPERIMENTAL TECHNIQUES

G.M. Sabnis, H.G. Harris, R.N. White, and M.S. Mirza
Prentice-Hall, Inc., Englewood Cliffs, NJ
1983, 585 pages

This book treats structural engineering modeling techniques of reinforced and prestressed concrete structures. It is part of a Prentice-Hall series in engineering and engineering mechanics. Emphasis is on applications in research and design. The text draws together recent literature as well as other work in the form of research reports and papers.

The first two chapters discuss the historical background of models relative to their design, testing, and analysis. The limitations, problems, and usefulness of elastic models in certain situations are dealt with in Chapter three. One of the most difficult steps in the modeling process is the accurate representation of material properties. Chapters four and five treat the models used for reinforced concrete. Scaling effects are always a problem because of the critical effects they can cause; scale effects are presented in Chapter six. Laboratory techniques and loading methods are given in Chapter seven. Strain measurement and interpretation are presented in an introduction to instrumentation techniques in Chapter eight.

As with any modeling technique reliability of results is important, as are random errors that may be introduced in the process. Chapter nine covers the accuracy of reliability modeling. Chapter 10 presents case studies of a wide spectrum of applications of structural modeling and their uses in design and research. Experimental techniques used to study the difficult problem of modeling dynamic loading of structures are presented in Chapter eleven. This chapter also contains examples of different types of structures under dynamic loading.

Several of the chapters contain problems for the interested reader. Unfortunately, no answers are given. Two appendices address dimensional analysis and the use of SI units. An excellent list of references is given at the end of the book.

Professionals engaged in model analysis and experimental methods should find this text a valuable source of information. It should also be of interest to those responsible for instrumenting test structures, regardless of their size.

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

SHORT COURSES

OCTOBER

MACHINERY INSTRUMENTATION AND DIAGNOSTICS

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.

UNDERWATER ACOUSTICS AND SIGNAL PROCESSING

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

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

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

MACHINERY VIBRATION ANALYSIS

Dates: Oct. 29 - Nov. 1, 1985
Place: Oak Brook, Illinois
Dates: February 11-14, 1986
Place: Orlando, Florida
Dates: August 19-22, 1986
Place: New Orleans, Louisiana
Dates: November 11-14, 1986
Place: Chicago, Illinois

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

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

VIBRATIONS OF RECIPROCATING MACHINERY

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

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

NOVEMBER

MACHINERY INSTRUMENTATION

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

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

DECEMBER

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

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

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

MARCH

MEASUREMENT SYSTEMS ENGINEERING

Dates: March 10-14, 1986
Place: Phoenix, Arizona

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

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

JULY

ROTOR DYNAMICS
Dates: July 14-18, 1986
Place: Rindge, New Hampshire
Objective: The role of rotor/bearing technology in the design, development and diagnostics of industrial machinery will be elaborated. The fundamentals of rotor dynamics; fluid-film bearings; and measurement, analytical, and computational techniques will be presented. The computation and measurement of critical speeds vibration response, and stability of rotor/bearing systems will be discussed in detail. Finite elements and transfer matrix modeling will be related to computation on mainframe computers, minicomputers, and microprocessors. Modeling and computation of transient rotor behavior and nonlinear fluid-film bearing behavior will be described. Sessions will be devoted to flexible rotor balancing including turbogenerator rotors, bow behavior, squeeze-film dampers for turbomachinery, advanced concepts in troubleshooting and instrumentation, and case histories involving the power and petrochemical industries.

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

SEPTEMBER

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

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

NEWS BRIEFS: news on current and Future Shock and Vibration activities and events

WORLD CONGRESS ON COMPUTATIONAL MECHANICS
September 22-25, 1986
Austin, Texas

The International Association of Computational Mechanics announces its first World Congress on Computational Mechanics to be held September 22-25, 1986 at The University of Texas at Austin. Host of the Congress will be the Texas Institute for Computational Mechanics (TICOM) and The George Washington University. Several other societies will also contribute support to this meeting. The meeting will bring together researchers in computational methods from many diverse areas including civil engineering, computational fluid mechanics, computational structural mechanics, control theory, applied mathematics, and supporting areas. There will also be sessions on artificial intelligence, expert systems, parallel computing, and displays of new hardware and software by various commercial firms is expected.

For further information contact: WCCM/TICOM, The University of Texas at Austin, Austin, TX 78712.

ABSTRACTS FROM THE CURRENT LITERATURE

ABSTRACT CONTENTS

AVAILABILITY OF PUBLICATIONS ABSTRACTED

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

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

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

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

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

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

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

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

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

MECHANICAL SYSTEMS

ROTATING MACHINES

85-1757
Rotordynamic Analysis of the SSME Turbopumps Using Reduced Models
S.T. Noah
Texas A&M Univ., College Station, TX
Rept. No. CR-171170, 72 pp (Sept 1984), N85-10355/4/GAR

KEY WORDS: Rotors, Spacecraft components, Rocket engines, Pumps

Alternative methods for the rotor-dynamic and sensitivity analysis of large rotor systems are examined. The methods are assessed for their ability to utilize accurate models of reduced size along with effective procedures for describing the dynamic behavior of the systems. Frequency response-based techniques are developed for determining the steady state response to imbalance of the space shuttle main engine (SSME) turbopumps and the related eigenvalue problem.

85-1758
Singular Asymptotic Expansions in Nonlinear Rotordynamics
W.B. Day
Auburn Univ., AL
Rept. No. NASA-CR-174012, 24 pp (Aug 10, 1984), N85-10100/4/GAR

KEY WORDS: Rotors, Spacecraft components, Rocket engines, Pumps

During hot firing ground testing of the Space Shuttle's Main Engine, vibrations of the liquid oxygen pump occur at frequencies which cannot be explained by the linear Jeffcott model of the rotor The model becomes nonlinear after accounting for deadband, side forces, and rubbing. Two phenomena present in the numerical solutions of the differential equations are unexpected periodic orbits of the rotor and tracking of the nonlinear frequency. A multiple scale asymptotic expansion of the differential equations is used to given an analytic explanation of these characteristics.

85-1759
Avoiding Errors in Critical-Speed Predictions
R.J. Iannuzzelli
Sperry Corp., Blue Bell, PA
Mach. Des., 57 (9), pp 83-86 (Apr 25, 1985), 5 figs

KEY WORDS: Critical speeds, Damped structures

Two basic methods are available for predicting critical speeds. Unfortunately, these techniques cannot always be used interchangeably. When rotating systems are significantly damped, a correction factor must be included in computations to eliminate certain discrepancies. This paper reviews the calculation procedures.

85-1760
Extended Aeroelastic Analysis for Helicopter Rotors with Prescribed Hub Motion and Blade Appended Pendulum Vibration Absorbers
R.L. Bielawa
United Technologies Res. Ctr., East Hartford, CT
Rept. No. NASA-CR-172455, 217 pp (Dec 1984), N85-12038/4/GAR

KEY WORDS: Helicopters, Rotors, Vibration absorption (equipment)

The mathematical development for the expanded capabilities of the G400 rotor aeroelastic analysis was examined. The G400PA expanded analysis simulates the dynamics of all conventional rotors, blade pendulum vibration absorbers, and the higher harmonic excitations resulting from prescribed vibratory hub motions and higher harmonic blade pitch control. The methodology for modeling the unsteady stalled airloads of two dimensional airfoils is discussed. Formulations for calculating the rotor impedance matrix appropriate to the higher harmonic blade excitations are outlined. Updates to the development of the original G400 theory, program documentation, user instructions and information are presented.

85-1761

Natural Frequencies of Twisted Rotating Plates

V. Ramamurti R. Kielb
Indian Inst. of Technology, Madras 600036, India

J. Sound Vib., 97 (3), pp 429-449 (Dec 9, 1984), 14 figs, 15 tables, 20 refs

KEY WORDS: Rotors, Plates, Natural frequencies

A detailed comparison is presented of the predicted eigenfrequencies of twisted rotating plates as obtained by using two different shape functions. Primarily, rotating twisted plates of two different aspect ratios and two different thickness ratios are considered. The effects of rotation are included by using a "stress smoothing" technique when calculating the augmented stiffness matrix. In addition, the effects of Coriolis acceleration, contributions from membrane behavior, setting angle and sweep angle are considered. The effects of geometric nonlinearity are briefly discussed. Finally, results of a brief study of cambered plates are presented.

85-1762

Vibrations of a Textile Machine Rotor

L. Cveticanin
Univ. of Novi Sad, 21000 Novi Sad, V. Vlahovića 3, Yugoslavia

J. Sound Vib., 97 (2), pp 181-187 (Nov 22, 1984), 7 figs, 5 refs

KEY WORDS: Shafts, Rotors, Textiles

In this paper the vibrations of a textile machine rotor, whose angular velocity is constant, are analyzed. The function of the rotor is to wind up a band of textile material into a roll. The elastic force in the shaft is assumed to be non-linear. First the free vibrations of this rotor are analyzed analytically and numerically. The results are compared. After that the vibrations in the non-resonant case are analyzed. The solution is found by use of the analytical method of multiple scales. The results for free vibrations and for the non-resonant case are compared.

85-1763

Unsteady Flows in Axial-Flow Compressors and a Mathematical Noise Model for the Subsonic Range (Instationare (Stromungen in Axialverdichtern und ein mathematisches Larmmodell fur den Unterschallbereich)

J. Jedryszek
Technische Hochschule Wroclaw (VR Polen), Institut fur Warmetechnik und Flussigkeitsmechanik

Maschinenbautechnik, 34 (2), pp 90-93 (1985), 9 figs, 11 refs (In German)

KEY WORDS: Compressors, Noise generation

Unsteady pressures and velocities at the after guide-blade-profiles of an axial-flow ventilator are calculated for weakly curved compressor lattices. They are compared with experimental results. The unsteady effects within the axial gap planes and on the blade surfaces as well as the noise level of the stage are gauged. The gauged unsteady pressures and noise levels of the stage agree rather exactly with theoretical calculations.

85-1764

Alignment Changes and Their Effects on the Operation and Integrity of Large Turbine Generators: Experience in the CEGB South Eastern Region

Y. Hashemi
Central Electricity Generating Board, London, UK

Steam and Gas Turbine Foundations and Shaft Alignment Conf. Feb 24, 1983, London, UK. Spons. The Power Industries Div. of IMechE., IMechE Conf. Pubs 1983-1, pp 19-30, 9 figs, 4 tables, 9 refs

KEY WORDS: Steam turbines, Generators, Alignment

A number of the factors which can lead to alignment changes in steam turbine generators and their effects on the rotor-bearing interactions are discussed. Some of the operational difficulties associated with misalignments are described and the actions which can be taken to overcome them are illustrated by reference to experience obtained from turbine plant in the SE Region of the CEGB.

85-1765

A Note on Tower Wake/Blade Interaction Noise of a Wind Turbine

S. Fujii, K. Takeda, H. Nishiwaki

National Aerospace Lab., Chofu, Tokyo, Japan

J. Sound Vib., 97 (2), pp 333-336 (Nov 22, 1984), 3 figs, 1 ref

KEY WORDS: Wind turbines, Noise generation

Experimental observations on wind turbine tower wake/blade interaction noise are presented. Results for circular, elliptical and square sections of the support tower legs are compared and quantified with respect to the acoustic frequency spectra produced. The results are preliminary ones obtained in a continuing study aimed at constructing a shape that may yield a lower interaction noise.

85-1766

Turbine Generator Alignment Using a Laser-Based Optical System

A.J. Batterham

Central Electricity Generating Board, Bristol, UK

Steam and Gas Turbine Foundations and Shaft Alignment Conf. Feb 24, 1983, London, UK. Spons. The Power Industries Div. of IMechE., IMechE Conf. Pub. 1983-1, pp 53-62, 6 figs, 1 table

KEY WORDS: Turbogenerators, Alignment, Lasers

A laser-based system has been adapted for aligning large turbine generators. Site trials have shown it is safe and accurate in use.. It is anticipated that plant outage times could be reduced by speeding the alignment process.

85-1767

Economical Optimisation of the Alignment of Turbine Generators

W.G.R. Davies, P.C. Pandey

Central Electricity Generating Board, Nottingham, UK

Steam and Gas Turbine Foundations and Shaft Alignment Conf., Feb 24, 1983, London, UK. Spons. by The Power Industries Div. of IMechE., IMechE Conf. Pub. 1983-1, pp 45-52, 5 figs, 6 tables

KEY WORDS: Turbogenerators, Alignment, Computer programs

In realigning a large multi-bearing turbine generator, it is important to minimize the amount of work involved. This can sometimes be achieved by reducing the number and magnitude of bearing height changes, even though this may leave one or more bearings misaligned with respect to the ideal catenary. A mathematical formulation has been derived to allow this procedure to be optimized, in two stages.

85-1768

Fatigue Reliability of Gas Turbine Engine Components Under Scheduled Inspection Maintenance

J.N. Yang, S. Chen

The George Washington Univ., Washington, D.C.

J. Aircraft, 22 (5), pp 415-422 (May 1985), 6 figs, 2 tables, 27 refs

KEY WORDS: Turbine engines, Turbine components, Fatigue life

A probabilistic method is developed for the fatigue reliability analysis of gas turbine engine components under scheduled inspection maintenance in service. Various statistical uncertainties involved in the complex design system of gas turbine engine components have been taken into account, including the time to crack initiation, fatigue crack propagation, service loads, crack modeling, crack geometry, nondestructive evaluation (NDE), etc. It is demonstrated that the service inspection maintenance can be used to improve the reliability of fatigue-critical components significantly. An example for the third-stage turbine disk of a TF-33 jet engine has been worked out to demonstrate the application of the analysis methodology developed.

85-1769

Study on Dynamic Characteristics of Liquid Oxygen Pumps for Rocket Engines

T. Shimura, K. Kamijo

National Aerospace Lab., Tokyo, Japan

Rept. No. NAL-TR-806, 11 pp (Apr 1984), N85-12088/9/GAR (In Japanese)

KEY WORDS: Rocket engines, Pumps

Transfer matrix methods, which were applied to cavitating inducers, are used in order to examine the dynamic response of a centrifugal liquid oxygen pump with an inducer.

RECIPROCATING MACHINES

85-1770

A Computer Simulation Study of Compressor Tuning Phenomena

J.J. Nieter, R. Singh

Ohio State Univ., Columbus, OH 43210

J. Sound Vib., 97 (3), pp 475-488 (Dec 8, 1984), 9 figs, 1 tables, 21 refs

KEY WORDS: Reciprocating compressors, Tuning, Acoustic pulses, Computerized simulation

Basic thermofluid processes of a positive displacement compressor are strongly dependent upon the acoustic behavior of the manifolds. The tuning process of such a compressor is fairly complex as increases in the mass flow rate may not correspond with higher energy efficiencies. In this paper a computer simulation program is described, which includes the manifold back pressure effect, developed to investigate and explain the tuning phenomena for a single or two-cylinder reciprocating compressor.

METAL WORKING AND FORMING

85-1771

Noise Reduction of the Exhaust from Pneumatic Tools

G. Lorenz

Inst. fuer Werkzeugmaschinen, Stuttgart Univ., Fed. Rep. Germany

Rept. No. BMFT-FB-HA-183-21, 100 pp (Sept 1983), N85-11799

KEY WORDS: Machine tools, Noise reduction

Noise in the vane type air motor is examined. Pressure pulses in the exhaust, caused by the thermodynamic cycles from the chambers and their periodic exhaust, are found to be the main causes of the noise. A silencer for the discrete frequency noise was developed.

85-1772

Modal Displacement Vectors Describing the Relative Behaviour on the Given Point. (Modalverlagerungsvektoren beschreiben Relativverhalten in der Wirkstelle)

H. Tonshoff, W. Kiehl, S. Bohao

Hannover, Fed. Rep. Germany

VDI-Z, 126 (18), pp 657-662 (1984), 7 figs, 1 table, 7 refs (In German)

KEY WORDS: Machine tools, Modal analysis

Modal analysis is an important aid for investigating the dynamic behavior of mechanical structures. By this means the modal parameters of natural frequency, compliance, phase angle, attenuation and mass of complex systems can be determined from experimentally calculated transfer function. Machine tools also pertain to this category. The method of modal displacement vectors is developed in this paper. This is suitable for progressive analysis of modal parameters and allows consideration for the relative movements between tool and workpiece as a function of the vibration behavior of a given weak point. The method also provides pointers for optimal layout of machine elements.

85-1773

Theoretical and Experimental Modal Analysis of a Machine Tool-Drive System (Rechnerische und experimentelle Modalanalyse einer Werkzeugmaschinen-Antriebsstruktur)

J. Milberg, H. Summer
Institut fur Werkzeugmaschinen und Betriebswissenschaften der Technischen Universitat Munchen, Fed. Rep. Germany

Dynamische Probleme. Modellierung und Wirklichkeit. Proc. Mtg. Oct 4-5, 1984, Hannover, Curt-Risch-Institut der Universitat Hannover, Hannover, Fed. Rep. Germany, Vol. II, pp 497-518, 5 figs, 5 refs (In German)

KEY WORDS: Machine tools, Modal analysis

Static and dynamic flexibility of a prestressed machine tool-drive system is calculated. The calculations are compared with an experimental modal analysis. In order to compare the two methods quantitatively, the dynamic deflections in their undamped state are determined.

85-1774

Designing Demands to Feed Axes and Frame Components of Machine Tools with Continuous-Path Control of High Accuracy

K. Grossmann
VEB Mikromat, Dresden

Maschinenbautechnik, 33 (12), pp 532-540 (1984), 15 figs, 9 refs (In German)

KEY WORDS: Machine tools, Automatic control

The analysis of stability behavior and response to a variation of the reference input of positioning automatic control loops is dependent on the lowest natural frequency of mechanical transmission elements. It must be tuned to the characteristic angular frequency of the automatic drive control loop. Plain evaluation possibilities for the fundamental frequency of the mechanical transmission system are stated, which can also be handled as a dimensioning base.

85-1775

Vibrations Increase Available Power at the Bit

D.W. Dareing
Norton Christensen Drilling Products, Houston, TX 77073

J. Energy Resources Tech., Trans. ASME, 107 (1), pp 138-141 (Mar 1985), 4 figs, 1 table, 2 refs

KEY WORDS: Drills, Fatigue life

Drillstring vibrations are generally considered to be detrimental to downhole drilling equipment because they produce cyclic or fatigue loading. Tool joint failures, tubular washouts, and bit breakage are often fatigue related. On the positive side, dynamic forces applied to roller cone rock bits have the potential to increase penetration rate. This paper quantifies the available vibration energy at the bit and shows how to control the level of energy through bottom hole assembly design and rotary speed.

85-1776

Modeling and Analysis of Flow-Induced Vibrations in Circular Saws

M.C. Leu, M. Jirapongphan
Cornell Univ., Ithaca, NY

J. Vib., Acoust., Stress, Rel. Des., Trans. ASME, 107 (2), pp 196-202 (Apr 1985), 10 figs, 26 refs

KEY WORDS: Circular saws, Fluid-induced vibration, Random vibration, Resonant response

Two types of flow-induced vibrations in idling circular saws, random vibration and resonant vibration, were modeled and ana-

lyzed. The excitation source, which is the flow pressure fluctuations, was modeled as discrete forces acting at the saw teeth. The response was assumed to be uncoupled from the excitation in the random vibration analysis but coupled with the excitation in the resonant vibration analysis. The random vibration was solved in terms of statistical rms amplitudes and the resonant vibration as a time function. The analytical results captured many characteristics of vibration phenomena observed in idling saw experiments.

MATERIALS HANDLING EQUIPMENT

85-1777

Design and Operating Criteria for vibratory Bowl Feeder (Auslegungs- und Betriebskriterien fur Vibrationswendelforderer

H. Ahrens

VDI-Z, 126 (22), pp 881-884 (1984), 7 figs, 1 table, 3 refs (In German)

KEY WORDS: Oscillating conveyors

For correct workpiece control on automated production and assembly lines the vibratory bowl feeder is the most frequently employed manipulating device. For making purposeful equipment design possible, the basic influencing factors and their mutual dependencies for the feeder processes in vibratory bowl feeders as design criteria are described. The actual working motion of vibratory bowl feeding is outlined and some basic conditions to be maintained for the vibratory system and the erection of the device are presented.

85-1778

Vibratory Feeding by Nonsinusoidal Vibration - Optimum Wave Form

S. Okabe, Y. Kamiya, K. Tsujikado, Y. Yokoyama

Kanazawa Univ., Kanazawa, Japan

J. Vib., Acoust., Stress, Rel. Des., Trans. ASME 107 (2), pp 188-195 (Apr 1985), 14 figs, 10 refs

KEY WORDS: Vibrators (machinery), Conveyors, Random excitation, Materials handling equipment

This paper presents the conveying velocity on a vibratory conveyor whose track is vibrated by nonsinusoidal vibration. The velocity wave form of the vibrating track is approximated by six straight lines, and five distortion factors of the wave form are defined. Considering the modes of motion of the particle, the mean conveying velocity is calculated for various conditions. Referring to these results, the optimum wave form is clarified analytically. The theoretical results are confirmed by experimental results.

85-1779

Dynamic Models for Control System Design of Integrated Robot and Drive Systems

M.C. Good, L.M. Sweet, K.L. Strobel

General Electric Co., Schenectady, NY 12345

J. Dynam. Syst., Meas. Control, Trans. ASME, 107 (1), pp 53-59 (Mar 1985) 10 figs, 18 refs

KEY WORDS: Robots, Linkages

This paper presents analytical models and experimental data to show that interactions between electromechanical drives coupled with compliant linkages to arm link drive points are of fundamental importance to robot control system design. Flexibility in harmonic drives produces resonances in the 5 Hz to 8 Hz range. Flexibility in the robot linkages and joints connecting essentially rigid arm members produces higher frequency modes at 14 Hz and 40 Hz. The nonlinear characteristics of the drive system are modeled, and compared to experimental data. The models presented have been validated over the frequency range 0 to 50 Hz. The paper concludes with a brief discussion of the influence of model characteristics on motion control design.

BRIDGES

85-1780
Feasibility Investigation of Utilizing the Internal Friction Damping Nondestructive Evaluation Technique (IFD-NDE) for Measuring the Degree of Fatigue in Mobile Bridge Structures
R.S. Weinreich
Daedalean Associates, Inc., Woodbine, MD
Rept. No. DAI-RSW-8409-1-TR, 56 pp (Nov 1984), AD-A148 717/2/GAR

KEY WORDS: Bridges, Fatigue tests, Internal friction, Coulomb friction, Nondestructive tests

This report discusses a nondestructive test technique which has the potential for measuring the degree of fatigue in military bridge structures.

85-1781
Dynamic Investigations of Large Bridges, in-situ Tests and Mathematical Models (Dynamische Untersuchungen von Grossbrucken, in situ- Versuche und Rechenmodelle)
K. Kernbichler, R. Flesch, G. Rauscher
Technisches Universitat-Graz, Austria
Dynamische Probleme. Modellierung und Wirklichkeit. Proc. mtg. Oct 4-5, 1984, Hannover, Curt-Risch-Institut der Universitat Hannover, Hannover, Fed. Rep. Germany, Vol. II, pp 379-398, 6 figs, 17 refs (In German)

KEY WORDS: Bridges, Testing techniques, Mathematical models

The dynamic behavior of bridges was investigated. The investigations consisted of dynamic in-situ tests and calculations. The aim is to improve the mathematical model for the analysis of dynamic loads. The development of a dynamic procedure for the inspection of the construction is reported.

85-1782
Aerodynamic Stability of Cable-Stayed Bridge with New Vierendeel-Type Girder
Y. Nakayama
Nippon Kokan K.K. 1-1-2, Marunouchi, Chiyoda-ku, Tokyo 100, Japan
Engrg. Struc., 7 (2), pp 85-92 (Apr 1985), 18 figs, 4 tables, 8 refs

KEY WORDS: Bridges, Cable stayed structures, Aerodynamic loads, Flutter

An aerodynamic study is described showing the stability of a new type of double deck cable-stayed bridge having both upper and lower flat, shallow, streamlined box girder decks connected by vertical members only. The three aerodynamic components of force have also been measured. For comparison, a wind-tunnel experiment has been carried out using a partial model of a conventional suspended structure of a typical truss type double deck cable-stayed bridge. It is shown that the new system is superior to the truss type from an aerodynamic stability viewpoint.

85-1783
Vehicle-Bridge Interaction
T. Dahlberg
Chalmers Univ. of Technology, S-412 96 Gothenburg, Sweden
Vehicle Syst. Dynam., 13 (4), pp 187-206 (1984), 8 figs, 1 table, 38 refs

KEY WORDS: Bridges, Moving loads, High speed transportation systems, Railroad trains

A method for estimation of the time-dependent vehicle-bridge interaction forces has been developed in the present The increase (or decrease) of the bridge response due to dynamic effects is determined. The moving constant-force problem is reviewed in some detail. Results obtained by the present method for the moving-mass problem are compared with existing experimental and theoretical results as reported in the literature. A parametric study of bridge responses is made.

85-1784

Dynamic Interaction Between Freight Train and Steel Bridge

M.H. Bhatti, V.K. Garg, K.H. Chu
GDS and Associates, Consulting Engineers, Chicago, IL

J. Dynam. Syst., Meas. Control, Trans. ASME, 107 (1), pp 60-66 (Mar 1985), 10 figs, 2 tables, 21 refs

KEY WORDS: Bridges, Moving loads, Railroad trains, Freight cars

The dynamic responses of a railway steel bridge due to vehicle-track-bridge interaction were investigated for the effects of vertical and lateral track irregularities, approach track quality, vehicle weight and type, and train speed. It was found that greater approach irregularities produce higher impact factors and dynamic forces in bridge members. Light weight and empty cars produce higher impact factors but small dynamic forces. Impact factors depend on such parameters as axle spacing, suspension system stiffness, and truck center distances.

BUILDINGS

85-1785

Modeling of Buildings for Earthquake Analysis (Modellierung von Gebauden fur Erdbebenanalysen)

J.G. Bouwkamp, J. Kollegger
Univ. of California, Berkeley, CA

Dynamische Probleme. Modellierung und Wirklichkeit. Proc. mtg. Oct 4-5, 1984, Hannover, Curt-Risch-Institut der Universitat Hannover, Hannover, Fed. Rep. Germany, Vol. II, pp 519-536, 14 figs, 5 tables, 11 refs (In German)

KEY WORDS: *Multistory buildings, Seismic* response, Mathematical models

A procedure developed for the determination of vibration response of multistory buildings is illustrated by testing natural and forced vibrations of a twelve story residential slab building. Comparison with calculations showed a large effect of ground deformation on the dynamic properties of the mathematical models. The flexibility of the soil was determined by the addition of another floor, whose height and stiffness were determined from the experimental data. Also available information from a foundation investigation was used. This model produced excellent agreement of experimental and analytical results.

85-1786

Vibration and Noise Reduction in a Building Above an Underground Train Tunnel (Erschutterungs- und Schallschutzmassnahmen fur ein Gebaude uber einem S-Bahn-Tunnel)

H. Grundmann, F.H. Muller, R. Muller
Technische Universitat Munchen, Fed. Rep. Germany

Dynamische Probleme. Modellierung und Wirklichkeit. Proc. mtg., Oct 4-5, 1984, Hannover, Curt-Risch-Institut der Universitat Hannover, Hannover, Fed. Rep. Germany, Vol. I, pp 215-232, 8 figs, 6 refs (In German)

KEY WORDS: Buildings, Noise reduction, Design techniques

A brief description of the problem in constructing a residential commercial building above an underground train tunnel is given. Calculations for damping structural noise in the building are presented.

85-1787

Earthquake Safety of Ductile Beam Frameworks (Zur Erdbebensicherheit duktiler Stabtragwerke)

U. Hohlsiepe, W.B. Kratzig, K. Meskouris
Lehrstuhl KIB III - Statik und Dynamik der Ruhr-Universitat Bochum, Fed. Rep. Germany

Dynamische Probleme. Modellierung und Wirklichkeit. Proc. mtg., Oct 4-5, 1984, Hannover, Curt-Risch-Institut der Universitat Hannover, Hannover, Fed. Rep. Germany, Vol. I, pp 261-278, 17 figs, 6 refs (In German)

KEY WORDS: Multistory buildings, Seismic design

A multistory building can sustain a much higher earthquake-induced excitations than it its design indicates if there is sufficient ductility at the critical points of the framework. To attain such construction requirements a method for a nonlinear response calculation is presented. It takes into consideration inelastic framework characteristics in which the supports remain in the elastic range while a considerable amount of seismic energy is dissipated by the yield hinges in the beams. By a proper choice of stiffness and ductility characteristics the engineer is able to design into the structure an unusually high degree of seismic safety.

85-1788

Dynamic Response of Multistoried Brick Buildings

M. Qamaruddin, A.S. Arya, B. Chandra
Univ. of Petroleum and Minerals, Dhahran, Saudi Arabia
Earthquake Engrg. Struc. Dynam., 13 (2), pp 135-150 (Mar/Apr 1985), 7 figs, 5 tables, 24 refs

KEY WORDS: Multistory buildings, Masonry, Seismic response

The paper presents the seismic response analysis of a typical multistoried brick building. A number of variables representing the physical properties of the structural system, namely, number of stories from one to four, wall thickness in various stories from one to one and a half brick thick and damping from 5 per cent to 15 per cent of critical value are considered. From this study the critical sections for providing reinforcing have been identified and the minimum amount of necessary steel has been estimated.

TOWERS

85-1789

Effects of Load Modelling on Dynamic Response: Articulated Tower

A. Bech, B.J. Leira
Selskapet for Industriell og Teknisk Forskning, Norges Tekniske Hoegskole, Trondheim, Norway
Rept. No. STF71-A84014, 26 pp (Mar 1984), PB85-124030

KEY WORDS: Towers

This report details the effects of using actual versus static positions as a basis for wave force calculations. An articulated tower has been studied, both by means of simplified analytical considerations and a numerical computer program. It is concluded that the effects of using instantaneous positions may be significant considering both load and response.

FOUNDATIONS

85-1790

Inelastic Seismic Response of Simple Eccentric Structures

W.K. Tso, A.W. Sadek
McMaster Univ., Hamilton, Ontario, Canada
Earthquake Engrg. Struc. Dynam., 13 (2), pp 255-269 (Mar/Apr 1985), 12 figs, 1 table, 7 refs

KEY WORDS: Seismic response, Ground motion, Eccentricity

The maximum ductility demand and the edge displacement of a simple single mass eccentric model is evaluated when the system is subjected to ground motions represented by the El Centro 1940 and Taft 1952 earthquake records. The resisting elements are taken to be bilinear hysteretic. It is found that the ductility demand depends to a great extent on the energy content of the ground motions, particularly in the period range beyond the elastic period of the system.

85-1791

Dynamic Slope Stability Analyses with a Non-Linear Finite Element Method

K. Toki, F. Miura, Y. Oguni

Kyoto Univ., Uji, Kyoto 611, Japan
Earthquake Engrg. Struc. Dynam., 13 (2), pp 151-171 (Mar/Apr 1985), 24 figs, 6 tables, 19 refs

KEY WORDS: Soils, Stability, Finite element technique, Seismic response,

A new technique is presented with which to investigate slope stability during strong earthquake motion. This technique is based on a non-linear finite element method that uses a joint element to express non-linear behavior and the progressive failure of a slope. Joint elements are arranged at every interface between soil elements. The method was used to investigate the stability of an existing slope during strong earthquake motions. Preliminary static analyses were made, and their results were compared with results obtained with Janbu's method in order to check the validity of our proposed method.

85-1792

Operating Mode: Determination of Dynamic Soil Modules by Resonance (Mode Operatoire: Determination des Modules Dynamiques des Sols par Resonance)

Centre de Recherches Routieres, Brussels, Belgium
Rept. No. MF-51/84, 54 pp (1984) PB85-136463/GAR (In French)

KEY WORDS: Soils, Vibration tests, Testing techniques

Determination of dynamic soil modules by resonance means subjecting a cylindrical soil sample of known length and volume mass at its base to sinusoidal vibrations. They are maintained longitudinally or in twist, at increasing frequency.

85-1793

Preventative Design/Construction Criteria for Turbomachinery Foundations

E.M. Renfro
Adhesive Services Co., Houston, TX
Steam and Gas Turbine Foundations and Shaft Alignment Conf. Feb 24, 1983, London, UK. Spons. by The Power Industries Div. of IMechE., IMechE Conf. Pub. 1983-1, pp 63-68, 7 figs, 5 refs

KEY WORDS: Machine foundations, Turbomachinery, Design techniques

The time to reduce maintenance costs on turbomachinery is in the design and construction stages. Faulty support ultimately results in alignment or vibration problems. These conditions in turn erode reliability and at the same time render increased maintenance costs. Support problems occur on equipment mounted on structural steel platforms, sometimes called baseplates, as well as on conventional concrete block mounted equipment. Common weaknesses of baseplates are examined with emphasis placed on the non-rigidity of typical baseplates, distortion due to loading and warping from piping stresses or thermal expansion.

85-1794

The Dynamics of Turbo-Alternator Foundations

A.W. Lees, I.C. Simpson
Central Electricity Generating Board, Bristol, UK
Steam and Gas Turbine Foundations and Shaft Alignment Conf., Feb. 24, 1983, London, UK. Spons. by The Power Industries Div. of IMechE., IMechE Conf. Pub. 1983-1, pp 37-44, 5 figs, 1 ref

KEY WORDS: Machine foundations, Turbomachinery

A review is given of the field of turbo alternator foundation dynamics. The results of both plant tests and theoretical studies which have been carried out over the past 15 years are examined.

85-1795

Foundation and Alignment Problems of Small Machines

L.F. Moore
Leslie F. Moore Associates, Dartford, Kent, UK

Steam and Gas Turbine Foundations and Shaft Alignment Conf. Feb 24, 1983, London, UK. Spons. by The Power Industries Div. of IMechE, IMechE Conf. Pub. 1983-1, pp 31-36, 3 figs

KEY WORDS: Machine foundations

This paper examines the reasons for rigidly or resiliently mounting machines and then discusses the merits of the various types of resilient mounting. The controlling parameters are surveyed together with ancillary requirements such as the need for inertia blocks, foundation plinths and holding-down bolts, and piping flexibility.

85-1796

Steel Foundations for the Support of High-Speed Machinery

R.O. Praefcke

MAN Maschinenfabrik Augsburg-Nurnberg, Ginsheim-Gustavsburg, W. Germany

Steam and Gas Turbine Foundations and Shaft Alignment Conf., Feb 24, 1983, London, UK. Spons. by The Power Industries Div. of IMechE., IMechE Conf. Pub. 1983-1, pp 9-18, 8 figs

KEY WORDS: Machinery foundations, Design techniques

Steel foundations have been successfully used to support turbo-generators and other high-speed machinery, generally with rated speeds of 300 ref/min and above. Their design, analysis, characteristics, fabrication, and site erection are described.

85-1797

Dynamic Pile Testing as a Nonlinear System Identification (Dynamische Pfahlprufung als nichtlineare System-identifikation)

O. Klingmuller

Bilfinger & Berger Bau AG, Mannheim, Fed. Rep. Germany

Dynamische Probleme. Modellierung und Wirklichkeit. Proc. of mtg. Oct 4-5, 1984, Hannover, Curt-Risch-Institut der Universitat Hannover, Hannover, Fed. Rep. Germany, Vol. II, pp 537-554, 6 figs, 9 refs (In German)

KEY WORDS: Pile structures, Dynamic tests, Nonlinear theories, System identification techniques

The dynamic pile testing is presented as a problem of nonlinear system identification. After a short introduction to the problem the solvability and the uniqueness of solutions is presented.

85-1798

Generation and Propagation of Excitations Caused by Pile Driving (Entstehung und Ausbreitung von Rammerschutterungen)

H. Hebener, W. Rucker

Bundesanstalt fur Materialprufung (BAM), Berlin, Fed. Rep. Germany

Dynamische Probleme. Modellierung und Wirklichkeit. Proc. mtg., Oct 4-5, 1984, Hannover, Curt-Risch-Institut der Universitat Hannover, Hannover, Fed. Rep. Germany, Vol. I, pp 195-214, 18 figs, 10 refs (In German)

KEY WORDS: Pile driving, Soil-structure interaction, Shock waves, Wave propagation

A theoretical analysis of the boundary conditions between piles and soil is presented using the methods for dynamic bearing strength determination. Mathematical simulation and experimental results from the propagation of impulse excitation in an inhomogenous half space are presented.

85-1799

Numerical Modeling of the Behavior of Water Saturated Soils Under Harmonic and Seismic Excitation (Numerische Modellierung des Verhaltens wassergesattigter Boden unter harmonischer und seismischer Belastung)

J. Strauss, H. Cramer, W. Wunderlich

Ruhruniversitat Bochum, Institut fur Konstruktiven Ingenieurbau, Fed. Rep. Germany

Dynamische Probleme. Modellierung und Wirklichkeit. Proc. mtg. Oct 4-5, 1984, Hannover, Curt-Risch-Institut der Universitat Hannover, Hannover, Fed. Rep. Germany, Vol. I, pp 177-194, 12 figs, 8 refs (In German)

KEY WORDS: Soil-structure interaction, Seismic excitation, Mathematical models, Nuclear power plants

Simulation of the behavior of soils is proposed taking into consideration the tensile strength. Continuous reduction of shear modulus of elasticity up to its ideal plastic range is included. Dependency of the shear modulus and bearing strength on the hydrostatic stress component is considered. The proposed material law is tested by means of the available experimental results. The model is illustrated in an analysis of seismic or aircraft penetration response of nuclear power plants.

85-1800
Non-Linear Soil-Structure-Interaction Analysis Using Green's Function of Soil in the Time Domain
J.P. Wolf, P. Obernhuber
Electrowatt Engrg. Services, Ltd., 8022 Zurich, Switzerland
Earthquake Engrg. Struc. Dynam., 13 (2), pp 213-223 (Mar/Apr 1985), 7 figs, 9 refs

KEY WORDS: Soil-structure interaction, Green function, Time domain method

Contribution of unbounded soil to basic equation of motion of a nonlinear analysis of soil-structure interaction consists of convolution integrals of displacement-force relationship in the time domain and history of interaction forces. The former is calculated using the indirect boundary-element method, which is based on a weighted-residual technique and involves Green's functions. As an example of a nonlinear soil-structure-interaction analysis, the partial uplift of the basemat of a structure is examined.

85-1801
Non-Linear Soil-Structure-Interaction Analysis Using Dynamic Stiffness or Flexibility of Soil in the Time Domain
J.P. Wolf, P. Obernhuber
Electrowatt Engrg. Services Ltd., 8022 Zurich, Switzerland
Earthquake Engrg. Struc. Dynam., 13 (2), pp 195-212 (Mar/Apr 1985), 14 figs, 1 table, 12 refs

KEY WORDS: Soil-structure interaction, Stiffness coefficients, Time domain method

The dynamic-stiffness or flexibility coefficient in the time domain is calculated as the inverse Fourier transform of the corresponding value in the frequency domain for an irregular soil with the linear unbounded soil.

85-1802
Displacement Solutions for Dynamic Loads in Transversely-Isotropic Stratified Media
G. Waas, H.R. Riggs, H. Werkle
Hochtief AG, Abt. KTI, Bockenheimer Landstr. 24, 6000 Frankfurt/Main 1, W. Germany
Earthquake Engrg. Struc. Dynam., 13 (2), pp 173-193 (Mar/Apr 1985), 5 figs, 2 tables, 26 refs

KEY WORDS: Soil-structure interaction, Layered Materials, Viscoelastic media Seismic response

Solutions for the displacements caused by dynamic loads in a viscoelastic transversely-isotropic medium are derived. The medium extends horizontally to infinity, but is bounded below by a rigid base. Stratification of the medium presents no difficulties.

POWER PLANTS

85-1803
Comprehensive Vibration Assessment Program for the Prototype System 80 Reactor Internals (Palo Verde Nuclear Generating Station Unit 1)
Combustion Engineering, Inc., Windsor, CT
Rept. No. CEN-202(V)-NP, 239 pp (1984), DE84901860

KEY WORDS: Nuclear power plants, Nuclear reactor components

In accordance with the U.S. Nuclear Regulatory Commission Regulatory Guide 1.20 (Rev. 2)a Comprehensive Vibration Assessment Program (CVAP) has been developed for Palo Verde Nuclear Generating Station Unit 1. Purpose of the CVAP is to verify the structural integrity of the reactor internals to flow induced loads prior to commercial operation. The dynamic flow related loads considered are associated with normal steady state operation and anticipated operating transients.

85-1804
Seismic Design Criteria and Their Application to Major Hazard Plants Within the United Kingdom
M.A.H.G. Alderson
UKAEA Risley Nuclear Power Development Establishment, Culcheth, UK
Rept. No. SRD-R-246, 71 pp (Dec 1982), DE83703876

KEY WORDS: Seismic design, Nuclear power plants

The nature of seismic motions and the implications are briefly described. The development of seismic design criteria for nuclear power plants in various countries is described. Finally this effect of earthquakes on major hazard plant is discussed in general terms including the seismic analysis of a typical plant item.

OFF-SHORE STRUCTURES

85-1805
Combined Wind, Wave and Current Forces — Extreme Value Analysis of a Simplified Model
A. Naess
Norwegian Hydrodynamic Labs., Hakon Hakansons gt 34 P.O.B. 4118 Valentinlyst, N-7001 Trondheim, Norway
Engrg. Struc., 7 (2), pp 105-113 (Apr 1985), 5 figs, 17 refs

KEY WORDS: Offshore structures, Wind-induced excitation, Wave forces, Stochastic processes

Studies are presented on the extreme value statistics of combined wind, wave and current loading on a fixed offshore structure. The emphasis is on a method developed by the author to study extreme values of compound stochastic processes. The effect on the extreme value estimates of considering the component loads separately or simultaneously is discussed.

85-1806
Coupled Response of Compliant Offshore Platforms
J.W. Leonard, R.A. Young
Ocean Engrg. Program, Oregon State Univ., Corvallis, OR 97331
Engrg. Struc., 7 (2), pp 74-84 (Apr 1985), 11 figs, 45 refs

KEY WORDS: Drilling platforms, Off-shore structures, Coupled response, Finite element technique

A three-dimensional finite element analysis has been used to simulate the coupled static and dynamic behavior of compliant ocean structures. Nonlinearities which result from large deflections, reduced or zero stiffness in compression, and nonconservative fluid loading are considered. Also the spatial variation of fluid loading is addressed.

85-1807
In-Line Forces on Vertical Cylinders in Deepwater Waves
T.H. Dawson
U.S. Naval Academy, Annapolis, MD 21402
J. Energy Resources Tech., Trans. ASME, 107 (1) pp 18-23 (Mar 1985), 6 figs, 2 tables, 8 refs

KEY WORDS: Off-shore structures, Cylinders, Hydrodynamic excitation, Experimental data

Laboratory measurements of the total in-line forces on a fixed vertical 2-in-dia cylinder in deep-water regular and random waves are given and compared with predictions from the Morison equation.

85-1808

Environmental Load Effect Analysis of Guyed Towers

O. Mo, T. Moan
A.S. Veritec, Det norske Veritas, Oslo, Norway

J. Energy Resources Tech., Trans. ASME, 107 (1), pp 24-33 (Mar 1985), 11 figs, 16 refs

KEY WORDS: Off-shore structures, Towers, Guyed structures, Hydrodynamic excitation

A general method for dynamic load effect analysis of slender offshore structures subjected to short crested random waves, current and wind, is given. The structure is a three-dimensional space frame model utilizing dash-pots and linear or nonlinear spring elements to represent guy lines and coupling between structure and foundation. The component mode synthesis formulation is used for reduction of the number of degrees of freedom.

85-1809

Effects of Load Modelling on Dynamic Response: Marine Riser Systems

A. Bech
Selskapet for Industriell og Teknisk Forskning, Norges Tekniske Hoegskole, Trondheim, Norway

Rept. No. STF71-A84013, ISBN-82-595-3454-1, 111 pp (Mar 1984), PB85-124022

KEY WORDS: Marine risers

This report details the effects of using actual static positions as a basis for wave force calculations in riser problems. Two riser systems have been studied: A drilling riser connected to a semi-submersible platform at 325 meters waterdepth. A production riser connected to a tension-legged platform at 350 meters waterdepth.

85-1810

Large Displacement Analysis of a Marine Riser

T. Huang, S. Chucheepsakul
Univ. of Texas, Arlington, TX 76019-308

J. Energy Resources Tech., Trans. ASME, 107 (1), pp 54-59 (Mar 1985), 6 figs, 8 refs

KEY WORDS: Offshore structures, Marine risers

A method of static analysis for a marine riser experiencing large displacements is presented. The method is suitable for analyzing a riser having a known top tension and a possible slippage at the top slip joint. Utilizing the stationary condition of a functional coupled with an equilibrium equation, one can conveniently obtain the equilibrium configuration numerically.

85-1811

Drag Forces on Oscillating Cylinders in a Uniform Flow

M. Kato, T. Abe, M. Tamiya, T. Kumakiri
Kobe Steel, Ltd., Kobe, Japan

J. Energy Resources Tech., Trans. ASME, 107 (1), pp 12-17 (Mar 1985), 8 figs, 2 tables, 14 refs

KEY WORDS: Off-shore structures, Marine risers, Cylinders, Hydrodynamic excitation, Drag coefficients

This paper describes the drag coefficients of cylinders oscillated in both in-line and transverse directions to a uniform flow. The drag coefficients have been obtained experimentally over a wide range of oscillation frequencies, amplitude and flow velocities for the cylinders of various diameters under simulated practical offshore conditions. New expressions are proposed for the drag coefficients of an oscillating cylinder in a uniform flow.

85-1812

Added Mass and In-Line Steady Drag Coefficient of Multiple Risers

T. Overvik, G. Moe
STATOIL, Norway

J. Energy Resources Tech., Trans. ASME, 107 (1), pp 2-11 (Mar 1985), 41 figs, 13 refs

KEY WORDS: Marine risers, Off-shore structures, Hydrodynamic excitation, Added mass effects, Drag coefficients

Part of the results of an investigation with multiple rise configuration exposed to steady currents are presented. Both the added mass, the frequency of vibration and the in-line steady drag coefficient are discussed both for vibration in the lock-in range and in the galloping mode.

85-1813

Comparisons of Simulation Methods for Motions of a Moored Body in Waves

M. Takagi, K. Saito, S. Nakamura
Hitachi Zosen Corp., Osaka, Japan
J. Energy Resources Tech., Trans. ASME, 107 (1), pp 34-41 (Mar 1985), 15 figs, 21 refs

KEY WORDS: Moorings, Time domain methods, Simulation

Based on the linear water wave theory, numerical simulations are carried out for motions in waves of a body moored by a nonlinear-type mooring system. Numerical results obtained by using the equation of motion described in the time domain with a convolution integral are compared with those of the second-order linear differential equation with constant coefficients. These results are also compared with experimental values measured from the initial stage.

VEHICLE SYSTEMS

GROUND VEHICLES

85-1814

Dynamics of Double Bottom Commercial Vehicles

M.J. Vanderploeg, J.E. Bernard
The Univ. of Iowa, Iowa City, IA
Intl. J. Vehicle Des., 6 (2), pp 139-148 (Mar 1985), 9 figs, 3 tables

KEY WORDS: Commercial transportation, Ground vehicles, Stability

The subject of this paper is the double bottom commercial vehicle which, in some configurations, has had severe stability problems. Through a literature review and linear analysis, it is shown that in the so-called Michigan Double configuration, the pup trailer, behaves in a volatile way in a lane change manoeuvre. Various design alternatives are shown to offer some improvement.

85-1815

Gaining a Better Understanding of the Vehicle Dynamics of Commercial Vehicles as a Contribution Towards Improving Active Safety (Entwicklung eines fahrdynamischen Konzeptes fur Nutzfahrzeuge als Beitrag zur aktiven Sicherheit)

E. Gohring, E.C. von Glasner, B. Maier
Anna-Schieber-Weg 43, 7300 Esslingen
Automobiltech. Z., 86 (12), pp 535-542 (Dec 1984), 15 figs, 20 refs (In German)

KEY WORDS: Ground vehicles, Vehicle-terrain interaction, Impact response

A means of accurately evaluating and optimizing a vehicle's behavior during vertical, lateral and longitudinal dynamic impact is described. This involves analyzing all vehicle components that directly affect the safety of a vehicle, its occupants or others, such as axle suspension, brakes, retarder and tires, for their reaction to the input of disturbing factors. A proper understanding often represents an optimal compromise among all pertinent influences.

85-1816

Immittance Identification: An Application to the Dynamic Modelling of Vehicle Components

N.G. Hemingway

The Hatfield Polytechnic, UK
Intl. J. Vehicle Des., 6 (1), pp 55-71 (Jan 1985), 6 figs, 9 refs

KEY WORDS: Modal analysis, Immittance identification, Ground vehicles, Suspension systems (vehicles)

If the dynamic characteristics of a number of components or sub-systems can be defined then it is possible to predict the vibration characteristics of an assembly comprising these sub-systems. One method of defining the dynamic characteristics of the sub-system is to specify its immittance matrix. It is therefore desirable to obtain a mathematical model of a component that is capable of generating this immittance matrix. Such a model can be obtained from experimental data produced from a vibration test on the component and the process of extracting the model from this data is termed immittance identification. This paper shows how such modeling was performed. Components comprising a vehicle suspension were considered.

85-1817

Investigations into the *Dynamics Behavior* of a Pusher-Type Articulated Bus (Fahrdynamische Untersuchungen an einem Schubgelenkbus)

H. Bruns, G. Matyssek, G. Stangl
Automobiltech. Z., 86 (12), pp 551-554 (Dec 1984), 8 figs (In German)

KEY WORDS: Buses, Articulated vehicles, Ride dynamics

Due to the controversy surrounding the vehicle dynamics of pusher-type articulated buses, thorough investigations were necessary. Kassbohrer developed an articulated unit for dynamic testing. This pusher was equipped with a "Schenk" type coupling. A brake integrated into the coupling provides full control of the relative horizontal movements of the two bus bodies. Critical driving situations were simulated at critical speeds, in particular: accelerating, swerving and braking on low-friction surfaces and especially swerving at high speeds. All these critical conditions can be controlled through correct application of the brake in the coupling. Thus the brake seems to have made articulated busses suitable for a wide range of operating conditions.

85-1818

Numerical Simulation of Dynamic No-Load Behaviour of Passenger Car Transmission (Numerische Simulation des dynamischen Leerlaufverhaltens von Pkw-Getrieben)

M. Weck, S. Lachenmaier, H. Salje
VDI-Z, 126 (18), pp 663-666 (1984), 3 figs, 1 table, 3 refs (In German)

KEY WORDS: Automobiles, *Power transmission systems*, Simulation

The low idling speeds imposed on passenger car engines for economical and environmental reasons lead to excessive speed fluctuations. These in their turn result in additional dynamic excitation within the subsequent power train system, manifested through "idle gear rattle" in the transmission. These additional excitations can be attenuated with the aid of special absorbing-type suspension systems, provided that optimal matching can be achieved. With the aid of numerical simulation programs it is possible to reproduce the complex vibration behavior of the structures involved, whereby the calculated variation of forces may serve as assessment function for the possible design of the suspension systems in question.

85-1819

Influence of Car Body Constructive Parameters on Acoustic Characteristics of Car Cavity

M. Kojic, Z. Petronijevic, V. Manojlovic
Zavodi Crvena Zastava', 34000 Kragujevac, Yugoslavia
Intl. J. Vehicle Des., 5 (6), pp 704-720 (Nov 1984), 20 figs, 4 tables, 9 refs

KEY WORDS: Automobiles, Interior noise, Modal analysis, Finite element technique, Computer programs

Some basic equations for the acoustic modal analysis of a car cavity, based on the finite element method are presented. Also equations for the acoustic pressure determination in the case of vibrations of car body parts are derived. A computer program is developed and applied to the analysis of the automobile 'Zastava 101.' From the results obtained, conclusions are drawn about the influence of some changes of the car body geometry on acoustic characteristics, as well as those corresponding to the pressure distribution due to the vibrations of the roof, floor, front and rear windows.

85-1820
Vehicle Interior Acoustic Design Using Finite Element Methods
D.J. Nefske, S.H. Sung
General Motors Res. Labs., Warren, MI
Intl. J. Vehicle Des., 6 (1), pp 24-40 (Jan 1985), 14 figs, 1 table, 14 refs

KEY WORDS: Automobiles, Interior noise, Noise source identification, Modal analysis, Finite element technique

This paper reviews the application of the finite element method to acoustic design of the automobile passenger compartment. Low-frequency noise in the passenger compartment is of primary interest, and particularly that noise which is generated by the structural vibration of the wall panels of the compartment. The paper describes the finite element methodology for analyzing the passenger compartment acoustics to diagnose and reduce this noise.

85-1821
A Nonlinear Analysis of the Generic Types of Loss of Stability of the Steady State Motion of a Tractor-Semitrailer
H. Troger, K. Zeman
Institut fur Mechanik Technische Universitat Wien Vienna, Austria
Vehicle Syst. Dynam., 13 (4), pp 161-172 (1984), 5 figs, 10 refs

KEY WORDS: Tractors, Articulated vehicles, Periodic response

All different types of loss of stability which occur generically for a tractor semitrailer vehicle are studied when varying two parameters namely the speed of the vehicle and the position d of the center of mass of the trailer. This paper furthermore indicates how a nonlinear investigation of stability problems in vehicle dynamics with no restriction to the number of degrees of freedom of the system can be done in a straight forward manner.

85-1822
Characteristics of Farm Profiles as Sources of Tractor Vibration
K. Ohmiya, K. Matsui
Hokkaido Univ., Sapporo, Japan
Proc. of Intl. Conf. on Performance of Off-Road Vehicles and Machines (8th), Vol. 1, Cambridge, England, Aug 5-11, 1984, pp 473-491, AD-P004 282/GAR

KEY WORDS: Tractors, Vehicle-terrain interaction

To evaluate farm field profiles as sources of tractor vibration, profiles of meadows and rough terrains were measured and analyzed.

85-1823
Comparison of Measured and Simulated Ride Comfort for an Agricultural Tractor and Influence of Travel Speed and Tyre-Inflation Pressure on Dynamic Response
C. Strauss, W. Christ
Battelle-Inst. e.V., Frankfurt am Main, Fed. Rep. Germany
Proc.of Intl. Conf. on Performance of Off-Road Vehicles and Machines (8th), Vol. 1, Cambridge, England, Aug 5-11, 1984, pp 451-471, AD-P004 281/2/GAR

KEY WORDS: Off-highway vehicles, Vehicle-terrain interaction

Off-road vehicles, wheeled or tracked, such as commercial vehicles or military vehicles, have to operate under extreme terrain conditions. One aspect of these conditions is the terrain roughness, which has an important influence, on the one hand on the vehicle stress, on the cargo or attached implements, and on the other hand on the ride comfort for the driver. Therefore, the need for reducing the shock and vibration levels, taking into account increasing travel speed, becomes an important criterion for the design of most of the above vehicles.

85-1824

Dynamic Simulation of Track Laying Vehicles

M.D. Bennett, P.H.G. Penny
Royal Military College of Science, Shrivenham, UK

Proc. of Intl. Conf. on Performance of Off-Road Vehicles and Machines (8th), Vol. 1, Cambridge, England, Aug 5-11, 1984, pp 153-170, AD-P004 266/3/GAR

KEY WORDS: Tracked vehicles, Computerized simulation

A computer model to simulate the dynamic response of a track laying vehicle traversing defined terrain is described. Results used for validation tests are given together with a selection of typical applications. The model has proved to be flexible with applicability to a wide range of problems.

85-1825

Evaluation of Track Stiffness and Track Damping

V.V. Singh, D. Deepak
Research Designs and Standards Organization, Lucknow 226011, India

J. Sound Vib., 97 (1), pp 129-135 (Nov 8, 1984), 2 figs, 2 tables, 9 refs

KEY WORDS: Railroad tracks, Stiffness coefficients, Damping coefficients

Correct estimation of track stiffness and track damping is essential for predicting the dynamic wheel loads of railway vehicles running on rough tracks. While several analytical procedures have been developed in the past to estimate track stiffness, there is no procedure readily available for estimating track damping. Experimental techniques involving the use of impulse tests have been used in this study to estimate track stiffness and track damping, on several different track structures on the Indian Railways. The results of these tests are presented.

85-1826

Dynamic Interaction Between Track and Soil

P. Parringer
Industrieanlagen-Betriebsgesellschaft m.b.H., Ottobrunn, Fed. Rep. Germany

Proc. of Intl. Conf. on Performance of Off-Road Vehicles and Machines (8th), Vol. 1, Cambridge, England, Aug 5-11, 1984, pp 329-347, AD-P004 274/7/GAR

KEY WORDS: Tracked vehicles, Solid-structure interaction, Measurement techniques

The knowledge of the dynamic interaction between track and soil is important to analyze high speed vehicles with flexible track. This paper describes a possible method for the measurement of this interaction. Force-and displacement-sensors are fixed in and on the track to measure longitudinal, transversal- and normal-load at one track-shoe, sinkage of this track-shoe and the longitudinal- and transversal slip of this track shoe.

85-1827

Analysis of Rail Transit Vehicle Dynamic Curving Performance

D.N. Wormley, J.K. Hedrick, M.L. Nagurka
Massachusetts Inst. of Tech., Cambridge, MA

Rept. No. UMTA-MA-6-25-84-1, DOT-TSC-UMTA-84-6, 230 pp (June 1984), PB85-112845/GAR

KEY WORDS: Railroad trains, Cornering effects

Computer simulation models have been developed to analyze the stability and curving performance of transit vehicles with conventional, radial and forced-steered trucks. Analytical tools were used to generate extensive parametric data characteriz-

ing the steady-state curving stability performance tradeoffs offered by various truck and wheel profile designs. The steady-state curving analysis has been extended to develop a dynamic curving model for computing the time varying wheel-rail interaction forces and vehicle suspension and body forces and motions during curve entry and exit. The dynamic curving model includes nonlinear wheel/rail geometry, including multi-point wheel-rail contact, nonlinear vehicle suspension elements, and rail lateral flexibility.

85-1828

Wheel/Rail Contact: Geometrical Study

E. Garcia-Vadillo, J.G Gimenez, J.A. Tarrago
Escuela Superior de Ingenieros Industriales. Alameda de Urquijo s/n. 48013 Bilbao
Vehicle Syst. Dynam., 13 (4), pp 207-214 (1984), 5 figs, 15 refs

KEY WORDS: Rail-wheel interaction

Before trying to ascertain the precise nature of the wheel-rail contact the geometrical problem must necessarily be solved. That is, for each position of the wheelset the two dependent parameters and the coordinates of the points of contact of each wheel, and rail must be obtained. A new method is proposed of obtaining the spatial position of a wheelset with reference to the rails, from the most general point of view.

85-1829

Simulation Model of a Freight Car for a Multibody System Formulation from a Finite Element Model and Stationary Vibration Tests

B. Fischer, P. Conrad, H. Bauer
Dynamische Probleme. Modellierung and Wirklichkeit. Proc. mtg. Oct 4-5, 1984, Hannover, Curt-Risch-Institut der Universitat Hannover, Hannover, Fed. Rep. Germany, Vol. I, pp 69-138, 22 figs, 1 table, 6 refs (In German)

KEY WORDS: High speed transportation systems, Railroad cards, Simulation, Computer programs

For the future high speed transportation systems a dynamic qualification of the vehicle is needed, so that the motion of wheel sets at high speeds could be controlled. For the interpretation of ride dynamics (sinusoidal motion, cornering) and vibration (ride comfort) an exact knowledge of the dynamic behavior of the entire system is indispensible. For the calculation of wheel-road interaction a program MEDUSA was developed. This program contains a linear multibody formulation for rigid and elastic bodies. The data for the elastic bodies can be obtained by means of an FE formulation and modal transformation,or it can be measured.

85-1830

Influence of Wheel-Rail Profiles on the Hunting Vibrations of Rail Vehicle Trucks

A.F. D'Souza, W.J. Tsung
Illinois Inst. of Technology, Chicago, IL 60616
J. Vib., Acoust., Stress, Rel. Des., Trans. ASME, 107 (2), pp 167-174 (Apr 1985), 12 figs, 2 tables, 12 refs

KEY WORDS: Railroad cars, Rail-wheel interaction, Hunting motion

The effect of several wheel and rail profiles on the hunting behavior of three-piece North American freight truck is investigated by the method of describing functions. It is shown that the wearing of the rail profile has a significant adverse effect on the dynamic behavior. It greatly lowers the critical speed for the onset of hunting and raises the frequency, thereby causing high acceleration levels. It is also shown that the modified Heumann wheel profile exhibits a superior dynamic performance for freight trucks than the standard new wheel profile used in North America. The effects of wheel wear and loads on hunting are also investigated.

85-1831

Dynamic Design Verification of a Rapid Transit Rail Car

O. Dossing

Bruel & Kjaer, Naerum, Denmark
S/V, Sound Vib., 19 (1), pp 16-21 (Jan 1985), 8 figs, 7 tables, 5 refs

KEY WORDS: Railroad cars, Modal analysis, Design techniques

This article presents the use of modal analysis to verify the dynamic design of a rail car prototype. The primary purpose of the test was to verify the natural frequency of the first vertical bending mode for the new design. Measurements were made on two prototype cars plus two similar cars of an older type. Based on the modal model, the sensitivity of the first bending mode to an assumed excitation was estimated and compared between the four cars. The change in frequency for the first bending mode due to adding payload (passengers) was then predicted by simulation.

85-1832

Numerical Investigation and Measurement of Rail-Wheel Interaction in Vehicles with High Rail and Wheel Flange Wear (Rechnerische Untersuchung und Messung des Zusammenwirkens von Rad und Schiene an zu starkem Schienenflanken-

O. Krettek, M. Ofierzynski
RWTH Aachen, Fed. Rep. Germany
Dynamische Probleme. Modellierung und Wirklichkeit. Proc. mtg. Oct 4-5, 1984, Hannover, Curt-Risch-Institut der Universität Hannover, Hannover, Fed. Rep. Germany, Vol. I, pp 155-176, 20 figs, 7 refs (In German)

KEY WORDS: Railroad trains, Transportation vehicles, Rail wheel interaction

The construction of rail transportation systems must adhere to strict geometric, kinematic, static and dynamic restrictions. A computer program under development is described which satisfies all four of the above requirements.

AIRCRAFT

85-1833

Identification and Verification of Frequency-Domain Models for XV-15 Tilt-Rotor Aircraft Dynamics

M.B. Tischler, J.G.M. Leung, D.C. Dugan
NASA Ames Res. Ctr., Moffett Field, CA
Rept. No. A-9851, NASA-TM-86009, 20 pp (Aug 1984), N84-34445/GAR

KEY WORDS: Aircraft, Frequency domain method

Frequency-domain methods are used to extract the open-loop dynamics of the XV-15 tilt-rotor aircraft from flight test data for the cruise condition. The frequency responses are numerically fitted with transfer-function forms to identify equivalent model characteristics.

85-1834

Theoretical Design of Acoustic Treatment for Noise Control in a Turboprop Aircraft

R. Vaicaitis, J.S. Mixson
Columbia Univ., New York, NY
J. Aircraft, 22 (4), pp 318-324 (Apr 1985), 9 figs, 1 table, 29 refs

KEY WORDS: Aircraft, Noise reduction

An analytical procedure has been developed for design of acoustic treatment for cabin noise control of light aircraft. Using this approach acoustic add-on treatments capable of reducing the average noise levels in the cabin by about 17 dB from the untreated condition are developed. The added weight of the noise control package is about 2% of the total gross takeoff weight of the aircraft. The analytical model uses modal solutions wherein the structural modes of the sidewall and the acoustic modes of the receiving space are accounted for. The input noise spectral levels are selected utilizing experimental flight data. The add-on treatments include aluminum honeycomb panels, constrained layer damping tape, porous acoustic materials, noise barriers, limp trim panels, and tuned dampers. To reduce the noise transmitted through the double-wall aircraft windows to acceptable levels, changes in the design of the aircraft window are recommended.

85-1835

Supersonic Jet Shock Noise Reduction

J.R. Stone

NASA Lewis Res. Ctr., Cleveland, OH

Rept. No. E-2299, NASA-TM-83799, N84-35085/9/GAR

KEY WORDS: Supersonic aircraft, Noise reduction

Shock-cell noise is identified to be a potentially significant problem for advanced supersonic aircraft at takeoff. Therefore NASA conducted fundamental studies of the phenomena involved and model-scale experiments aimed at developing means of noise reduction. The results of a series of studies conducted to determine means by which supersonic jet shock noise can be reduced to acceptable levels for advanced supersonic cruise aircraft are reviewed.

85-1836

Impact of Fuselage Incidence on the Supersonic Aerodynamics of Two Fighter Configurations

R.M. Wood, D.S. Miller

NASA Langley Res. Ctr., Hampton, VA

J. Aircraft, 22 (5), pp 423-428 (May 1985), 15 figs, 11 refs

KEY WORDS: Supersonic aircraft, Aerodynamic loads

An experimental and theoretical investigation of fuselage-incidence effects on two fighter aircraft models, which differed in wing planform shape only, has been conducted in Plan Wind Tunnel at Mach numbers 1.6, 1.8, and 2.0. Experimental and theoretical results were obtained on the two models with fuselage-incidence angles of 0, 2, and 5 deg. The fuselage geometry consisted of two side-mounted, flow-through, half-axisymmetric inlets and twin vertical tails. The two planforms tested were advanced cranked wings of 70/66 and 70/30 deg leading-edge sweep angles. The purpose of the study was to evaluate the effects of fuselage incidence on wing performance and to determine the ability of two linearized theory aerodynamic methods to predict these effects.

85-1837

Dynamics of Forebody Flow Separation and Associated Vortices

L.E. Ericsson, J.P. Reding

Lockheed Missiles and Space Co., Inc., Sunnyvale, CA

J. Aircraft, 22 (4), pp 329-335 (Apr 1985), 18 figs, 28 refs

KEY WORDS: Aircraft, Aerodynamic loads, Vortex shedding

It is well established that there is a strong coupling between body motion and boundary layer separation with attendant vortex shedding. In the present paper this coupling is studied for the particular case of a missile or an aircraft fuselage at very high angles of attack. It is shown that the unusual results obtained in recent tests can be explained by considering the so-called "moving-wall effect" on boundary layer transition and/or separation.

85-1838

Application of Advanced Parameter Identification Methods for Flight Flutter Data Analysis with Comparisons to Current Techniques

H.J. Perangelo, P.R. Waisanen

Grumman Aerospace Corp., Calverton, NY

29 pp (July 1984)(Proc. Flight Mechanics Panel Symp., Lisbon, Portugal, Apr 2-5, 1984, pp 5-1 - 5-29), AD-P004 102

KEY WORDS: Aircraft, Flutter, Parameter identification technique

Grumman has been pursuing the implementation and evaluation of advanced parameter identification software for use in flutter test data processing operations as its Automated Telemetry Station. They have been motivated by aircraft design tending toward thin, lightweight aircraft structures, which make it difficult to use authoritative shaker systems, and the continuing development of high-speed digital computer technology. This development activity is aimed at establishing an on-line processing capability, in the 1985 time frame that will initially use the maximum likelihood parameter identification algorithm in conjunction with a detailed physical aeroelastic aircraft model to perform optimal flutter test data analysis.

85-1839
Design of a Flutter Suppression System for an Experimental Drone Aircraft
J.R. Newsom, A.S. Pototzky, I. Abel
NASA Langley Res. Ctr., Hampton, VA
J. Aircraft, 22 (5), pp 380-386 (May 1985), 11 figs, 21 refs

KEY WORDS: Aircraft, Remote control, Active flutter control

This paper describes the design of a flutter suppression system for a remotely-piloted research vehicle. The modeling of the aeroelastic system, the methodology used to synthesize the control law, the analytical results used to evaluate the control law performance, and ground testing of the flutter suppression system onboard the aircraft are discussed. The major emphasis is on the use of optimal control techniques employed during the synthesis of the control law.

85-1840
Active Vibration Suppression of a Cantilever Wing
L. Meirovitch, L.M. Silverberg
Virginia Polytechnic Inst. and State Univ., Blacksburg, VA
J. Sound Vib., 97 (3), pp 489-498 (Dec 8, 1984), 4 figs, 13 refs

KEY WORDS: Cantilever beams, Aircraft wings, Active vibration control, Modal control technique

A method for the active vibration suppression of a cantilever wing is presented. The approach is based on modal control, in which a modal feedback control law relating the motion of the control surfaces to the controlled modes is implemented. Modal displacements and velocities required for feedback are extracted from sensor measurements by means of modal filters. A numerical example is presented.

85-1841
Measured and Calculated Airloads on a Transport Wing Model
W.E. McCain
NASA Langley Res. Ctr., Hampton, VA
J. Aircraft, 22 (4), pp 336-342 (Apr 1985), 12 figs, 1 table, 15 refs

KEY WORDS: Aircraft wings, Aerodynamic loads

Wind tunnel measurements of steady and unsteady pressures for a high-aspect-ratio supercritical wing model are compared with calculations by the linear unsteady aerodynamic lifting-surface theory, known as the doublet lattice method, at Mach number of 0.60 (subsonic) and 0.78 (transonic). The steady-pressure data comparisons are made for incremental changes in angle of attack and control-surface deflection. The unsteady-pressure data comparisons are made for oscillating control-surface deflections. Some differences between the measured and calculated aerodynamics are attributed to viscous and transonic effects not accounted for in the doublet lattice analysis. Comparisons of the transonic unsteady-pressure data for the oscillating control surfaces are improved by applying empirical corrections, based on the steady-pressure measurements, to the unsteady doublet lattice calculations.

85-1842
Aerodynamic Canard/Wing Parametric Analysis for General Aviation
M.W. Keith, B.P. Selberg
Univ. of Missouri, Rolla, MO
J. Aircraft, 22 (5), pp 401-408 (May 1985) 16 figs, 17 refs

KEY WORDS: Aircraft Wings, Aerodynamic Loads

Vortex panel and vortex lattice methods have been utilized in an analytic study to determine the two-and three-dimensional aerodynamic behavior of canard/wing configurations. The purpose was to generate data useful for the design of general-aviation canard aircraft. Moderate two-dimensional coupling was encountered and the vertical distance between the lifting surfaces was found to be the main contributor to interference effects of the three-dimensional analysis. All canard configurations were less efficient than a forward wing with an aft horizontal tail, but were less sensitive to off-optimum division of total lift between the two surfaces, such that trim drag could be less for canard configuratio.ıs. For designing a general-aviation canard aircraft, results point toward large horizontal and vertical distances between the canard and wing, a large wing-to-canard area ratio, and the canard at a low-incidence angle relative to the wing.

85-1843

Ground Vibration Test of F-16 Airplane with Initial Decoupler Pylon

F.W. Cazier, M.W. Kehoe
NASA Langley Res. Ctr., Hampton, VA
Rept. No. NASA-TM-86259, 47 pp (Oct 1984) N84-34439/GAR

KEY WORDS: Aircraft, Wing stores, Active flutter control

A ground vibration test was conducted on an F-16 airplane loaded on each wing with a 370-gal tank mounted on a standard pylon, a GBU-8 store mounted on a decoupler pylon, and an AIM-9J missile mounted on a wing-tip launcher. The decoupler pylon is a passive wing/store flutter-suppression device. The test was conducted prior to initial flight tests to determine the modal frequencies, mode shapes, and structural damping coefficients. The data presented include frequency plots, force effect plots, and limited mode shape data.

85-1844

Noise Transmission Through Aircraft Panels

R. Vaicaitis, F.W. Grosveld, J.S. Mixson
Columbia Univ., New York, NY
J. Aircraft, 22 (4), pp 303-310 (Apr 1985) 9 figs, 47 refs

KEY WORDS: Aircraft, Panels, Noise Transmission, Structural members

This paper describes analytical and experimental studies of noise transmission through aircraft panels. The theoretical solutions of the governing acoustic-structural equations are developed utilizing modal decomposition and a Galerkin-type procedure. Single, discretely stiffened, and double wall panels are considered. Theoretical predictions are compared with experimental measurements.

85-1845

Noise Transmission Through an Acoustically Treated and Honeycomb-Stiffened Aircraft Sidewall

F.W. Grosveld, J.S. Mixson
The Bionetics Corp., Hampton, VA
J. Aircraft, 22 (5), pp 434-440 (May 1985) 14 figs, 18 refs

KEY WORDS: Aircraft, Honeycomb structures, Noise transmission, Structural members

The noise transmission characteristics of test panels and acoustic treatments representative of an aircraft sidewall are experimentally investigated in the NASA Langley Research Center transmission loss apparatus. The test panels were built to represent a segment of sidewall in the propeller plane of a twin-engine, turboprop light aircraft. It is shown that an advanced treatment, which uses honeycomb for structural stiffening of skin panels, has better noise transmission loss characteristics than a conventional treatment. An alternative treatment for the same total surface mass. Effects on transmission loss of a variety of acoustic treatment materials (acoustic blankets, septa, damping tape, and trim panels) are presented. Damping tape does not provide additional benefit when the other treatment provides a high level of damping.

Window units representative of aircraft installations are shown to have low transmission loss relative to a completely treated sidewall.

85-1846

Model-Rotor High-Speed Impulsive Noise: Full-Scale Comparisons and Parametric Variations

F.H. Schmitz, D.A. Boxwell, W.R. Splettstoesser, K.J. Schultz
Aeromechanics Lab., U.S. Army Res. & Technology Labs (AVRADCOM), Moffett Field, CA 94035

Vertica, 8 (4), pp 395-422 (1984) 23 figs, 16 refs

KEY WORDS: Helicopter rotors, Noise measurements, Model testing

A 1/7-scale research model of the AH-1 series helicopter main rotor was tested in the open-jet anechoic test section. Model-rotor acoustic data were recorded at high forward speeds where full-scale helicopter high-speed impulsive noise levels are known to be dominant. Model-rotor measurements of the peak acoustic pressure levels, waveform shapes, and directivity patterns are directly compared with full-scale investigations, using an equivalent in-flight technique. Model data are shown to scale remarkably well in shape and amplitude with full-scale results. Parametric variations of the model-rotor acoustic measurements are also presented.

85-1847

Rotorcraft Air Resonance in Forward Flight with Various Dynamic Inflow Models and Aeroelastic Couplings

J. Nagabhushanam, G.H. Gaonkar
Hindustan Aeronautics Limited, Bangalore, India

Vertica, 8 (4), pp 373-394 (1984) 23 figs, 3 tables, 18 refs

KEY WORDS: Helicopters, Resonant response

Air resonance with dynamic inflow is studied in forward flight. Effects of trimming conditions and parameters such as lag structural damping, blade and body inertias and aeroelastic couplings are included. The stability margin of the lag regressing mode in the hovering could worsen in forward flight, particularly for the soft inplane rotors in propulsive trim and for the stiff inplane rotors in moment or wind-tunnel trim.

85-1848

Review of Some Theoretical and Experimental Studies on Helicopter Rotor Noise

S. Lewy, M. Caplot
ONERA - BP 72, 92322 Chatillon Cedex, France

Vertica, 8 (4), pp 309-321 (1984) 11 figs, 32 refs

KEY WORDS: Helicopter noise

The present paper deals with the investigation on helicopter main rotor noise performed at ONERA. Theoretical results, already published, are only summarized. An overview of the experimental scopes is also given. The joint program with the U.S. Army is emphasized: measurements in CEPRA 19 anechoic wind tunnel are described. The comparison with U.S. Army inflight data validates the similitude rules on scaled models; finally the computation of thickness noise shows a good agreement with experimental results.

85-1849

Comparison of Frequency-Domain and Time-Domain Rotorcraft Vibration Control

N.K. Gupta
Integrated Systems, Inc., Palo Alto, CA

Rept. No. NASA-CR-166570, 149 pp (Apr 1984) N84-34431/6/GAR

KEY WORDS: Helicopter vibration, Active vibration control, Frequency domain method, Time domain method

Active control of rotor-induced vibration in rotorcraft has received significant attention

recently. Two classes of techniques have been proposed. The more developed approach works with harmonic analysis of measured time histories and is called the frequency-domain approach. The more recent approach computes the control input directly using the measured time history data and is called the time-domain approach. The report summarizes the results of a theoretical investigation to compare the two approaches.

85-1850
A Description of Helix and Felix, Standard Fatigue Loading Sequences for Helicopters, and of Related Fatigue Tests Used to Assess Them
P.R. Edwards
Royal Aircraft Establishment, Farnborough, Happen, England
Vertica, 9 (1), pp 13-34 (1985) 15 figs, 15 tables, 10 refs

KEY WORDS: Helicopters, Fatigue tests

Helix and Felix are standard loading sequences which relate to the main rotors of helicopters with articulated and semi-rigid rotors respectively. The purpose of the loading standards is, first, to provide a convenient tool for providing fatigue data under realistic loading, which can immediately be compared with data obtained by other organizations. Second, loading standards can be used to provide design data. This paper outlines the form of Helix and Felix, summarizes their statistical content according to different counting methods and gives results of fatigue tests used to assess their usefulness.

85-1851
Noise Measurement Flight Test for Boeing Vertol 234/CH 47-D Helicopter: Data/Analyses
J.S. Newman, T.L. Bland, K.R. Beattie
Federation Aviation Admn., Washington, D.C.
Rept. No. FAA/EE-84-7, 195 pp (Sept 1984)
AD-A148 172

KEY WORDS: Helicopter noise, Noise measurements

This report documents the results of a Federal Aviation Administration noise measurement flight test program with the Boeing-Vertol CH-47D helicopter. The report contains documentary sections describing the acoustical characteristics of the subject helicopter and provides analyses and discussions addressing topics ranging from acoustical propagation to environmental impact of helicopter noise.

85-1852
Noise Measurement Flight Test: Data/Analyses, Hughes 500 D/E Helicopter
J.S. Newman, E.J. Rickley, T.L. Bland, K.R. Beattie
Federal Aviation Admn., Washington, D.C.
Rept. No. FAA/EE-84-3, 78 pp (May 1984)
AD-A148 110

KEY WORDS: Helicopter noise, Noise measurement

The report contains documentary sections describing the acoustical characteristics of the subject helicopter and provides analyses and discussions addressing topics ranging from acoustical propagation to environmental impact of helicopter noise. This report is the third in a series of seven documenting the FAA helicopter noise measurement program conducted at Dulles International Airport during the summer of 1983. The Hughes 500D/E test program involved the acquisition of detailed acoustical, position and meteorological data.

MISSILES AND SPACECRAFT

85-1853
Analytical Model of Pulsing of Solid Propellant Rocket Motors
R.M. Hackett, C.E. DeVilbiss
The Univ. of Alabama in Huntsville, Huntsville, AL
J. Spacecraft, 22 (2), pp 201-210 (Mar/Apr 1985) 5 figs, 15 refs

KEY WORDS: Solid propellant rocket engines, Finite element technique, Modal superposition methods, Acoustical pulses

The finite-element formulations of structural and acoustical free-vibration problems are reviewed and compared, and the mode superposition analysis technique is presented. A direct analogy is developed between the application of mode superposition to combustion instability analysis, and its proven application in structural analysis. A computer program which models the response of pulsed solid propellant rocket motor cavities is presented, and examples that demonstrate the application of the program are discussed.

85-1854

Vibration, Acoustic, and Shock Design and Test Criteria for Components on the Solid Rocket Boosters (Srb), Lightweight External Tank (Lwt), and Space Shuttle Main Engines (Ssme).

NASA George C. Marshall Space Flight Ctr., Huntsville, AL

Rept. No. NASA-RP-1127, 812 pp (Sept 1984) N85-10405 /7/GAR

KEY WORDS: Spacecraft components

The vibration, acoustics, and shock design and test criteria for components and subassemblies on the space shuttle solid rocket booster lightweight tank and main engines are presented. Specifications for transportation, handling, and acceptance are also provided.

85-1855

Damping Synthesis for a Spacecraft Using Substructure and Component Data

K.W. Lips, F.R. Vigeron

Communications Res. Centre, Ottawa, Ontario, Canada

Rept. No. CRC-1365, 88 pp (Aug 1984) N85-12082 /2/GAR

KEY WORDS: Spacecraft, Modal synthesis, Modal damping, Substructuring methods, Component mode analysis

A method for the synthesis of modal damping factors and other modal data for a spacecraft in orbit is demonstrated It is based on input information at the component/substructure level. Also, the use of the method and the level of accuracy obtained is illustrated in a case study of the Hermes spacecraft. The synthesis procedure is demonstrated for a spacecraft configuration consisting of a central rigid body, solar array substructures, a momentum wheel and a liquid mercury damping device.

85-1856

Dynamic Response of the LE-5 Rocket Engine Liquid Oxygen Pump

T. Shimura, K. Kamijo

National Aerospace Lab. of Japan, Miyagi, Japan

J. Spacecraft, 22 (2), pp 195-200 (Mar/Apr 1985) 14 figs, 4 tables, 14 refs

KEY WORDS: Pumps, Liquid propellant rocket engines, POGO effect

A three stage H-1 rocket has been developed, the second stage of which has a LOX/LH_2 engine. LE-5. Regarding the POGO phenomenon of the second stage of the H-1 rocket, analyses are being conducted in order to determine whether or not a POGO suppression device is necessary for the LE-5 engine. In this study, the dynamic characteristics of the liquid oxygen pump of the LE-5 engine were examined by artificially creating periodical perturbations in the pump flow in order to obtain the data necessary for POGO analysis of the H-1 rocket.

BIOLOGICAL SYSTEMS

HUMAN

85-1857

Further Development in Ride Quality Assessment

N.R. Murphy, Jr.

Army Engineer Waterways Experiment Station, Vicksburg, MS
(Proc. of Intl. Conf. on Performance of Off-Road Vehicles and Machines (8th), Vol. 1, Cambridge, England, Aug 5-11, 1984, pp 433-449) AD-P004 280/4/GAR

KEY WORDS: Human response, Vibration excitation, Ground vehicles

Internationally, a growing concern has developed and widespread disagreement has occurred over the present methods for quantitatively describing and assessing the effects of vehicle vibrations on humans, and over the short-and the long-term effects of vibrations on drivers and occupants of heavy trucks, agricultural and earthmoving equipment, and military vehicles. None of the present methods is completely satisfactory; in fact, most criteria were developed for low-level boulevard rides and are highly suspect when applied to the several vibrational levels conducted in earthmoving and military-type operations.

85-1858
Ride Comfort of Off-Road Vehicles
G.H. Hohl
Austrian Federal Army, Vienna
Proc. of Intl. Conf. on Performance of Off-Road Vehicles and Machines (8th), Vol. 1, Cambridge, England, Aug 5-11, 1984, pp 413-432 AD-P004 279/6/GAR

KEY WORDS: Off-highway Vehicles, Human response

Because of the roughness of the terrain they encounter, cross country vehicles experience more shock and vibration than ordinary road vehicles. Hence off-road speed is usually limited by the ability of the operator to withstand these vibrations to negotiate and to retain adequate, control of the vehicle. In addition to the other factors, the comfort of the operator, which contributes to his general safety, also depends on the physical characteristics of the seat, which is the link between the driver and the vehicle.

85-1859
Simulation of Human Body Dynamic Response to Crash Loads
D.H. Robbins, D. Simic
Univ. of Michigan, Ann Arbor, MI 48109
Intl. J. Vehicles Des., 6 (2), pp 216-227 (Mar 1985) 11 figs, 40 refs

KEY WORDS: Human response, Collision research (automotive)

A review of the development of several crash victim simulation models. Applications of these models to various automotive safety problems are described based on the work of a number users both in the United States and Europe. It is concluded that crash victim simulation models can serve the automobile designer as a tool to reduce test costs when combined with well-conceived laboratory test programs.

MECHANICAL COMPONENTS

ABSORBERS AND ISOLATORS

85-1860
Dynamic Testing of Glass-Fibre Reinforced Plastics for the Design of Bumper Systems
K.D. Johnke, H. Fehrecke
Volkswagenwerk AG - Wolfsburg, Fed. Rep. Germany
Intl. J. Vehicle Des., 6 (2), pp 199-215 (Mar 1985) 13 figs, 6 tables, 14 refs

KEY WORDS: Bumpers, Glass-reinforced plastics, Dynamic tests

The extent to which lightweight construction can realistically be applied to bumper systems by using composite materials and the question as to whether or not these high polymers can make it possible to save enough energy to meet economic requirements are discussed here. In addition, the findings, arising from the determination of deformation-related degrees of damage to glass-fibre reinforced plastics and their possible influence on the design of new bumper systems are discussed. Examples show how glass-fibre reinforced and glass-fibre mineral reinforced high-polymers, both compact and foamed, can be used effectively.

85-1861
Strain-Rate and Inertia Effects in the Collapse of Two types of Energy-Absorbing Structure
C.R. Calladine, R.W. English
Univ. of Cambridge, Cambridge CB2 1PZ, UK
Intl. J. Mech. Sci., 26 (11/12), pp 689-701 (1984) 9 figs, 12 refs

KEY WORDS: Energy absorption, Strain rate, Inertial forces

The dynamic plastic collapse of energy-absorbing structures is more difficult to understand than the corresponding quasi-static collapse, on account of two effects which may be described as the "strain-rate factor" and the "inertia factor," respectively. The first of these is a material property whereby the yield stress is raised, while the second can affect the collapse mode, etc. It has recently been discovered that structures whose load-deflection curve falls sharply after an initial "peak" are much more "velocity sensitive" than structures whose load-deflection curve is "flat-topped." In this paper we investigate strain-rate and inertia effects in these two types of structure by means of some simple experiments performed in a drop hammer testing machine together with some simple analysis which enables us to give a satisfactory account of the experimental observations. The work is motivated partly by difficulties which occur in small-scale model testing of energy-absorbing structures, on account of the fact that the strain-rate and inertia factors not only scale differently in general, but also affect the two distinct types of structure differently.

85-1862
Electronically Controlled Suspension System
S. Wada, M. Hirata
Mitsubishi Electric Corp., Tokyo, Japan
Mitsubishi Denki Giho, 58 (1), pp 20-25 (1984) PB85-136042/GAR (In Japanese)

KEY WORDS: Suspension systems (vehicles), Automatic control

Mitsubishi Electric has developed, in cooperation with Mitsubishi Motors Corporation, an electronically controlled suspension (ECS) system that well satisfies the demands for both a comfortable ride and drive stability. One important features of this ECS is its combination of the vehicle-height control function with the functions for selecting spring constants and damping force, and the high reliability of its sensors, actuators and control unit. The article includes descriptions of the system configuration and its functions.

85-1863
Synthesis of Dynamic Vibration Absorbers
B.P. Wang, L. Kitis, W.D. Pilkey, A. Palazzolo
Univ. of Texas at Arlington, Arlington, TX 76019
J. Vib., Acoust., Stress, Rel. Des., Trans. ASME, 107 (2), pp 161-166 (Apr 1985) 11 figs, 12 refs

KEY WORDS: Dynamic vibration absorption (equipment), Beams

A method for designing dynamic vibration absorbers which create antiresonances at specified points on a sinusoidally forced vibratory system is described. Spring-mass absorber systems are treated in detail. Among all possible solutions, a unique minimum mass solution is shown to exist if the relative displacement of the absorber mass is constrained. The sensitivity of the design to variations in frequency, spring constant, and absorber mass is discussed. The procedure is illustrated by numerical results for a simply supported uniform beam.

85-1864
Pneumatic Actuators for Vehicle Active Suspension Applications
D. Cho, J.K. Hedrick

Massachusetts Inst. of Tech., Cambridge, MA 02139
J. Dynam. Syst., Meas. Control, Trans. ASME, 107 (1), pp 67-72 (Mar 1985) 11 figs, 2 tables, 13 refs

KEY WORDS: Suspension systems (vehicles), Actuators, Active control, Railroad trains

The use of actively controlled pneumatic actuators in parallel with conventional passive suspensions to improve vehicle dynamics was investigated. For application on the secondary lateral suspension of AMTRACK passenger cars, it is shown that using 4 in. bore pneumatic cylinders with a valve which has a peak flow capability of 40 SCFM at 130 psi can reduce the rms carbody lateral acceleration by 46 percent and the rms secondary lateral suspension stroke by 34 percent with a power requirement of 7.6 hp per car.

85-1865

An Active Suspension for a Formula One Grand Prix Racing Car

J. Dominy, D.N. Bulman
Rolls-Royce Ltd., Transmissions Research Group, Aero Div., Derby, UK
J. Dynam. Syst., Meas. Control, Trans. ASME, 107 (1), pp 73-78 (Mar 1985) 12 figs, 6 refs

KEY WORDS: Suspension systems (vehicles), Active control, Automobiles

During 1982, Formula 1 racing cars generated very high downforces by the use of "ground effect" aerodynamics. Such cars required very stiff suspensions to maintain a reasonably constant ride height with the result that the slightest bump unsettled the chassis and reduced cornering speeds. A semi-active suspension would have been capable of withstanding the variations in downforce while remaining "soft" to rapid road inputs. This paper proposes such a system and describes an analysis of its dynamic responses.

85-1866

A New Rear Axle Suspension for M.A.N. Buses (Neue Hinterachsfuhrung fur M.A.N.-Omnibusse)

U. Breitling, P. Wypich
Herzogstrasse 59, 8000 Munchen 40
Automobiltech. Z., 86 (12), pp 545-548 (Dec 1984) 6 figs (In German)

KEY WORDS: Suspension systems (vehicles), Buses, Fatigue life, Finite element technique

A standardized suspension system was to be developed for the drive axles in M.A.N.'s various production bus models. An A-frame design was chosen to provide the required driving comfort, but modified into an open-ended unit separable into two parts to facilitate manufacture and assembly while reducing weight. Extensive load data were collected by evaluating vehicle test runs both at home and abroad. A preliminary design was determined by FEM computation. The suspension's fatigue life was documented using a hydro-power test rig while vehicle tests were carried out. After proving its worth in prototype vehicles, the new A-frame suspension has been introduced into regular production.

85-1867

Vibration Response — Wheel Suspension — Comfort (Schwingungsverhalten —Radaufhangungen — Komfort)

M. Mitschke
Proc. of the 5th Symp. of the Inst. f. Fahrzeugtechnik T.V. Braunschweig, June 26-27, 1984 (In German)

KEY WORDS: Suspension systems (vehicles), Wheels

In the paper the effects of wheel suspension on the vibration of vehicle riding on an uneven street is discussed. It is shown that rigid axles are worse for the wheel during lateral vibration than good individual wheel suspensions, and that a compromise between comfort and safety is hard to find.

85-1868

Railway Wheel Squeal (3rd Report, Squeal of a Disk Simulating a Wheel in Internal Resonances)

M. Nakai, M. Yokoi
Kyoto Univ., Yoshida-honmachi, Sakyo-ku, Kyoto, Japan

Bull. JSME, 28 (237), pp 500-507 (Mar 1985) 13 figs, 4 refs

KEY WORDS: Railway wheels, Squeal, Disks

We made an apparatus with a steel rod and a thin steel disk. A disk serving as a railway wheel was clamped at inner radius and was free at its end. When a certain relationship exists among the natural frequencies in the axial direction of the disk, various internal resonances occur. We analyzed a squeal of the disk in internal resonances theoretically.

85-1869

Operating Mode: Measurement of Tire/-Road Contact Noise (Mode Operatoire: Mesure du Bruit de Contact Pneu/Route)

Centre de Recherches Routieres, Brussels, Belgium

Rept. No. MF-50/84, 40 pp (1984) PB85-136471/GAR (In French)

KEY WORDS: Tire-pavement interaction, Noise generation, Measurement techniques

A mode of operation is described for measuring the noise level due to tire/road contact of a rolling vehicle in free deceleration, with the engine turned off. The first section deals with measuring the level of maximum noise emitted outside of the vehicle passing in front of a stationary microphone. Part Two concerns measurement of the average noise level prevailing within the (inhabited) vehicle.

85-1870

Aeroelastic Stability of an Elastic Circulation Control Rotor Blade in Hover

I. Chopra
Univ. of Maryland, College Park, MD 20742

Vertica, 8 (4), pp 353-371 (1984) 19 figs, 11 refs

KEY WORDS: Propeller blades, Helicopters, Aeroelasticity, Aerodynamic loads

The aeroelastic stability of flap bending, lead-lag bending, and torsion of a circulation control rotor blade in hover is investigated using a finite element formulation based on Hamilton's principle. Quasisteady strip theory is used to evaluate the aerodynamic forces, and the airfoil characteristics are represented either in the form of simple analytical expressions or in the form of data tables. The blade is discretized into beam elements, each with fifteen nodal degrees of freedom. The nonlinear equations of motion are solved for steady blade deflections through an iterative procedure. The flutter solution is calculated assuming blade motions to be small perturbations about the steady solution. The normal mode method, based on the coupled rotating natural modes about the steady deflections, is used to reduce the number of equations in the flutter eigenanalysis. The effects of several parameters on blade stability are examined, including thrust level, collective pitch, nature of blowing distribution, lag frequency, torsion frequency, and structural damping, and Theodorsen lift deficiency function.

85-1871

A New Look at Sound Generation by Blade/Vortex Interaction

J.C. Hardin, J.P. Mason
NASA Langley Res. Ctr., Hampton, VA 23665

J. Vib., Acoust., Stress, Rel. Des., Trans. ASME, 107 (2), pp 224-228 (Apr 1985) 9 figs, 10 refs

KEY WORDS: Blades, Vortex-induced vibration, Sound generation

As a preliminary attempt to understand the dynamics of blade/vortex interaction, the two-dimensional problem of a rectilinear vortex filament interacting with a Joukowski airfoil is analyzed in both the lifting and nonlifting cases. The vortex velocity components could be obtained analytically and integrated to determine the vortex trajectory. With this information, the aeroacoustic low-frequency Green's function approach could then be employed to calculate the sound produced during the encounter. The results indicate that the vortex path deviates considerably from simple convection due to the presence of the airfoil and that a reasonably sharp sound pulse is radiated during the interaction whose fundamental frequency is critically dependent upon whether the vortex passes above or below the airfoil. Determination of this gross parameter of the interaction is shown to be highly nonlinearly dependent upon airfoil circulation, vortex circulation, and initial position.

85-1872
A Pitch Control System for the KaMeWa Wind Turbine
B.S. Liebst
Univ. of Minnesota, Minneapolis, MN 55455
J. Dynam. Syst., Meas. Control, Trans. ASME, 107 (1), pp 47-52 (Mar 1985) 6 figs, 2 tables, 7 refs

KEY WORDS: Turbine blades, Wind turbines, Wind-induced excitation, Vibration control

This study is the design of a pitching blade control system for the national Swedish Board for Energy Source Development KaMeWa wind turbine. Full state controllers are designed utilizing optimal control theory to reduce blade and tower vibration, power oscillations, and improve gust response. The results show that substantial vibration reduction can be obtained with the existing pitch actuators installed presently on the machine.

BEARINGS

85-1873
Vibrational Power Transmission of an Idealised Gearbox
E.C.N. Leung
Southampton Univ., UK
Rept. No. REPT-124, 96 pp (June 1984) N85-11346

KEY WORDS: Gear boxes, Journal bearings, Eccentricity, Vibration transfer

The vibrational power transmission of an idealized gearbox or electric motor was analyzed. It is shown that a journal bearing with a high eccentricity ratio has smaller effect on the power transmission process than a journal bearing with a low eccentricity ratio. In the analyses of the point inertances, it was found that the local stiffness at the point of the application force governs the antiresonance. The first resonance of the idealized gearbox configuration is estimated with reasonable accuracy using the result of the point inertance of an infinite plate. The transfer inertance was examined on an aluminum disc. The results agree well with the theoretical predictions.

85-1874
A Finite Element Investigation of a Bearing/Cartridge Interface for a Fretting Corrosion Study
R.J. Stover, H.H. Mabie, M.J. Furey
Virginia Polytechnic Inst. and State Univ., Blacksburg, VA 24061
J. Tribology, Trans. ASME, 107 (2), pp 157-163 (Apr 1985) 11 figs, 16 refs

KEY WORDS: Bearings, Fretting corrosion, Finite element technique

The bearing/cartridge interfaces of a Ship Service Motor Generator Set were modeled by using finite element technology. The purpose of this analytical study was to verify the results of earlier experimental tests made on an actual SSMG unit. This research is part of a larger research project to examine the important parameters influencing the fretting of rolling element bearings.

for the case of a fixed journal axis with a bearing length to diameter ratio of unity. It is concluded that thermal effects are more pronounced for misaligned journal bearings.

85-1875
Effects of Turbulence and Viscosity Variation on the Dynamic Coefficients of Fluid Film Journal Bearings
D.F. Wilcock, O. Pinkus
Tribolock, Inc.
J. Tribology, Trans. ASME, 107 (2), pp 256-261 (Apr 1985) 10 figs, 4 tables, 11 refs

KEY WORDS: Journal bearings, Stiffness coefficients, Damping coefficients, Turbulence, Viscosity effects

Many high-speed or large fluid film bearings operate in the turbulent regime. However, relatively little consideration has been given to the effects of turbulence and of the variation in viscosity on the dynamic stiffness and damping characteristics of the bearings. Since the dynamic behavior of the rotor supported on such bearings is often closely tied to the bearing dynamic coefficients, knowledge of them may be critical to both the design and the in-place correction of rotor instabilities. These effects are here considered in some detail on the basis of computer calculated analytical results, both in general dimensionless terms and with regard to a specific numerical example.

85-1876
An Adiabatic Solution of Misaligned Journal Bearings
M.O.A. Mokhtar, Z.S. Safar, M.A.M. Abd-El-Rahman
Cairo Univ., Cairo, Egypt
J. Tribology, Trans. ASME, 107 (2), pp 263-267 (Apr 1985) 8 figs, 9 refs

KEY WORDS: Journal bearings, Alignment

The paper presents an adiabatic analysis of misaligned journal bearings. The misalignment is allowed to vary in magnitude as well as in direction with respect to the bearing boundaries. Results are obtained

GEARS

85-1877
In-Flight Estimation and Induction of Cumulative Fatigue Damage to Helicopter Gears.
K.F. Fraser
Aeronautical Res. Labs., Melbourne, Australia
Rept. No. ARL-AERO-PROP-REPORT-164, AR-3-13, 113 pp (Mar 1984) N85-12050/GAR

KEY WORDS: Gears, Helicopters, Fatigue life

The safe fatigue life of helicopter transmission components made if in service load data together with transmission fatigue data, represented as the number of cycles of failure as a function of tooth load, were estimated. Instrumentation was developed to provide in flight, estimation and indication of the proportion of safe fatigue life expended for critical gears in single or twin engine helicopter transmission systems.

COUPLINGS

85-1878
Tailoring Drive Output with Elastomeric Couplings
M. Seneczko, ed.
Mach. Des., pp 123-125 (Apr 11, 1985) 6 figs

KEY WORDS: *Couplings, Elastomers*

Most elastomeric couplings are available with interchangeable flexible members. Thus, besides handling shaft misalignments, couplings can be modified to isolate and damp vibrations, cushion shock, or even provide overload protection. This paper

reviews coupling selection to attendant vibrations and shock.

FASTENERS

85-1879
Corrosion Fatigue Tests on Welded Tubular Joints
T. Iwasaki, J.G. Wylde
The Welding Inst., Abington, Cambridge, UK
J. Energy Resources Tech., Trans. ASME, 107 (1), pp 68-73 (Mar 1985) 7 figs, 5 tables, 22 refs

KEY WORDS: Joints, Corrosion fatigue, Fatigue tests

The corrosion fatigue performance of welded tubular joints is recognized as one of the most important factors in the design of offshore structures. Because of the cost of such tests it has been practice to carry out tests on tubular joints in air and to perform corrosion fatigue tests on simple welded joints. The present paper describes the results of fatigue tests which have been carried out on welded tubular joints both in air and in sea water environment.

SEALS

85-1880
An Analysis of "Ringing" Phenomena on a Water Pump Mechanical Seal
K. Kiryu, T. Yanai, S. Matsumoto, T. Koga
Eagle Industry Co., Ltd., Okayama, Japan
ASLE, Trans., 28 (2), pp 261-267 (Apr 1985) 15 figs, 4 tables, 3 refs

KEY WORDS: Seals, Pumps, Sound generation, Stick-slip response

Mechanical seals are used as sealing devices of water pumps in cooling systems of automobile engines. It is observed that water pump seals sometimes generate a "ringing" sound under certain conditions; however, the mechanisms of "ringing" phenomena have rarely been studied because of the difficulty in reproducing these phenomena. The present investigation is concerned with an experimental and fundamental analysis of "ringing." As a result of observation and discussion of these phenomena, it becomes clear that this "ringing" sound is closely related to the surface condition and the "stick-slip" phenomena of rubbing surfaces of water pump seals.

STRUCTURAL COMPONENTS

STRINGS AND ROPES

85-1881
Vibration of a Bowed String (1st Report — No. 1 Monochord Subject to Air Resistance Only)
S. Maezawa, K. Temma
Meisei Univ., Hodokubo 337, Hino City, Tokyo, 191 Japan
Bull. JSME, 28 (237), pp 475-482 (Mar 1985) 8 figs, 16 refs

KEY WORDS: Strings, Self-excited vibrations

Steady self-excited vibrations of a bowed string, which is perfectly flexible land subject to negative damping due to solid frictional force of general characteristic and to positive damping due to air resistance only, are studied by means of a Fourier series method utilizing series transformation.

CABLES

85-1882
On the Fatigue Strength of Wires in Spiral Ropes
K. Gabriel
Institut f. Massivbau, Universitat Stuttgart, Stuttgart, Germany

J. Energy Resources Tech., Trans. ASME, 107 (1), pp 107-112 (Mar 1985) 14 figs, 18 refs

KEY WORDS: Cables, Wire, Fatigue life

Spiral ropes of high load-bearing capacity are usually made of cold-drawn steel wires of high tensile strength. This material has been investigated by many researchers, not only to determine the mechanical properties of cold-drawn wires, but also to find out more about their stress-strain behavior under tensile loading and local three-dimensional stresses. A method of determining the fatigue strength of tension members made of cold-drawn wires is described using statistical methods, results of fatigue tests on short specimens, and precision measurements of the cold-drawn wire.

BARS AND RODS

85-1883

On a Lower Bound for the Instability Range of Beck's Rod

H.H.E. Leipholz

Univ. of Waterloo, Waterloo, Ontario, Canada N2L 3G1

Mech. Res. Comm., 11 (6), pp 379-383 (Nov/Dec 1984) 1 fig, 4 refs

KEY WORDS: Rods, Antennas, Flutter

In this paper, a lower bound for the critical values of a parameter in a boundary eigenvalue problem will be derived. It will provide a safe datum for the design of an unconditionally stable control for the antenna arm.

85-1884

A Global Analysis of a Non-Linear System under Parametric Excitation

R.S. Guttalu, C.S. Hsu

Univ. of California, Berkeley, CA 94720

J. Sound Vib., 97 (3), pp 399-427 (Dec 8, 1984) 16 figs, 3 tables, 9 refs

KEY WORDS: Bars, Periodic excitation, Parametric vibration, Global fitting method

A strongly nonlinear mechanical system consisting of a rigid damped bar subjected to a periodic parametric excitation is treated in an exact manner. The emphasis is on the global behavior of this system which is carried out by using the point mapping and the cell-to-cell mapping methods. The mechanical system is a simple one, yet it has a very complex global behavior. It is shown that the newly developed theory of cell-to-cell mappings offer a tremendous advantage in obtaining the global domains of attraction of strongly nonlinear dynamical systems.

BEAMS

85-1885

Numerical Analysis of Damped Transient Beam Vibrations by Use of Fourier Transforms

L. Karlsson

Lulea Univ. of Tech., Lulea, Sweden

Intl. J. Numer. Methods Engrg., 21 (4), pp 683-689 (Apr 1985) 8 figs, 1 table, 6 refs

KEY WORDS: Beams, Damped modes, Winkler foundations, Fast Fourier transform, Noise generation

As an approximation for the mechanism behind noise emission from a rock drilling rod, the transient damped vibrations of a beam (the drilling rod) in bending and shear is studied. At one end the beam is supported by a distributed damped Winkler-type foundation. In order to determine required transfer function from an applied moment at the other end of the beam, it is divided into two finite elements. Each element is treated as a uniform Rayleigh-Timoshenko beam in an ambient medium. The fast Fourier transform technique is utilized.

85-1886

Wave Reflection and Transmission in Beams

B.R. Mace

Univ. of Auckland, Private Bag, Auckland, New Zealand
J. Sound Vib., 97 (2), pp 237-246 (Nov 22, 1984) 9 figs, 7 refs

KEY WORDS: Beams, Wave reflection, Wave transmission

The vibrational behavior of beam systems can be expressed in terms of waves of both propagating and near field types. A propagating wave incident upon a discontinuity gives rise to reflected and transmitted waves of both kinds whose amplitudes may be found from well-known reflection and transmission coefficients. In this paper the approach is extended to the case of incident near field waves, reflection and transmission matrices being derived for the cases of a point support and a change in section. Reflection at a boundary and the effects of applied excitations are also considered.

85-1887
Non-Linear Free Torsional Vibrations of Thin-Walled Beams with Bisymmetric Cross-Section
B. Rozmarynowski, C. Szymczak
Technical Univ. of Gdansk, 80-952 Gdansk, ul. Majakowskiego 11/12, Poland
J. Sound Vib., 97 (1), pp 145-152 (Nov 8, 1984) 1 fig, 7 tables, 6 refs

KEY WORDS: Beams, Torsional vibrations, Finite element technique

A finite element method for studying nonlinear free torsional vibrations of thin-walled beams with bisymmetric open cross-section is presented. The nonlinearity of the problem arises from axial loads generated at moderately large amplitude torsional vibrations due to immovability of end supports. The derivation of the fundamental differential equation of the problem is based on the classical assumption of a thin-walled beam with a non-deformable cross-section. The nonlinear eigenvalue problem is solved iteratively by series of linear eigenvalue problems until the required accuracy is obtained.

85-1888
Optimal Design of Thin-Walled I Beams for a Given Natural Frequency of Torsional Vibrations
C. Szymczak
Technical Univ. of Gdansk, 80-952 Gdansk, ul. Majakowskiego 11/13, Poland
J. Sound Vib., 97 (1), pp 137-144 (Nov 8, 1984) 4 figs, 8 refs

KEY WORDS: Beams, Natural frequencies, Torsional vibrations, Axial force, Warping

A method of extremum weight design of thin-walled I beams for a given natural frequency of torsional vibrations is presented. The effects of warping stresses and constant axial loads are taken into account.

85-1889
Vibration of a Beam Due to a Random Stream of Moving Forces with Random Velocity
P. Sniady
Inst. of Civil Engrg., Technical Univ. of Wroclaw, Wroclaw, Poland
J. Sound Vib., 97 (1), pp 23-33 (Nov 8, 1984) 4 figs, 16 refs

KEY WORDS: Beams, Moving loads, Bridges

The problem of dynamic response of a beam to the passage of a train of concentrated forces with random amplitudes and velocities is considered. Force arrivals at the beam are assumed to constitute the point stochastic process of events. Thus, the excitation process is an idealization of vehicular traffic loads on a bridge. An analytical technique is developed to determine the response of the beam. Explicit expressions for the expected value and the variance of the beam deflection are provided.

85-1890
Remote Impact Analysis by Use of Propagated Acceleration Signals, I: Theoretical Methods
G.S. Whiston
Central Electricity Generating Board, Leath-

erhead KT22 7SE, UK
J. Sound Vib., 97 (1), pp 35-51 (Nov 8, 1984) 5 figs, 2 refs

KEY WORDS: Beams, Impact response

A technique for remote impact analysis applicable to on-line vibration wear assessment of installed plant is presented. Beam acceleration transients propagated from impact sites can be spectrally inverted to yield the impact site location and the force time history. The effect of various possible types of signal contamination is analyzed.

85-1891
Remote Impact Analysis by Use of Propagated Acceleration Signals, II: Comparison Between Theory and Experiment
R.W. Jordan, G.S. Whiston
Central Electricity Generating Board, Leatherhead KT22 7SE, UK
J. Sound Vib., 97 (1), pp 53-63 (Nov 8, 1984) 8 figs, 2 refs

KEY WORDS: Beams, Impact response, Timoshenko theory

Techniques for remote impact analysis are analyzed from an experimental point of view. Comparison is made between the theoretical and experimental Timoshenko transfer functions between the remote acceleration transform and the impact force-time history transform. The inversion process has been applied with success to experimental impacting data.

85-1892
Random Vibrations of Elastic Beams and Circular Plates Resting on Viscoelastic Foundations
Y.J. Lin
Hughes Aircraft Co., El Segundo, CA
J. Vib., Acoust., Stress, Rel. Des., Trans. ASME, 107 (2), pp 180-187 (Apr 1985) 5 figs, 6 refs

KEY WORDS: Beams, Circular plates, Random vibration, Viscoelastic foundations

Analytical and numerical results are reported for the dynamic responses of elastic beams and circular plates resting on viscoelastic foundations and excited by stationary, wide-band random forces. Each viscoelastic foundation is treated as a series of an infinite number of many spring-dashpot systems. Three different types of linear viscoelastic models are considered.

85-1893
Vibration Frequencies for a Non-Uniform Beam with End Mass
J.H. Lau
Hewlett-Packard Labs., Palo Alto, CA 94303

J. Sound Vib., 97 (3), pp 513-521 (Dec 8, 1984) 2 figs, 6 tables, 12 refs

KEY WORDS: Cantilever beams, Mass-beam systems, Natural frequencies, Rotatory inertia effects

This study deals with the determination of natural frequencies of a non-uniform cantilever beam which carries a concentrated mass at the free end. The effect of the rotatory inertia of the end mass has been included. Numerical results for the first five eigenfrequencies are presented for a wide range of values of the beam dimensions and the concentrated mass.

85-1894
Nonlinear Vibrations of a Beam with a Mass Subjected to Alternating Electromagnetic Force
H. Kojima, K. Nagaya, H. Shiraishi, A. Yamashita
Gunma Univ., Tenjin-cho, Kiryu, Gunma 376, Japan
Bull. JSME, 28 (237), pp 468-474 (Mar 1985) 6 figs, 1 table, 3 refs

KEY WORDS: Mass-beam systems, Electromagnetic excitation, Superharmonic vibrations, Subharmonic oscillations, Harmonic balance method

The parametric nonlinear forced vibrations of a beam with a mass subjected to alternating electromagnetic force are investigated analytically and experimentally. The beam is fixed at one end, and an alternating electromagnetic force acts on the mass attached to the other end of the beam. The governing partial differential equations are solved by harmonic balance method, and second order superharmonic and one-second order subharmonic vibrations are obtained as well as the harmonic vibration.

CYLINDERS

85-1895

Flow-Induced Vibrations of Mixing Vessel Internals

R. King
BHRA, The Fluid Engrg. Ctr., Cranfield, Bedford, UK

J. Vib., Acoust., Stress, Rel. Des., Trans. ASME, 107 (2), pp 253-258 (Apr 1985) 10 figs, 11 refs

KEY WORDS: Cylinders, Submerged structures, Fluid-induced excitation

The results of research work on cylinders excited to oscillate by flow within unbaffled mixing vessels are presented. Oscillations of an anchor mixer and of dip tubes are described, including those cases in which the cylinders are mounted close to the vessel wall. The results are used to define guidelines for calculating safe operating limits of cylinders dipping into water, and for avoiding vortex excited oscillations of an anchor mixer by a device which actually improves its efficiency as a mixer.

85-1896

Calculation of Radiated Noise from Cylinder Block Using Finite Element Model

K. Maekawa, S. Morita
Toyo Kogyo Co. Ltd., Hiroshima-shi, Japan

Intl. J. Vehicle Des., 6 (2), pp 228-239 (Mar 1985) 12 figs, 1 table, 6 refs

KEY WORDS: Cylinders, Engine noise, Noise prediction, Finite element technique, Modal analysis

The work described in this paper was undertaken as part of a program aimed at predicting engine noise and vibration characteristics at the design stage. The operating engine test and artificial excitation test were carried out with a 4-cylinder, 1500 cc gasoline engine. Radiated noise and vibration characteristics of a cylinder block were investigated and noise controlling parameters, such as radiation efficiency, forcing functions and modal damping, were examined. Surface response level and radiated noise from the cylinder block were calculated using a finite element model by combining noise controlling parameters obtained by the tests.

FRAMES AND ARCHES

85-1897

Active Reduction of Deflections and Vibrations: Advantages, Problems, and Applications (Aktive Unterdruckung von Durchbiegungen und Schwingungen: Vorteile, Probleme, Realisierungsmoglichkeiten)

H. Domke, H. Bouten, H. Meyr, B. Zach
Lehrstuhl f. Konstruktive Gestaltung, Mies-van-der-Rohe Str. 1, 51 Aachen, Fed. Rep. Germany

Dynamische Probleme. Modellierung und Wirklichkeit. Proc. of a Meeting, Oct 4-5, 1984, Hannover, Curt-Risch-Institut der Universitat Hannover, Hannover, Fed. Rep. Germany, Vol. II, pp 399-416, 15 figs, 6 refs (In German)

KEY WORDS: Supports, Active vibration control

An active deflection control system for cable-prestressed concrete support structures is discussed. The control is achieved by means of actively controlled coupling members between the cable and support structure. Smallest measured deflections release reverse control instructions in the coupling members, causing the deflection to reverse. As a result of flexural freedom each load in the concrete component results in a uniformly distributed compression load, while the cable deforms in such a manner as if it were directly loaded.

MEMBRANES, FILMS, AND WEBS

85-1898

Control of the Dynamic Response of a Damped Membrane by Distributed Forces

I. Sadek, S. Adali

National Res. Inst. for Mathematical Sciences, Pretoria, South Africa

Rept. No. CSIR-TWISK-312, 40 pp (June 1983) N85-10406/5/GAR

KEY WORDS: Membranes, Damped structures

The problem of damping out the oscillations of a rectangular membrane by means of distributed forces is solved analytically. The membrane is initiated by given initial displacement and velocity conditions. The basic control problem is to minimize the deflection and the velocity of displacements in a given period of time with the minimum possible expenditure of force. The necessary conditions of optimality are obtained from a control theory approach and formulated in the form of a maximum principle in terms of an adjoint variable. Numerical results are given for various problem parameters and the efficiency of the control mechanism is investigated.

PANELS

85-1899

The Effect of Acoustic/Thermal Environments on Advanced Composite Fuselage Panels

J. Soovere

Lockheed-California Co., Burbank, CA

J. Aircraft, 22 (4), pp 257-263 (Apr 1985) 4 tables, 10 refs

KEY WORDS: Panels, Composite materials, Aircraft components, Acoustic fatigue, Temperature effects

Described is a sonic fatigue program to determine the effect of elevated temperature on flat integrally stiffened graphite/-epoxy panels. The program involved comparative sonic fatigue testing of two J-stiffened monolithic and two bladed-stiffened orthogrid panels, with one panel of each design tested at ambient temperature and the other at 254°F. Existing analysis methods are also evaluated. The elevated temperature could affect the sonic fatigue life of composite panels.

85-1900

A Harmonic Gradient Method for Unsteady Supersonic Flow Calculations

Ping-Chih Chen, D.D. Liu

Northrop Corp., Hawthorne, CA

J. Aircraft, 22 (5), pp 371-379 (May 1985) 7 figs, 4 tables, 23 refs

KEY WORDS: Panels, Aircraft wings, Frequency domain method

An accurate and effective method for calculations of unsteady three-dimensional supersonic flow has been developed. The method is capable of handling general cases of planar, coplanar, and nonplanar wing planforms in the complete frequency domain. A harmonic-gradient potential model is provided for elementary doublet panels to be made compatible with the wave number generated.

PLATES

85-1901

Torsional Excitation of an Infinite Elastic Plate with a Soft, Circular Indenter

S. Ljunggren

The Aeronautical Res. Inst. of Sweden, S-161 11 Bromma, Sweden

J. Sound Vib., 97 (2), pp 189-199 (Nov 22, 1984) 8 figs, 11 refs

KEY WORDS: Plates, Torsional excitation

An analytical solution is determined for the motion of an infinite elastic plate, excited by a torsional moment. The driving moment is sinusoidal in time and applied to an indenter with a circular base, fixed to the plate. It is shown that the input admittance due to a soft indenter is larger than in the case of a rigid indenter and that the results for both cases, with consideration of the different stress distributions, are supported by the results previously gi en for a perfectly rigid indenter (obtained with mixed boundary conditions).

85-1902

Nonlinear Static and Dynamic Analysis of Circular Plates and Shallow Spherical Shells Using the Collocation Method

Y. Nath, P.C. Dumir, R.S. Bhatia
Indian Inst. of Tech., Delhi, India

Intl. J. Numer. Methods Engrg., 21 (3), pp 565-578 (1985) 12 figs, 2 tables, 21 refs

KEY WORDS: Circular plates, Spherical shells, Collocation method

The present work investigates the efficacy and applicability of interior global orthogonal point collocation method to the axisymmetric nonlinear analysis of elastic circular plates and shallow spherical shells subjected to uniformly distributed transverse load. Spacewise discretization is carried out using a polynomial expansion with the zeros of a Chebyshev polynomial as collocation points. The static response and snap-through buckling results, as well as, the dynamic response and dynamic buckling results under a uniformly distributed step load are obtained and found to agree closely with available results.

85-1903

Natural Frequencies of a Non Homogeneous Isotropic Elastic Infinite Plate of Variable Thickness Resting on Elastic Foundation

J.S. Tomar, D.C. Gupta, V. Kumar
Univ. of Roorkee, Roorkee, India

Meccanica, 19 (4), pp 320-324 (Dec 1984) 6 figs, 6 refs

KEY WORDS: Plates, Variable cross section, Elastic foundation, Natural frequencies

The dynamic free response of a nonhomogeneous isotropic elastic infinite plate of parabolically varying thickness resting on an elastic foundation are studied. The frequencies, deflections and moments corresponding to the first five modes of vibration are computed for the two combinations of boundary conditions, clamped-clamped and clamped-simply supported and various values of taper constant, nonhomogeneity parameter and foundation modulus by applying the method of Frobenius for the solution of the governing differential equation of motion.

85-1904

A Note on Vibrating Circular Plates Carrying Concentrated Masses

P.A.A. Laura, P.A. Laura, G. Diez, V.H. Cortinez
Institute of Applied Mechanics and Universidad Nacional del Sur, 8111 Puerto Belgrano Naval Base, Argentina

Mech. Res. Comm., 11 (6), pp 397-400 (Nov/Dec 1984) 2 tables, 4 refs

KEY WORDS: Circular plates, Fundamental frequencies

This note deals with the approximate determination of the fundamental frequency of vibration of circular plates elastically restrained against rotation and carrying a concentrated mass at its center. In the case of clamped plates the results are in excellent agreement with values predicted by the exact solution. The present algorithmic procedure allows for the calculation of the fundamental frequency of vibration for any value of the flexibility coefficient in a very simple yet quite accurate fashion.

85-1905

Non-Linear Axisymmetric Transient Analysis of Orthotropic Thin Annular Plates with a Rigid Central Mass

P.C. Dumir, Y. Nath, M.L. Gandhi
Indian Inst. of Tech., New Delhi-110016, India

J. Sound Vib., 97 (3), pp 387-397 (Dec 8, 1984) 8 figs, 1 table, 8 refs

KEY WORDS: Annular plates, Mass-plate systems, Periodic excitation, Transient response

The geometrically nonlinear, axisymmetric transient elastic response is determined of cylindrically orthotropic thin annular plates with a rigid central mass subjected to a uniformly distributed load on the plate as well as a central load on the rigid mass. The response of isotropic and orthotropic, clamped as well as simply supported, annular plates with a rigid central mass, subjected to step function and sinusoidal pulse loads, is calculated for two values of the annular ratio. The influence of the mass ratio and the magnitude of the step load on the deflection response is determined. The effect of mass ratio, amplitude and duration of sinusoidal pulse on the deflection response is also studied.

85-1906

Energy Propagation Velocity of Elastic Waves in Sandwich Layer

T. Ohyoshi

Akita Univ., Akita City, Japan 010

J. Vib., Acoust. Stress, Rel. Des., Trans. ASME, 107 (2), pp 235-242 (Apr 1985) 8 figs, 12 refs

KEY WORDS: Sandwich structures, Plates, Elastic waves, Wave propagation

The explicit characteristic velocities of mechanical energy are obtained in computation for designing structures and acoustical inspections of a sandwich composite plate made of three elastic constituent layers. The dependence of the energy velocity upon the parameters such as ratio of shear velocity, volume fraction, and Poisson's ratios of constituent layers is discussed in graph form with curves of frequency to energy arrival time. Numerical calculations are carried out up to several higher modes within the range of practical frequencies.

SHELLS

85-1907

Acoustic Radiation from Single and Double Ribbed Circular Cylindrical Shells

C.B. Burroughs, S.I. Hayek, J.E. Hallander, D.A. Bostian

Pennsylvania State Univ., State College, PA

Rept. No. ARL-PSU-TM-84-76, 104 pp (Mar 30, 1984) AD-A148 771

KEY WORDS: Cylindrical shells, Elastic waves, Sound waves, Wave radiation

Measurements of the acoustic radiation from single and double ribbed circular cylindrical shells were made on the NUSC transducer calibration platform. Six different types of mechanical drives were used at each of three locations inside the inner shell. Analysis of the processed data is presented and discussed.

85-1908

Dynamics and Stability of Coaxial Cylindrical Shells Containing Flowing Fluid

M.P. Paidoussis, S.P. Chan, A.K. Misra

McGill Univ., Montreal, Quebec, Canada

J. Sound Vib., 97 (2), pp 201-235 (Nov 22, 1984) 12 figs, 10 tables, 42 refs

KEY WORDS: Cylindrical shells, Concentric structures, Fluid-induced excitation

An analytical model for the dynamics and stability of coaxial cylindrical shells conveying incompressible or compressible fluid in the inner shell and in the annulus between the two shells is presented. Shell motions are described by Flugge's thin-shell equations and the fluid forces are determined by means of linearized potential flow theory and formulated with the aid of generalized force Fourier transform techniques.

85-1909

A Comparison of Some Shell Theories Used for the Dynamic Analysis of Cross-Ply Laminated Circular Cylindrical Panels

K.P. Soldatos

Univ. of Ioannina, Ioannina, Greece
J. Sound Vib., 97 (2), pp 305-319 (Nov 22, 1984) 2 figs, 8 tables, 27 refs

KEY WORDS: Shells, Panels, Layered materials

The free vibration problem of thin elastic cross-ply laminated circular cylindrical panels is considered. A theoretical unification, as well as a numerical comparison of the thin shell theories most commonly used, is presented. By using a closed form solution obtained for simply supported panels, a comparison of corresponding numerical results is attempted.

85-1910

A Numerical Approach for Vibration Analysis of an Axisymmetric Shell Structure with a Nonuniform Edge Constraint

Y.F. Hwang
David Taylor Naval Ship R&D Ctr., Bethesda, MD 20084
J. Vib., Acoust., Stress, Rel. Des., Trans. ASME, 107 (2), pp 203-209 (Apr 1985) 4 figs, 6 tables, 6 refs

KEY WORDS: Shells, Bodies of revolution, Vibration analysis, Numerical methods

A numerical approach for computing the eigenvalues and eigenfunctions of an axisymmetric shell with a nonaxisymmetric edge constraint is presented. The shell structures are modeled without constraint by an assemblage of axisymmetric shell elements.

85-1911

Geometrically Non-Linear Transient Analysis of Laminated, Doubly Curved Shells

J.N. Reddy, K. Chandrashekhara
Virginia Polytechnic Inst. and State Univ., Blacksburg, VA 24061
Intl. J. Nonlin. Mech., 20 (2), pp 79-90 (1985) 8 figs, 19 refs

KEY WORDS: Spherical shells, Cylindrical shells, Layered materials, Transverse shear deformation effects

A dynamic, shear deformation theory of a doubly curved shell is used to develop a finite element for geometrically nonlinear (in the von Karman sense) transient analysis of laminated composite shells. The element is employed to determine the transient response of spherical and cylindrical shells with various boundary conditions and loading. The effect of shear deformation and geometric nonlinearity on the transient response is investigated.

85-1912

Large Amplitude Free Vibrations of Shallow Spherical Shell and Cylindrical Shell — A New Approach

G.C. Sinharay, B. Banerjee
Hooghly Mohsin College, P.O. Chinsurah, Dist. Hooghly, West Bengal, India
Intl. J. Nonlin. Mech., 20 (2), pp 69-78 (1985) 4 figs, 9 refs

KEY WORDS: Spherical shells, Cylindrical shells

Large amplitude free vibrations of thin elastic shallow spherical and cylindrical shells are investigated following a new approach. Numerical results for movable as well as immovable edge conditions are presented graphically and compared with other known results.

RINGS

85-1913

In-Plane Vibrations of Circular Rings

S.-I. Suzuki
Tsujido Higashikaigan 2-17-21, Fujisawa 251, Japan
J. Sound Vib., 97 (1), pp 101-105 (Nov 8, 1984) 3 figs, 9 refs

KEY WORDS: Rings, Warping, Natural frequencies

Except in a few cases rings have been treated one-dimensionally as curved beams in analyses to determine their frequencies of vibration. Consequently, for thick rings there are large discrepancies between theoretical and experimental results. In this paper an analysis is carried out in which account is taken of the warping of the cross section. The frequencies of free vibration are determined by using the principle of minimum total potential energy. Numerical calculations are made for a ring of rectangular cross section.

PIPES AND TUBES

85-1914

Acoustic Characteristics of Circular Bends in Pipes

D. Firth, F.J. Fahy
Inst. of Sound and Vib. Res., Univ. of Southampton, Southampton S09 5NH, UK

J. Sound Vib., 97 (2), pp 287-303 (Nov 22, 1984) 10 figs, 1 table, 13 refs

KEY WORDS: Sound waves, Mode shapes, Pipe joints, Piping systems

The acoustic properties of circular bends in pipework systems are investigated by calculation of the ode shapes and propagation constants of the acoustic modes of the bend, the torus modes, and by evaluation of the transmission and reflection coefficients at a bend in an otherwise infinite straight pipe. The coefficients for the first three cylinder and torus modes are plotted against frequency for the case of a plane wave incident upon a 90° bend. The pipe walls are assumed to be rigid.

85-1915

A Concept for Design of Submarine Pipelines to Resist Ocean Forces

I.. Karal
SINTEF, Trondheim, Norway

J. Energy Resources Tech., Trans. ASME, 107 (1), pp 42-47 (Mar 1985) 2 figs, 10 refs

KEY WORDS: Underwater pipelines, Hydrodynamic excitation, Design techniques

A philosophy for design of submarine pipelines on the seabed to resist ocean forces is proposed. The pipeline response to hydrodynamic forces is calculated and the predicted response parameters are compared with the permitted values given by the design criteria. Some guidelines are given to achieve compatibility of individual elements in the design procedure.

85-1916

Wave Speeds in Rotating Thick-Walled Elastic Tubes

D.M. Haughton
Univ. of Glasgow, Glasgow G12 8QW, Scotland

J. Sound Vib., 97 (1), pp 107-116 (Nov 8, 1984) 6 figs, 10 refs

KEY WORDS: Tubes, Torsional vibrations, Longitudinal vibrations

The wave speeds in rotating thick-walled circular cylinders of incompressible, isotropic, hyperelastic material at finite deformation are investigated. It is proved that pure torsional, longitudinal and breathing mode vibrations no longer exist when rotation is initiated. Numerical results are given for a number of different situations when an empirical three term Ogden strain-energy function is used. Comparisons are made with the corresponding results for membrane shells and solid cylinders.

85-1917

Heat Exchanger Tube Fretting Wear: Review and Application to Design

P.L. Ko
National Res. Council, Canada Western Lab., Vancouver, BC

J. Tribology, Trans. ASME, 107 (2), pp 149-156 (Apr 1985) 13 figs, 15 refs

KEY WORDS: Heat exchangers, Tubes, Supports, Fluid-induced excitation,

Flow-induced vibration in steam generators and heat exchangers can cause dynamic interactions between tubes and tube supports resulting in fretting-wear. The effects on

tube wear of various parameters, such as tube/support interactions, materials, and tube/support clearances have been studied. Techniques to predict the dynamic tube/-support interaction and analyze the impact force at the support have been developed. The results of this work are reviewed and discussed in the context of how best they may be applied in the assessment of heat exchanger designs.

The response of long floating structures to a harmonic excitation is the basis for the response calculation in a short-crested wave field. Consistent formulas for obtaining the nodal loads in a finite element analysis are presented. The accuracy of the method is compared with the results obtained using a Rayleigh-Ritz approximation of the response with continuous eigenfunctions. The error of using an irrational finite element model is demonstrated for comparison.

85-1918

Alternate Procedures for the Seismic Analysis of Multiply Supported Piping Systems

M. Subudhi, P. Bezler, Y.K. Wang, R. Alforque

Brookhaven National Lab., Upton, NY

Rept. No. BNL-NUREG-51773, 329 pp (Oct 1984) NUREG/CR-3811/GAR

KEY WORDS: Piping systems, Seismic analysis

Independent support motion methodologies have been used to analyze piping systems subjected to multiple support excitations. Methods to compute both the dynamic and pseudo-static components of response were investigated. In order to formulate a general procedure for predicting seismic response, a sample of six piping systems, two of which were subjected to thirty-three earthquakes, were analyzed. The dynamic component of response was evaluated considering fourteen variations of the combination sequence and procedure between modes, directions and support groups.

85-1919

Finite Element Modeling of the Response of Long Floating Structures under Harmonic Excitation

C. Georgiadis

SINTEF, The Foundation of Scientific Industrial Res. at the Norwegian Inst. of Tech., Trondheim, Norway

J. Energy Resources Tech., Trans. ASME, 107 (1), pp 48-53 (Mar 1985) 12 figs, 10 refs

KEY WORDS: Floating structures, Harmonic excitation, Finite element technique

DUCTS

85-1920

Models for Describing Active Noise Control in Ducts

S.J. Elliott, P.A. Nelson

Univ. of Southampton, UK

ISVR Tech. Rept. No. 127, pp 1-61 (Apr 1984) 5 figs, 1 table, 24 refs

KEY WORDS: Ducts, Active noise control

A number of methods have been proposed for controlling the sound propagating in a duct by introducing secondary sources to cancel the original sound wave produced by a primary source. The physics of such active noise control systems is fairly straightforward and well understood. This report describes the technology associated with this process.

85-1921

Sound Transmission at Low Frequencies through the Walls of Distorted Circular Ducts

A. Cummings, I.-J. Chang

Univ. of Missouri-Rolla, Rolla, MO 65401

J. Sound Vib., 97 (2), pp 261-286 (Nov 22, 1984) 13 figs, 20 refs

KEY WORDS: Ducts, Sound transmission

A theoretical treatment of sound transmission through the walls of distorted circular ducts is given, for plane mode transmission within the duct. The transmission mechanism is essentially that of mode coupling, whereby higher structural modes in the duct walls are excited, because of the wall distortion, by the internal sound field. The theory is in two parts: an approximate analytical model for the structural response of the walls to the internal sound field, and a structural radiation model. Computed results, based on the theory, are compared to measurements on long-seam air conditioning ducts.

BUILDING COMPONENTS

85-1922
Analytical Models for the Nonlinear Seismic Analysis of Reinforced Concrete Structures
M. Keshavarzian, W.C. Schnobrich
Univ. of Illinois at Urbana-Champaign, Urbana, IL 61801
Engrg. Struc., 7 (2), pp 131-142 (Apr 1985) 14 figs, 50 refs

KEY WORDS: Structural members, Reinforced concrete, Seismic analysis, Hysteretic damping

Analytical techniques for nonlinear dynamic analysis of reinforced concrete structures are discussed. The strain-rate effect, damping, and hysteretic behavior of structural members are reviewed. Three classifications of analytical models of RC structures are reviewed, and their applications to the different types of structural systems discussed.

ELECTRIC COMPONENTS

MOTORS

85-1923
Excitation Conditions of Flexural Traveling Waves for a Reversible Ultrasonic Linear Motor
M. Kuribayashi, S. Ueha, E. Mori
Tokyo Inst. of Technology, Midoriku, Yokohama 227, Japan
J. Acoust. Soc. Amer., 77 (4), pp 1431-1435 (Apr 1985), 10 figs, 7 refs

KEY WORDS: Motors, Beams, Flexural vibrations, Wave propagation

This paper presents a theory and experiments on a reversible ultrasonic linear motor, consisting of a thin beam, two ultrasonic transducers, and a slider. The slider rides upon the crests of transverse traveling flexure waves propagating down the beam from one transducer to the other.

ELECTRONIC COMPONENTS

85-1924
Taming Resonance in Servos
G.J. Schneider
Autocon Systems, Pleasanton, CA
Machine Des., pp 73-76 (Feb 7, 1985), 10 figs

KEY WORDS: Transducers, Resonant response, Servomechanisms

Resonant transducers used in motion control systems which can cause instability are described. The paper shows a simple network which can be used in the servo loop to counteract the resonance.

DYNAMIC ENVIRONMENT

ACOUSTIC EXCITATION

85-1925
The Application of a Biorthogonality Principle to the Solution of the End Problem of a Liquid-Filled Rectangular Viscous Acoustic Waveguide
W.F. Albers, E.J. Brunelle, H.A. Scarton

Rensselaer Polytechnic Inst., Troy, NY 12180-3590
J. Vib., Acoust., Stress, Rel. Des., Trans. ASME, 107 (2), pp 243-252 (Apr 1985), 7 figs, 8 refs

KEY WORDS: Waveguide analysis

This paper presents a biorthogonality property of the eigenfunctions for the acoustic modes of the rectangular, liquid-filled waveguide. It provides an immediate solution for the end condition expansion coefficients.

85-1926
Resonances of Plates and Cylinders: Guided Waves
G. Maze, J.L. Izbicki, J. Ripoche
Université du Havre, Laboratoire d'Electronique et d'Automatique, Groupe "Ultrasons," U.E.R.S.T. Place Robert Schuman, 76610 Le Havre, France
J. Acoust. Soc. Amer., 77 (4), pp 1352-1357 (Apr 1985), 10 figs, 1 table, 27 refs

KEY WORDS: Sound waves, Wave scattering, Plates, Cylinders

The normal diffusion of an ultrasonic plane wave by cylinders and plates imbedded in water, showing resonances which are natural modes of vibration, is studied. When a natural mode of an elastic target is excited, energy stored during forced excitation is emitted at the end of the forced excitation. Backscattered spectra obtained by the Resonance Isolation and Identification Method from an aluminum cylinder showing supplementary resonances is observed.

85-1927
Analysis of Elastic Wave Signals from an Extended Source in a Plate
C. Chang, W. Sachse
Cornell Univ., Ithaca, NY 14853
J. Acoust. Soc. Amer., 77 (4), pp 1335-1341 (Apr 1985), 8 figs, 35 refs

KEY WORDS: Elastic waves, Wave propagation, Plates

The forward and inverse problems of an extended, finite source of elastic waves in a thick plate are considered. The signals received at a point in the nearfield of a source are computed by a superposition of the signals found with a generalized ray algorithm from point sources of variable strength arranged along a straight line. Synthetic waveforms corresponding to several source types and spatial distributions on the surface and in the interior of the plate are shown. A processing algorithm is also developed which utilizes the signals detected at just one receiver point to obtain the solution to the inverse source problem.

85-1928
On the Time-Average Acoustic Pressure
K. Beissner
Information from the Physikalisch-Technische Bundesanstalt, Braunschweig
Acustica, 57 (1), pp 1-4 (Jan 1985) 19 refs

KEY WORDS: Sound pressures

The time-average acoustic pressure in Eulerian coordinates is an important part of the radiation pressure. It has been dealt with in the literature mainly in two different ways, one of which refers to the general case of a three-dimensional field. These are discussed and compared and their equivalence in the one-dimensional case is shown.

85-1929
Soil Impedance Measurement by an Acoustic Pulse Technique
C.G. Don, A.J. Cramond
Chisolm Inst. of Tech., Caulfield East, 3145 Victoria, Australia
J. Acoust. Soc. Amer., 77 (4), pp 1601-1609 (Apr 1985) 16 figs, 14 refs

KEY WORDS: Soils, Impedance, Measurement techniques, Acoustic pulses,

Impulses generated by the discharge of a rifle cartridge have been used to determine the complex acoustic impedance of grassland, cultivated earth, a layered forest floor, and highly reflecting stone impregnated ground.

85-1930
Relations Among Different Frequency Rating Procedures for Traffic Noise
D.R. Flynn, S.L. Yaniv
National Bureau of Standards, Gaithersburg, MD 20899
J. Acoust. Soc. Amer., 77 (4), pp 1436-1446 (Apr 1985) 6 figs, 9 tables, 24 refs

KEY WORDS: Traffic noise, Rating

A series of calculations was to ascertain how well one frequency-weighted rating, such as weighted sound level, loudness level, or perceived noise level, may be predicted from another such rating. A total of 103 average sound level spectra, measured at several distances from different types of highways, was used in these calculations.

85-1931
Factors Influencing dB(A) Ratings for Sound Insulation: Incident Noise Spectrum and Shape of the Transmission Loss Curve
A. Moreno
Instituto de Acustica, Serrano 144, Madrid 6, Spain
J. Sound Vib., 97 (2), pp 337-348 (Nov 22, 1984) 9 figs, 22 refs

KEY WORDS: Acoustic insulation, Sound transmission loss

A computer study of the influence of both the incident noise spectrum and the shape of the transmission loss curve on dB(A) ratings for assessing acoustical insulation is undertaken.

85-1932
Asymptotic Fluid-Structure Interaction Theories for Acoustic Radiation Prediction
H. Huang, Y.F. Wang
Naval Surface Weapons Ctr., White Oak, Silver Spring, MD 20910
J. Acoust. Soc. Amer., 77 (4), pp 1389-1394 (Apr 1985) 11 figs, 11 refs

KEY WORDS: Fluid-structure interaction, Sound waves, Wave radiation

It is well known that at extremely high or low frequencies, the fluid-structure interaction effects can be represented asymptotically by simple equations. Thus, it appears that an optimum computation scheme for predicting acoustic pressure field radiated from a submerged elastic structure could be a combination of various asymptotic theories and the exact formulation. This paper explores the ranges of applicability of some asymptotic theories, using the problem of radiation from a spherical elastic shell as the bench mark.

85-1933
Analysis of Higher-Order Mode Effects in the Circular Expansion Chamber with Mean Flow
Jeong-Guon Ih, Byung-Ho Lee
Dept. of Test and Experiments, Tech. Ctr., Daevoo Motor Co., Buk-ku, Inchon, Korea
J. Acoust. Soc. Amer., 77 (4), pp 1377-1388 (Apr 1985) 10 figs, 26 refs

KEY WORDS: Mufflers, Acoustic absorption, Noise control

The effects of higher-order acoustic modes produced by the areal discontinuities of the simple expansion chamber with mean flow on the acoustic performance are studied. The chamber is modeled as a piston-driven circular rigid tube with no losses and, by using the Fourier-Bessel expansion, a general expression of the output pressure to the given input uniform volume velocity is obtained for a whole chamber.

85-1934
Measurement of Sound Absorption in Low Salinity Water of the Baltic Sea
H.G. Schneider, R. Thiele, P.C. Wille
Forschungsanstalt der Bundeswehr f. Wasserschall- und Geophysik, Klausdorfer Weg 2-24, D-2300 Kiel, Fed. Rep. Germany

J. Acoust. Soc. Amer., 77 (4), pp 1409-1412 (Apr 1985) 5 figs, 2 tables, 17 refs

KEY WORDS: Acoustic absorption, Oceans

Shallow water propagation measurements in the thermocline-halocline refractive sound channel of the Baltic Sea are utilized to estimate the absorption coefficient in low salinity water. The lower margin of the present data which are derived from transmission loss by subtraction of cylindrical spreading can be represented by the Francois and Garrison formula of 1982.

85-1935

Reverberation Time in Enclosures: The Surface Reflection Law and the Dependence of the Absorption Coefficient on the Angle of Incidence

G. Benedetto, R. Spagnolo
Istituto Elettrotecnico Nazionale Galileo Ferraris, Corso Massimo d'Azeglio 42, Torino, Italy

J. Acoust. Soc. Amer., 77 (4), pp 1447-1451 (Apr 1985) 8 figs, 1 table, 10 refs

KEY WORDS: Enclosures, Acoustic absorption

The sound decay and reverberation time of enclosures depend on the amount of randomization achieved during the decay. The randomization is determined by the degree of surface roughness and absorptivity and is also related to the shape of the enclosure. Many authors showed that, even in the hypothesis of a memoryless reflection law, the reverberation time largely varies when the absorptivity is nonuniformly distributed on the surfaces, for a fixed value of the sound absorption coefficient. In this paper, applyi a ray-tracing simulation procedure to a simple two-dimensional enclosure, the effect is shown to be still stronger when a certain fraction of specular reflection is taken into account.

85-1936

On the Production and Absorption of Sound by Lossless Liners in the Presence of Mean Flow

M.C. Quinn
Univ. of Southampton, Southampton S09 5NH, UK

J. Sound Vib., 97 (1), pp 1-9 (Nov 8, 1984) 4 figs, 20 refs

KEY WORDS: Acoustic linings, Sound generation, Acoustic absorption

The interaction of sound with the leading and trailing edges of a nominally lossless acoustic liner is examined in the presence of mean flow. It is argued that acoustic energy is conserved only if the whole flow is irrotational. In practice the sound induces vorticity production at the liner, and in particular that generated at the edges of the liner leads to a net transfer of energy between the acoustic field and the mean flow. Analytical results are given for a pressure release liner in a rigid plane wall.

85-1937

Near-Field Frequency-Domain Theory for Propeller Noise

D.B. Hanson
Hamilton Standard, Windsor Locks, CT

AIAA J., 23 (4), pp 499-504 (Apr 1985) 6 figs, 9 refs

KEY WORDS: Propellers, Noise generation, Frequency domain method, Near field region

Near field noise equations are developed from the author's helicoidal surface theory for propeller aerodynamics and noise. Thickness, steady loading, and quadruple sources are included. Apart from the thin-blade approximation and neglect of radial source terms, the equations are exact.

85-1938

Computation of Far-Field Sound Generation in a Fluid-Structure Interaction Problem

A.T. Conlisk
Ohio State Univ., Columbus, OH 43210

J. Vib., Acoust., Stress, Rel. Des., Trans. ASME, 107 (2), pp 210-215 (Apr 1985) 7 figs, 2 tables, 33 refs

KEY WORDS: Sound generation, Fluid-structure interaction

The inviscid flow past a bump on a plane wall in which vorticity disturbances initially placed upstream convect downstream and interact with the bump is examined.

SHOCK EXCITATION

85-1939

Structural Instability in Fluid-Structure Systems under Hydrodynamic Shock Conditions

N. Akkas, J.E. Jackson, Jr.
Middle East Technical Univ., Ankara, Turkey

J. Sound Vib., 97 (2), pp 247-259 (Nov 22, 1984) 8 figs, 1 table, 52 refs

KEY WORDS: Fluid-structure interaction, Shock wave propagation

The effects of nonlinear fluid-structure interaction on the dynamic buckling of structures are investigated. Structural buckling characteristics are studied for the case of a strong shock wave propagating through a fluid medium striking a structure. Nonlinear terms are retained for both fluid and structural systems. A one-dimensional example consisting of a perfect gas-spring-mass system is solved for shock wave loading.

85-1940

Calculation of Shock Problems by Using Four Different Schemes

W.H. Lee, P.P. Whalen
Los Alamos National Lab., NM

Rept. No. LA-UR-84-344, CONF-840720-1, 12 pp (1984) DE84006032/GAR

KEY WORDS: Shock response

Results are shown of the use of several different shock treatments in one-and two-dimensional Lagrangian code calculations of strong shock problems with known solutions. The shock treatments are von Neumann-Richtmyer artificial viscosity, fixed length artificial viscosity, artificial energy diffusivity combined with artificial viscosity, and modified Godunov.

85-1941

Blast Door and Entryway Design and Evaluation

D.W. Hyde, S.A. Kiger
Army Engineer Waterways Experiment Station, Vicksburg, MS

Rept. No. WES-TR/SL-84-13, 82 pp (July 1984) AD-A146 814/GAR

KEY WORDS: Blast resistant structures, Doors, Reinforced concrete

Objectives of this project were to design and test a walk-in, reinforced concrete blast shelter entryway and blast door. Two door configurations were designed, constructed, and tested: a commercially available standard exterior door with special supports, and 3-inch-thick reinforced concrete door.

85-1942

Modal Analysis Applied to the DAA Model for Fluid Structure Interaction in Underwater Shock

J.H. Ginsberg, C.E. Rosenkilde
School of Mech. Engrg., Georgia Inst. of Tech., Atlanta, GA

Rept. No. UCRL-90831, CONF-8409131-1, 24 pp (Aug 1984) DE85001750

KEY WORDS: Modal analysis, Fluid-structure interaction, Doubly asymptotic approximation, Underwater structures, Shock waves

Past studies of the response of cylindrical types of pressure vessels to underwater shock waves have treated relatively simple cases of incidence such as broadside. The present study develops a general algorithm for shock response in which a variety of effects can be described in modular form. The concept is then used to investigate a case of oblique incidence. The overall technique employs the doubly asymptotic approximation of fluid-structure interaction,

but in the less well-known modal expansion form. A general procedure is outlined.

85-1943
Mach Reflection Flowfields Asociated with Strong Shocks
H. Mirels
The Aerospace Corp., El Segundo, CA
AIAA J., 23 (4), pp 522-529 (Apr 1985) 7 figs, 3 tables, 9 refs

KEY WORDS: Shock waves, Wave reflection

The Mach reflection associated with the passage of a shock wave over a wedge is treated in the limit of an ideal gas and a strong shock. Characteristic velocities in the recirculation region associated with double-Mach reflection are estimated. Local surface pressure maxima at the upstream and downstream edges of the recirculation region are also estimated.

85-1944
Unsteady Laminar Boundary-Layer Separation on Oscillating Configurations
W. Geissler
DFVLR, Gottingen, Fed. Rep. Germany
AIAA J., 23 (4), pp 577-582 (Apr 1985) 6 figs, 17 refs

KEY WORDS: Boundary layer excitation, Plates, Airfoils, Finite difference technique

A finite difference procedure has been developed to calculate unsteady two-dimensional laminar boundary layers on oscillating configurations. The method works in regions of reversed flow without numerical difficulties. The oscillating flat plate is investigated as a first test case to prove the validity and efficiency of the calculation procedure. The method is then applied to the case of an airfoil with pitching oscillations.

85-1945
The Effects of Seismic Waves
S. De
National Research Inst., P.O. Bankisol, Bankura, W. Bengal, India
Shock Vib. Dig., 17 (2), pp 3-32 (Feb 1985) 370 refs

KEY WORDS: Seismic response, Ground motion, Earthquake prediction, Reviews

This review article deals with the effects of seismic waves on ground motion and structures, mechanisms and prediction of earthquakes, abnormal animal behavior before earthquakes, and disturbances in the ionosphere. Some recent problems in seismology are described.

VIBRATION EXCITATION

85-1946
Transonic Time Responses of the MBB A-3 Supercritical Airfoil Including Active Controls
J.T. Batina, T.Y. Yang
Purdue Univ., West Lafayette, IN
J. Aircraft, 22 (5), pp 393-400 (May 1985) 12 figs, 3 tables, 20 refs

KEY WORDS: Airfoils, Aeroelasticity, Time response loops, Fluid-induced excitation

Aeroelastic time-response analyses are performed for the MBB A-3 supercritical airfoil in small-disturbance transonic flow based on the use of transonic code LTRAN2-NLR. Three degrees of freedom are considered: plunge, pitch, and aileron pitch. The main objective was to investigate the applicability and accuracy of state-space aeroelastic modeling for two-dimensional airfoils with active controls in transonic flow. A state-space aeroelastic model was formulated using a Pade aerodynamic approximation. The resulting equations are explicitly solved in the time domain yielding the aeroelastic displacement responses.

85-1947
The Mode-Amplitude Technique and Hierarchial Stress Elements — A Simplified and Natural Approach

J. Robinson
Robinson and Associates, Horton Rd., Woodlands, Wimborne, Dorset, UK
Intl. J. Numer. Methods Engrg., 21 (3), pp 487-507 (1985) 16 figs, 3 tables, 15 refs

KEY WORDS: Mode-amplitude technique, Finite element technique, Stress elements

The derivation procedure of conventional stress-based elements is reviewed and it is shown how the procedure can be simplified using degrees-of-freedom which are amplitudes of the boundary loading modes (mode-amplitude technique). This gives one class of element based on stress assumptions and uses only one virtual principle. The natural formulation of hierarchical stress elements is shown.

85-1948

Quenching of a Primary Resonance by a Combination Resonance of the Additive or Difference Type

A.H. Nayfeh
Virginia Polytechnic Inst. and State Univ., Blacksburg, VA 24061
J. Sound Vib., 97 (1), pp 65-73 (Nov 8, 1984) 4 figs, 5 refs

KEY WORDS: Resonant response, Single degree of freedom systems

An investigation is presented of the interaction of primary resonances and combination resonances of the additive and difference types in single-degree-of-freedom systems with quadratic and cubic nonlinearities. The method of multiple scales is used to derive two coupled first order ordinary differential equations that describe the evolution of the amplitude and phase with damping, nonlinearity and both primary and combination resonances.

85-1949

Harmonic Analysis of Time-Limited Signals

M. Petternella, R. Vitelli
Facolta di Ingegneria, Universita Tor Vergata, Via O. Raimondo, 00173, Roma, Italy
J. Sound Vib., 97 (1), pp 87-99 (Nov 8, 1984) 7 figs, 5 refs

KEY WORDS: Harmonic analysis, Pulse excitation

The problem of the estimation of the harmonic content of a signal is studied. The study is limited to the class of causal signals which are the response of linear stable systems to pulse inputs. Two cases are examined: the output of a system whose model has one real pole; the output of a system whose model has a complex conjugate pole pair. An analytical expression for the error that arises when using the finite Fourier transform is obtained.

85-1950

Contribution to the Linear Dynamic Analysis of Slender Bodies in Low and Medium Frequency Ranges

P. Gibert
Office National d'Etudes et de Recherches Aerospatiales, B.P. 72, 92322 Chatillon Cedex, France
J. Sound Vib., 97 (3), pp 499-511 (Dec 8, 1984), 6 figs, 9 refs

KEY WORDS: Vibration analysis, Linear theories, Aircraft fuselages

New methods of analysis of slender bodies in the low- and medium-frequency ranges are introduced. In the medium-frequency range, the modes can be expected to be very oscillatory along the axis of the body. For this reason, the use of standard numerical calculation methods, such as the finite element method, is accompanied by severe practical difficulties. The alternative technique proposed here is of W.K.B.J. type, well-known in quantum mechanics.

85-1951

Parametric Excitation in a Self-Exciting System (2nd Report, Behaviors in the Regions of Resonances of Orders 1/3 and 2)

S. Yano
Fukui Univ., 3-9-1, Bunkyo, Fukui, Japan
Bull. JSME, 28 (237), pp 483-491 (Mar 1985), 17 figs, 3 refs

KEY WORDS: Parametric excitation, Self-excited vibrations, Subharmonic oscillations, Nonlinear theories

In a self-exciting system of Van der Pol type with the restoring force expressed as the product of a nonlinear function of deflection and a periodic function of time self-excitation and parametric excitation induce resonances of higher orders than orders 1 and 1/2. Behavior in the region of subharmonic resonance of order 1/3 are investigated in the phase plane by using the averaging method. An approximate solution and the stability of a parametric resonance of order 2 is determined.

MECHANICAL PROPERTIES

DAMPING

85-1952

Accuracy of Consistent and Lumped Viscous Dampers in Wave Propagation Problems

Y.K. Chow
National Univ. of Singapore, Singapore

Intl. J. Numer. Methods Engrg., 21 (4), pp 723-732 (Apr 1985), 7 figs, 4 tables, 6 refs

KEY WORDS: Viscous damping, Wave propagation, Finite element technique, Boundary layer damping

This paper examines the use of frequency-independent viscous dampers in the study of wave propagation in unbounded solids, in conjunction with the finite element method. These dampers can be used in the frequency or in the time domain. In modeling the infinite domain using viscous dampers, Lysmer and Kuhlemeyer have conveniently lumped the dampers at the nodes and reasonable results have been obtained. Subsequently, this idea of lumping the dampers has been used by other researchers (e.g Dungar and Eldred). Theoretically, the dynamic stress condition imposed by the viscous dampers at the truncated boundary is continuous and thus should be treated as such. A consistent formulation of the viscous damper boundary using the finite element approach will lead to a damping matrix coupling the boundary nodes of the element. The accuracy of the solution obtained with this consistent formulation of the viscous damping matrix was evaluated. The effect of lumping this viscous damping matrix was also examined.

85-1953

On the Use of Exact Modal Analysis Techniques in the Design of Damping Devices for Multi-Conductor Overhead Power Lines, Part I: The Control of Aeolian Vibration

A. Simpson, P.S. Sembi
Univ. of Bristol, Bristol BS8 1TR, UK

J. Sound Vib., 97 (3), pp 357-385 (Dec 8, 1984), 10 figs, 12 refs

KEY WORDS: Dampers, Transmission lines, Modal analysis, Vibration control, Wind-induced excitation

A mathematical model of a multi-conductor overhead power line with spacer-dampers is presented. Advanced methods of exact modal and response analysis, requiring no more than single-precision computational accuracy, are used to develop a method for spacer-damper design which requires no more computational power than that of a standard microcomputer. An outline is presented of the application of this method to the control of Aeolian vibration by using self-damping spacers.

85-1954

Analysis of an Oscillatory Oil Squeeze Film Containing a Central Gas Bubble

S. Haber, I. Etsion
Technion -- Israel Inst. of Technology, Haifa, Israel

ASLE, Trans., 28 (2), pp 253-260 (Apr 1985), 9 figs, 7 refs

KEY WORDS: Squeeze-film dampers

A squeeze-film damper, consisting of two circular plates having only normal oscillatory relative motion is considered. The liquid lubricant between the plates is assumed to contain a single central gas bubble. The effect of the bubble on the damper performance is analyzed. Comparison is made with the performance of a pure liquid damper.

85-1955

Stiffness and Damping Coefficients of Rubber

M.I. Abdulhadi
Yarmouk Univ., Irbid, Jordan
Shock Vib. Dig., 17 (5), pp 3-9 (May 1985) 6 figs, 4 refs

KEY WORDS: Damping coefficients, Stiffness coefficients, Elastomers, Reviews

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.

FATIGUE

85-1956

Acoustic Emission Monitoring of Fatigue in 7010 Aluminum Alloys

G. Weatherly, J.M. Titchmarsh, C.B. Scruby
UKAEA Atomic Energy Res. Establishment, Harwell, UK
Rept. No. AERE-R-11167, 43 pp (Mar 1984) N85-12152/3/GAR

KEY WORDS: Fatigue life, Acoustic emission, Aluminum

Acoustic emission (AE) was monitored in test-pieces of 7010 aluminium alloy containing growing fatigue cracks. Both high purity and commercial casts were studied in underaged, peak and overaged conditions.

ELASTICITY AND PLASTICITY

85-1957

Recent Progress in the Dynamic Plastic Behaviour of Structures, Part IV

N. Jones
Univ. of Liverpool, Liverpool, L69 3BX, UK
Shock Vib. Dig., 17 (2), pp 35-47 (Feb 1985) 118 refs

KEY WORDS: Dynamic buckling, Beams, Plates, Shells, Crashworthiness

This article surveys literature published on the dynamic plastic behavior of structures since the previous review in 1981. It focuses on additional work on the effects of transverse shear and rotatory inertia; recent publications on beams, plates, and shells; and dynamic plastic buckling. Some comments on scaling and structural crashworthiness are included.

WAVE PROPAGATION

85-1958

Diffraction of Rayleigh Waves in a Half-Space. I. Normal Edge Crack

B.Q. Vu, V.K. Kinra
Naval Ocean Systems Ctr., Code 9322, San Diego, CA 92152
J. Acoust. Soc. Amer., 77 (4), pp 1425-1430 (Apr 1985) 8 figs, 22 refs

KEY WORDS: Rayleigh waves, Wave diffraction, Cracked media

This paper is concerned with the diffraction of Rayleigh surface waves by an edge-crack normal to the free surface of a half-space. An experimental technique was developed to yield accurate and reproducible measurements of the scattered field on the free surface both in the vicinity of the crack and far away from it.

EXPERIMENTATION

MEASUREMENT AND ANALYSIS

85-1959
Digital Acceleration Measurement by Means of Microcomputers (Digitale Drehbeschleunigungsmessung mit Hilfe eines Mikrorechners)
D. Severin, P.L. Hartwig
Technische Universitat Berlin, Jebensstrasse 1, D-1000 Berlin 12, Fed. Rep. Germany
Techn. Messen-TM, 51 (11), pp 405-407 (Nov 1984), 4 figs, 8 refs (In German)

KEY WORDS: Acceleration measurement, Measuring instruments

The acceleration in rotating drives will be used more and more to optimize control systems. Pulse generators may be a useful alternative to the common acceleration sensors. In the present paper a microcomputer calculates the acceleration function using two consecutive impulses of a pulse generator. The system is based on measuring time intervals. By superposing a constant turning speed and the input signal, the acceleration can be determined even by low speed.

85-1960
Scanning Laser Doppler Vibration Analysis System (Flachenabtastendes Laser-Doppler-Schwingungsanalysesystem)
B. Stoffregen
Volkswagenwerk AG, Forschung-Messtechnik-Optik, D-3180 Wolfsburg 1
Techn. Messen - TM, 51 (11), pp 394-397 (Nov 1984), 7 figs, 5 refs (In German)

KEY WORDS: Vibration measurement, Measuring instruments, Lasers

The vibration velocity of object surface points can be measured by means of laser Doppler techniques (laser-Doppler-vibrometry). Based on this effect a new measuring system "SOVAS" (Scanning Optical Vibration Analysis System) has been developed. It analyzes the vibration amplitude of whole surface areas by means of computer controlled laser scanning and fast Fourier transform of the velocity signals. As a result, single or averaged frequency spectra as well as vibration patterns of up to seven frequency ranges can be displayed.

85-1961
An Adaptation of the Discrete Fourier Transform for the Determination of Modal Parameters of a Structure (Ein an die diskrete Fourier Transformation angepasstes Verfahren zur Bestimmung der modalen Parameter einer Struktur)
D. Bouchard, H. Waller
Institut f. Mechanik, Ruhr-Universitat Bochum, Fed. Rep. Germany
Dynamische Probleme. Modellierung und Wirklichkeit. Proc. mtg., Oct 4-5, 1984, Hannover, Curt-Risch-Institut der Universität Hannover, Hannover, Fed. Rep. Germany, Vol. II, pp 321-336, 10 figs, 2 refs (In German)

KEY WORDS: Modal analysis, Discrete Fourier transform

Free vibrations of a linear system can be represented by a sum of exponentially damped sinus functions. The proposed method is based on two ideas: the analytical fourier transform of an exponentially damped sinus function is calculated and its relationship with the discrete fourier transform is investigated; the inaccuracies of the analysis caused by the superposition of discrete Fourier transform can be eliminated by iteration. Thus systematic errors, which frequently cause difficulties in vibration analysis, can be eliminated and it is not necessary to employ windows or band spread analysis. Only a few periods of a signal need to be investigated.

85-1962
Theoretical and Experimental Study of Modal Interaction in a Two-Degree-of-Freedom Structure
A.G. Haddow, A.D.S. Barr, D.T. Mook

Univ. of Dundee, Dundee DD1 4HN, Scotland
J. Sound Vib., 97 (3), pp 451-473 (Dec 8, 1984), 15 figs, 1 table, 14 refs

KEY WORDS: Modal analysis, Two degree of freedom systems

For a two-degree-of-freedom structure, an experimental and theoretical investigation has been made of the primary resonances of the system, which occur when the frequency of excitation is near one of the natural frequencies.

85-1963
A More General Method of Substructure Mode Synthesis for Dynamic Analysis
J.H. Kuang, Y.G. Tsuei
Univ. of Cincinnati, Cincinnati, OH
AIAA J., 23 (4), pp 618-623 (Apr 1985), 6 figs, 15 refs

KEY WORDS: Modal synthesis, Substructuring methods, Undamped structures

A method of substructure mode synthesis for determining the dynamic characteristics of an undamped system in a specified frequency band is investigated. The motion of each substructure is represented by the three mode sets: inertia, selected normal, and residual modes.

DYNAMIC TESTS

85-1964
Tracked Vehicle Test Plant for the Simulation of Dynamic Operation
I.C. Schmid
Hochschule der Bundeswehr, Hamburg, Germany
19 pp (Aug 1984)(Proc. of Intl. Conf. on Performance of Off-Road Vehicles and Machines (8th), Vol. 1, Cambridge, UK, Aug 5-11, 1984, pp 835-853, AD-P004 305/9/GAR

KEY WORDS: Test facilities, Tracked vehicles

A modern test plant in Germany has the capability to simulate not only rolling resistance, but also the inertia of vehicle mass and the turning resistance of a tracked vehicle. The dynamic loads of real vehicle action on the road and in the terrain can be run on the test stand.

85-1965
Model Mount System for Testing Flutter
M.G. Farmer
NASA Langley Res. Ctr., Hampton, VA
U.S. Patent No. 4-475 385

KEY WORDS: Mountings, Wind tunnels, Flutter, Airfoil, Aircraft

A wind tunnel model mount system is disclosed for effectively and accurately determining the effect of attack and airstream velocity on a model airfoil or aircraft. Conventional instrumentation is employed to effect model rotation through a turntable and to record model flutter data as a function of the angle of attack versus dynamic pressure.

85-1966
Seismic Simulation at C-E
K.H. Haslinger
Dynamic Testing Combustion Engineering, Inc., Windsor, CT
Test, 46 (6), pp 6, 10-12 (Dec/Jan 1984-85) (continued from 46 (5), 5 figs 5 refs

KEY WORDS: Seismic response, Simulation, Test facilities

C-E's seismic simulation test system, recently upgraded to meet current and future nuclear power industry standards in seismic testing, is described.

85-1967
Dynamic Investigation of Composite Structures — Process Controlled Computer Testing and Measurement ((Dynamische Untersuchungen an Verbundkonstruktionen — Prozessrechnergesteuerte Versuchs- und Messtechnik

W. Hanenkamp, W. Hammer
Ruhr-Universität Bochum, Institut f. Konstruktiven Ingenieurbau, Fed. Rep. Germany
Dynamische Probleme. Modellierung und Wirklichkeit. Proc. of a Meeting, Oct 4-5, 1984, Hannover, Curt-Risch-Institut der Universität Hannover, Hannover, Fed. Rep. Germany, Vol. II, pp 357-376, 14 figs, 2 refs (In German)

KEY WORDS: Fatigue tests, Composite structures, Girders, Computer aided techniques

The hardware and software of a process control computer system for dynamic testing and measurement of composite structural components is presented. The system is illustrated in a fatigue test of composite girders and steel shell covered buildings.

85-1968
Multiaxial Simulation of Dynamic Processes (Mehraxiale Simulation dynamischer Vorgange)
P. Pantucek, V. Grubisic
Fraunhofer-Institut f. Betriebsfestigkeit (LBF), Darmstadt, Fed. Rep. Germany
Dynamische Probleme. Modellierung und Wirklichkeit. Proc. of a Meeting, Oct 4-5, 1984, Hannover, Curt-Risch-Institut der Universität Hannover, Hannover, Fed. Rep. Germany, Vol. II, pop 337-356, 12 figs, 12 refs (In German)

KEY WORDS: Test equipment, Aircraft, Ground vehicles

The shortcomings and limitations of servo-hydraulic test machines for the determination of strength and useful life of aircraft or ground vehicles, or their components are discussed. To eliminate these effects, an improved hardware is proposed, which includes a multiaxial excitation component and a semirigid restraint of defined stiffness and conventional control electronics.

85-1969
Validation of Track Geometry Input to the Vibration Test Unit (VTU) and Endurance Capability of the VTU
B.R. Rajkumar, F.D. Irani
Assn. of American Railroads, Pueblo, CO
Rept. No. TCC-3(FRA-FR84), FRA/ORD-84/09, 59 pp (June 1984) PB85-111995/GAR

KEY WORDS: Test facilities, Railroad tracks

This report describes a series of tests conducted to validate two forms of track geometry inputs to the vibration test unit (VTU), capable of reproducing actual revenue track conditions. The first form consisted of reformatted Plasser geometry input. The second track geometry input was developed based on the locomotive track hazard detector concept.

85-1970
Nondestructive Testing of Resin Mortar Using Ultrasonic Pulses
T. Morimitsu, T. Yabuta, T. Tsujimura, T. Nakayama
Ibaraki Electrical Communication Lab., Nippon Telegraph and Telephone Corp., Tokai, Ibaraki-ken, 319-11, Japan
J. Vib., Acoust., Stress, Rel. Des., Trans. ASME, 107 (2), pp 229-234 (Apr 1985) 13 figs, 8 refs

KEY WORDS: Dynamic tests, Ultrasonic techniques, Tunnel linings

A quick-setting resin mortar, developed to accomplish a new small diameter shield tunneling method, is described. A nondestructive testing method employing ultrasonic pulses is used for estimating the strength of resin mortar. Young's modulus, the density, the strength, and the ultrasonic velocity of resin mortar of varying contents are measured.

85-1971
Progress Toward Magnetic Suspension and Balance Systems for Large Wind Tunnels
C.P. Britcher
NASA Langley Res. Ctr., Hampton, VA
J. Aircraft, 22 (4), pp 264-269 (Apr 1985) 14 figs, 13 refs

KEY WORDS: Wind tunnels, Magnetic suspension systems, Aircraft, Test facilities

Recent developments and current research efforts leading toward realization of a large-scale production wind tunnel magnetic suspension and balance facility are reviewed. Progress has been made in the areas of model roll control, high-angle-of-attack testing, digital system control, calibration techniques, high magnetic moment superconducting solenoid model cores, and system failure tolerance.

DIAGNOSTICS

85-1972

Studies on the Vibration and Sound of Defective Rolling Bearings (Third Report, Vibration of Ball Bearing with Multiple Defects)

T. Igarashi, J. Kato

Technological Univ. of Nagaoka, Kamitomioka-cho, Nagaoka, Niigata, Japan

Bull. JSME, 28 (237), pp 492-499 (Mar 1985) 11 figs, 8 refs

KEY WORDS: Diagnostic techniques, Roller bearings, Ball bearings

A procedure for diagnosing the extent of rolling bearing defects from their vibration and sound is investigated. The vibration of a ball bearing with multiple dents on the race surface of either the inner or outer ring was studied.

85-1973

Differentiating Rotor Response Due to Radial Rubbing

R.F. Beatty

Rockwell International, Canoga Park, CA 91304

J. Vib., Acoust., Stress, Rel. Des., Trans. ASME, 107 (2), pp 151-160 (Apr 1985) 29 figs, 2 tables, 11 refs

KEY WORDS: Diagnostic techniques, Rotors, Turbomachinery, Rubs

Among the factors leading to destructive instability of rotors in high-speed, high-performance turbomachinery is excessive rubbing between rotating and stationary parts. This paper proposes a mathematical rationale of rubbing identification; defines the limits between benign contact and the initiation of a destructive instability based on harmonic spectral data; correlates the results with industry experience, published findings, and extensive laboratory tests; and details the response format of diagnostic data in actual cases.

MONITORING

85-1974

The Development of Structural Monitoring Systems, Chebyshev and Maximum Likelihood Evaluation Methods (Zur Entwicklung von strukturellen Oberwachungssystemen, Tschebyscheff- und Maximum-Lilkelihood Schatzverfahren)

W. Wedig

Universitat Karlsruhe, 75 Karlsruhe, Kaiserstr., 12

Dynamische Probleme. Modellierung und Wirklichkeit. Proc. of a Meeting, Oct 4-5, 1984, Hannover, Curt-Risch-Institut der Universität Hannover, Hannover, Fed. Rep. Germany, Vol. II, pp 441-454, 5 figs, 9 tables (In German)

KEY WORDS: Monitoring techniques, Chebyshev method, Maximum likelihood method

In the development of a structural monitoring system the aim is to analyze stochastic residual vibrations of an elastic structure and to obtain from it dependable information about eventual changes in the stiffness parameters. Parameter identification methods, derived by means of a filter technique or maximum likelihood method, are suitable only when only a few parameters of the high frequency system are to be measured, or a large amount of measured data or a-priori knowledge is available. These difficulties are caused by low convergence of all evaluation methods. This problem is investigated in a low pass system which is simulated in its time discrete form. Evaluation by means of the maximum likelihood method is obtained and explained. By the introduction of Chebyshev measure, which is evaluated by an optimization method, the convergence behavior of the maximum likelihood evaluation is considerably improved.

85-1975

Signal Extraction for Automatic Monitoring of Machine Tool Drives (Signalgewinnung zur automatischen Überwachung von Werkzeugmaschinenantrieben)

P. Menz, H. Heinke
Technische Hochschule Otto von Guericke Magdeburg

Maschinenbautechnik, 33 (12), pp 544-547 (1984) 7 figs, 1 table, 7 refs (In German)

KEY WORDS: Monitoring techniques, Machine tools

Automatic monitoring of components or whole machine tools has become increasingly important. The selection of suitable measured values is essential. A sensor with strain resistant gauges can complexly record several measured values.

ANALYSIS AND DESIGN

ANALYTICAL METHODS

85-1976

Resonant Non-Linear Waves — III. Elastic Continuum with Quadratic NonLinearity

M. Can, A. Askar
Istanbul Technical Univ., Maslak, Istanbul, Turkey

Intl. J. Nonlinear. Mech., 20 (2), pp 103-111 (1985) 1 fig, 5 refs

KEY WORDS: Boundary value problems, Resonant frequencies, Elastic media

The paper derives the relevant nonlinear integro-differential evolution equation by the method due to Collins expanding on a procedure by Keller. The quadratically nonlinear case is not a trivial variation over the cubically nonlinear case that was presented in preceding papers.

85-1977

Resonant Non-Linear Waves — IV. Continuous and Discontinuous Solutions and an Assessment of Modal Analyses

M. Can, A. Askar
Istanbul Technical Univ., Maslak, Istanbul, Turkey

Intl. J. Nonlinear. Mech., 20 (2), pp 113-119 (1985) 4 figs, 6 refs

KEY WORDS: Boundary value problems, Resonant frequencies, Modal analysis

This paper indicates that near resonances many nonlinear systems develop discontinuous solutions and discusses the range of applicability of the single mode analysis. The discussion is based on the construction of an exact solution to a nonlinear integro-differential equation derived by a method due to Collins expanding on a procedure by Keller and applied to various problems in preceding articles.

85-1978

Two-Sided Estimates in Linear Elastodynamics

A.A. Liolios
Aristotle-University of Thessaloniki, Thessaloniki, Greece

Mech. Res. Comm., 11 (6), pp 363-371 (Nov/Dec 1984), 1 fig, 12 refs

KEY WORDS: Boundary value problems, Elastodynamic response

Methods of bounding from above and below the solutions of self-adjoint boundary value problems in linear elastostatics are extended to linear problems in elastodynamics. A procedure is presented which provides two-sided solution estimates for the mixed boundary-initial-value problem of linear elastodynamics.

85-1979
Bifurcation Analysis of Nonlinear Turning Point Problems
C.G. Lange, G.A. Kriegsmann
Univ. of California, Los Angeles, CA
SIAM J. Appl. Math., 45 (2), pp 175-199 (Apr 1985) 3 figs, 1 table, 17 refs

KEY WORDS: Boundary value problems, Bifurcation theory, Perturbation theory

A bifurcation analysis is carried out on a class of nonlinear two-point boundary value problems for which the associated linearized equations have turning point structure. A perturbation method is used to study the behavior of solutions branching from large eigenvalues.

85-1980
Secondary Bifurcation of Quasi-Periodic Solutions Can Lead to Period Multiplication
J.B. Grotberg, E.L. Reiss
Northwestern Univ., Evanston, IL 60201
SIAM J. Appl. Math., 45 (2), pp 169-174 (Apr 1985), 1 fig, 16 refs

KEY WORDS: Boundary value problems, Bifurcation theory

Perturbation and asymptotic methods are used to obtain the secondary bifurcation of quasi-periodic solutions from periodic solutions for a model problem. It is a two-cell model consisting of a coupled system of van der Pol-Duffing oscillators.

85-1981
Differential Methods in Inverse Scattering
A.M. Bruckstein, B.C. Levy, T. Kailath
Stanford Univ., Stanford, CA 94305
SIAM J. Appl. Math., 45 (2), pp 312-335 (Apr 1985), 4 figs, 51 refs

KEY WORDS: Wave scattering, Differential equations

A new set of differential methods for solving the inverse scattering problem associated with the propagation of waves in an inhomogeneous medium are discussed. By writing the medium equations in the form of a two-component system describing the interaction of rightward and leftward propagating waves, the causality of the propagation phenomena is exploited in order to identify the medium layer by layer.

85-1982
Finite Element Analysis of Nonlinear Oscillators
K. Krishnamurthy, T.D. Burton, L.D. Zeller
Washington State Univ., Pullman, WA
Intl. J. Numer. Methods Engrg., 21 (3), pp 409-420 (1985), 5 figs, 5 tables, 24 refs

KEY WORDS: Finite element technique, Nonlinear systems, Periodic response

A finite element method for the analysis of nonlinear oscillations which exhibit periodic response is presented. The basic idea of the method is to recast the initial value problem as a boundary value problem in which the domain (period) may be unknown.

85-1983
Maximum Likelihood Estimation of Seismic Impulse Responses
B. Holberg
Selskapet for Industriell og Teknisk Forskning, Norges Tekniske Hoegskole, Trondheim, Norway
Rept. No. STF28-A84003, 36 pp (Feb 1984), PB85-123008

KEY WORDS: Seismic excitation, Maximum likelihood method

A seismic trace is assumed to consist of a known signal pulse convolved with a reflection coefficient series plus a moving average noise process (colored noise). The method of maximum likelihood is used to estimate the reflection coefficients and the unknown noise parameters. If the reflection coefficients are known from well logs, the seismic pulse and the noise parameters can be estimated. When the further assumption is made that the noise is white, the method of maximum likelihood is equivalent to the method of least squares.

85-1984

Topological Analysis of a Class of Lumped Vibrational Systems by the Method of Structural Numbers

K. Arczewski
Technical Univ. of Warsaw, 00-665 Warszawa, UL. Nowowiejska 24, Poland

J. Sound Vib., 97 (1), pp 75-86 (Nov 8, 1984), 4 figs, 1 table, 8 refs

KEY WORDS: Lumped parameter method, Topological methods, Method of structural numbers

The method of structural numbers (MSN), which is a relatively new approach to the analysis of a class of lumped mechanical vibration systems is presented. In recent years the MSN has been substantially developed and, due to rapid progress in the fields of modification analysis, sensitivity analysis, synthesis and optimization, new areas of application of MSN have been revealed.

85-1985

The Bifilar Pendulum: Numerical Solution to the Exact Equation of Motion

B.E. Karlin, C.J. Maday
North Carolina State Univ., Raleigh, NC 27695-7910

J. Vib., Acoust., Stress, Rel. Des., Trans. ASME, 107 (2), pp 175-179 (Apr 1985) 14 figs, 4 refs

KEY WORDS: Pendulums, Equations of motion, Numerical methods

The bifilar pendulum is often used for indirect measurements of mass moments of inertia of bodies that possess complex geometries. The exact equation of motion of the bifilar pendulum is highly nonlinear, and has not been solved in terms of elementary functions. Extensive use has been made, however, of the linearized approximation to the exact equation, and it has been assumed that the simple harmonic oscillator adequately describes the motion of the bifilar pendulum. It is shown here that such is generally not the case. Numerical solutions to the exact nonlinear differential equations of motion are obtained for a range of values of initial angular displacement, filament length, and radius of gyration.

85-1986

Block Lanczos Method for Dynamic Analysis of Structures

B. Nour-Omid, R.W. Clough
Univ. of California, Berkeley, CA 94720

Earthquake Engrg. Struc. Dynam., 13 (2), pp 271-275 (Mar/Apr 1985) 2 refs

KEY WORDS: Lanczos method

The simple Lanczos method presented recently, with application to single vector loads, is extended to include a more general dynamic loading represented as a linear combination of k vectors (load patterns). The result is a set of orthogonal vectors that is used to transform the equations of motion to a banded form.

85-1987

A Note on Computing Elastodynamic Full Field Displacements Arising from Subsurface Singular Sources

J.M. Rice, M.H. Sadd
Univ. of Rhode Island, Kingston, RI 02881

Mech. Res. Comm., 11 (6), pp 385-390 (Nov/Dec 1984) 4 figs, 7 refs

KEY WORDS: Underground explosions, Green function

Elastodynamic problems in half-spaces subject to impulsive buried point loads or other sources is studied. These problems are directly related to fundamental singular solutions (i.e., Green's functions) for the half-space geometry. This paper is directed at developing a Green's function for a two-dimensional, isotropic half-space.

85-1988

On the Dynamics of Coupled Structures (Zur Dynamik gekoppelter Strukturen)

L. Gaul, B. Zastrau, S. Bohlen
Institut f. Mechanik, Hochschule der Bundeswehr Hamburg, Fed. Rep. Germany

Dynamische Probleme. Modellierung und Wirklichkeit. Proc. of a Meeting, Oct 4-5, 1984, Hannover, Curt-Risch-Institut der Universitat Hannover, Hannover, Fed. Rep. Germany, Vol. I, pp 45-68, 12 figs, 8 refs (In German)

KEY WORDS: Substructuring methods

The dynamic response of a complex structure is approximated from measured and calculated parameters of its substructures. Using measured or calculated modal parameters of the substructures the dynamics of the complete system are approximated. The coupled eigenvalue problem is bypassed. The changes in natural frequency, mode shape, and damping of the main system caused by the addition of supplementary system obtained by the method described are compared with the measurement and FEM results for the entire system. Nonlinear transfer properties of joints in the approximation method are handled on the basis of equivalent linearization.

85-1989

On the Solution of S(ω)x = 0 by a Newtonian Procedure

A. Simpson
Univ. of Bristol, Bristol BS8 1TR, UK

J. Sound Vib., 97 (1), pp 153-164 (Nov 8, 1984) 3 figs, 2 tables, 6 refs

KEY WORDS: Natural frequencies, Mode shapes

A method is developed for the solution of eigenvalue problems with symmetric matrices and a positive definite frequency constant. A dynamic stiffness matrix whose elements are transcendental functions of the radian natural frequency is allowed. The method enables all natural frequencies and mode shapes across a prescribed frequency range to be determined infallibly and in ascending frequency order at a speed approaching twice that associated with bisection and sing counting methods. It is ideally suited for use on micro- and minicomputers where single precision working is the norm. Much larger problems, of course, may be dealt with on mainframe machines.

MODELING TECHNIQUES

85-1990

Contributions to the Finite Element Solution of the Fan Noise Radiation Problem

W. Eversman, A.V. Parrett, J.S. Preisser, R.J. Silcox
NASA Langley Res. Ctr., Hampton, VA

J. Vib., Acoust., Stress, Rel. Des., Trans. ASME, 107 (2), pp 216-223 (Apr 1985) 7 figs, 13 refs

KEY WORDS: Fans, Sound waves, Wave radiation, Finite element technique

The radiation of fan generated noise to the far field from a nacelle of realistic geometry is investigated using the finite element method. Several innovations have been introduced to minimize the computational requirements and create a highly efficient numerical scheme.

85-1991

Correction of a Mathematical Model of a Vibrating Structure from Measured Natural Frequencies (Korrektur des Rechenmodells einer schwingungsfahigen Konstruktion aus gemessenen Eigenfrequenzen)

R. Poppel
Mahrenholtz & Partner, Ingenieurburo f. Maschinendynamik, Hannover, Fed. Rep. Germany

Dynamische Probleme. Modellierung und Wirklichkeit. Proc. of a Meeting, Oct 4-5, 1984, Hannover, Curt-Risch-Institut der Universitat Hannover, Hannover, Fed. Rep. Germany, Vol. II, pp 479-496, 8 figs, 2 tables, 6 refs (In German)

KEY WORDS: Mathematical models

For the description and calculation of the dynamic response of a structure under various loads a mathematical model of the system is needed. An identification algorithm is presented which enables to correct the mathematical model from the known natural frequencies in such a way that the difference between the calculated and measured frequencies becomes minimal. This is attained through determination of the weighting factors for the element matrices. The Sauss-Newton method is used.

85-1992
Mathematical Modeling in Dynamics (Modelle der Technischen Dynamik)
W. Schiehlen
Institute B. f. Mechanik, Universitat Stuttgart, Fed. Rep. Germany
Dynamische Probleme. Modellierung und Wirklichkeit. Proc. of a Meeting, Oct 4-5, 1984, Hannover, Curt-Risch-Institut der Universitat Hannover, Hannover, Fed. Rep. Germany, Vol. I, pp 31-44, 8 figs, 3 refs (In German)

KEY WORDS: Mathematical models

The method of multibody systems, finite element technique, and the method of continuous systems for dynamic modeling of structures are described and illustrated by simple examples.

85-1993
A Time Varying AR Coefficient Model for Modelling and Simulating Earthquake Ground Motion
W. Gersch, G. Kitagawa
Univ. of Hawaii, Honolulu, Hawaii 96822
Earthquake Engrg. Struc. Dynam., 13 (2), pp 243-254 (Mar/Apr 1985) 5 figs, 21 refs

KEY WORDS: Earthquake simulation, Mathematical models

A smoothness priors-time varying autoregressive (AR) coefficient model method for the modeling of earthquake ground motion is shown. The method yields the instantaneous smoothed values of the AR coefficients and the instantaneous smoothed values of the innovations variance. These results in turn yield estimates of the instantaneous spectral density, the time varying covariance function and a simulation model for the ground motion data.

NONLINEAR ANALYSIS

85-1994
Comparison of Free Component Mode Synthesis Techniques Using MSC/NASTRAN
D.R. Martinez, D.L. Gregory
Sandia National Labs., Albuquerque, NM
Rept. No. SAND-83-25, 25 pp (June 1984)
DE84014451

KEY WORDS: Component mode synthesis, Computer programs

MSC/NASTRAN was used to compare three techniques of component mode synthesis (CMS) using free modes. A free-free beam model was analyzed by the three methods and compared to the finite element results for the entire beam. The three CMS techniques use different combinations of assumed displacement vectors.

STATISTICAL METHODS

85-1995
On the Role of Dynamic Stochastic Processes in Reliability Theory (Ober die Rolle stochastisch dynamischer Prozesse in der Zuverlässigkeitstheorie)
H. Grundmann, G.I. Schueller
Technische Universitat Munchen, Fed. Rep. Germany
Dynamische Probleme. Modellierung und Wirklichkeit. Proc. of a Meeting, Oct 4-5, 1984, Hannover, Curt-Risch-Institut der Universitat Hannover, Hannover, Fed. Rep. Germany, Vol. I, pp 233-260, 6 figs, 25 refs (In German)

KEY WORDS: Stochastic processes

Using examples from structural and machine industry the need for a theoretical treatment of stochastic processes in dynamics is illustrated. The classical power spectrum theory with its assumptions is described.

85-1996
Failure Probability of Dynamic Systems Caused by Damage Accumulation (Versagenswahrscheinlichkeit dynamischer Systeme bei Schadensakkumulation)
E. Grossmann, R. Rackwitz
Technische Universitat Munchen, Fed. Rep. Germany
Dynamische Probleme. Modellierung und Wirklichkeit. Proc. of a Meeting, Oct 4-5, 1984, Hannover, Curt-Risch-Institut der Universitat Hannover, Hannover, Fed. Rep. Germany, Vol. I, pp 281-302, 24 refs (In German)

KEY WORDS: Statistical analysis, Fracture properties, Reliability, Crack propagation

A dynamic system under Gaussian excitation, whose components become damaged over a period (scalar damage), is investigated.

PARAMETER IDENTIFICATION

85-1997
Experimental Determination of Stiffness and Inertia Coefficients of Torsional Elements (Experimentelle Ermittlung der Steifigkeits- und Tragheitskoeffizienten von Torsionselementen)
R. Nordmann, P. Schibinger, M. Keim
Universitat Kaiserslautern, Fed. Rep. Germany
Dynamische Probleme. Modellierung und Wirklichkeit. Proc. of a Meeting, Oct 4-5, 1984, Hannover, Curt-Risch-Institut der Universitat Hannover, Hannover, Fed. Rep. Germany, Vol. II, pp 455-478, 11 figs, 3 refs (In German)

KEY WORDS: Torsional vibration, System identification technique

A method of system identification for experimental determination of stiffness and inertia parameters of complicated torsional elements is presented.

85-1998
The Application of Shifted Legendre Polynomials to Time-Delay Systems and Parameter Identification
Rong-Yeu Chang, Maw-Ling Wang
National Tsing Hua Univ., Hsinchu, Taiwan, Rep. of China
J. Dynam. Syst., Meas. Control, Trans. ASME, 107 (1), pp 79-85 (Mar 1985) 1 fig, 1 table, 18 refs

KEY WORDS: Parameter identification technique, Time-delay systems

A linear time-delay state equation is solved by the proposed shifted Legendre polynomials method. The parameter identification of such a system with time delay is also studied.

85-1999
The Identification of Mechanical Systems (Zur Identifikation mechanischer Systeme)
H.G. Natke
Curt-Risch-Institut f. Dynamik, Schall- und Messtechnik, Universität Hannover, Callinstr. 32, 3000 Hannover 1, Fed. Rep. Germany
Dynamische Probleme. Modellierung und Wirklichkeit. Proc. of a Meeting, Oct 4-5, 1984, Hannover, Curt-Risch-Institut der Universität Hannover, Hannover, Fed. Rep. Germany, Vol. II, pp 417-440, 1 fig, 31 refs (In German)

KEY WORDS: System identification

In the dynamically complicated linear elastomechanical system the mathematical model belongs to a priori knowledge. Methods for linear systems are discussed using their mathematical models. The identification method is based on the excitation and response measurement and on measured natural frequencies.

COMPUTER PROGRAMS

85-2000
Vibration Analysis of Frame and Cable-Stayed Footbridges by 'VAFCAF'

J.T. Cheung
Transport and Road Research Lab., Crowthorne, England
Rept. No. TRRL/SR-824, 36 pp (1984)
PB85-116788/GAR

KEY WORDS: Computer programs, Vibration analysis, Finite element technique, Cable stayed structures, Frames

The computer program VAFCAF has been developed; it is based on the finite element method and is intended for use in analyzing the behavior of cable-stayed footbridges, continuous beams and plane frames. The Timoshenko beam element has been incorporated into the program.

85-2001
Finite Element Analysis on Your PC
K. Blakely, B. Lahey, D. McLean
MacNeal-Schwendler Corp., Los Angeles, CA
S/V, Sound Vib., 19 (1), pp 26-32 (Jan 1985) 20 figs, 3 tables, 2 refs

KEY WORDS: Computer programs, Finite element technique

An overview of MSC/pal, a PC program for three-dimensional static and dynamic finite element analysis is presented. Several examples show that meaningful stress and vibration analyses can be performed with a personal computer, benefiting structural analysts, designers, and testers.

85-2002
The Dynamic Duo: Dram and Adams
G. Dawson
Mechanical Dynamics, Inc., Ann Arbor, MI
Computers Mech. Engrg., 3 (5), pp 20-24 (Mar 1985) 5 figs

KEY WORDS: Machines, Design techniques, Computer programs

The first general-purpose program to calculate the time response of multifreedom, constrained machinery undergoing large displacements -- DRAM (Dynamic Response of Articulated Machinery) -- is described. A second program ADAMS (Automated Dynamic Analysis of Mechanical Systems), designed as a three-dimensional, large-displacement dynamics program that could also handle kinematics and statics problems, is also described.

AUTHOR INDEX

ABSTRACT CATEGORIES

MECHANICAL SYSTEMS

Rotating Machines
Reciprocating Machines
Power Transmission Systems
Metal Working and Forming
Isolation and Absorption
Electromechanical Systems
Optical Systems
Materials Handling Equipment

STRUCTURAL SYSTEMS

Bridges
Buildings
Towers
Foundations
Underground Structures
Harbors and Dams
Roads and Tracks
Construction Equipment
Pressure Vessels
Power Plants
Off-shore Structures

VEHICLE SYSTEMS

Ground Vehicles
Ships
Aircraft
Missiles and Spacecraft

BIOLOGICAL SYSTEMS

Human
Animal

MECHANICAL COMPONENTS

Absorbers and Isolators
Springs
Tires and Wheels
Blades
Bearings
Belts
Gears
Clutches
Couplings
Fasteners
Linkages
Valves
Seals
Cams

STRUCTURAL COMPONENTS

Strings and Ropes
Cables
Bars and Rods
Beams
Cylinders
Columns
Frames and Arches
Membranes, Films, and Webs
Panels
Plates
Shells
Rings
Pipes and Tubes
Ducts
Building Components

ELECTRIC COMPONENTS

Controls (Switches, Circuit Breakers
Motors
Generators
Transformers
Relays
Electronic Components

DYNAMIC ENVIRONMENT

Acoustic Excitation
Shock Excitation
Vibration Excitation
Thermal Excitation

MECHANICAL PROPERTIES

Damping
Fatigue
Elasticity and Plasticity
Wave Propagation

EXPERIMENTATION

Measurement and Analysis
Dynamic Tests
Scaling and Modeling
Diagnostics
Balancing
Monitoring

ANALYSIS AND DESIGN

Analogs and Analog Computation
Analytical Methods
Modeling Techniques
Nonlinear Analysis
Numerical Methods
Statistical Methods
Parameter Identification
Mobility/Impedance Methods
Optimization Techniques
Design Techniques
Computer Programs

GENERAL TOPICS

Conference Proceedings
Tutorials and Reviews
Criteria, Standards, and Specifications
Bibliographies
Useful Applications

CALENDAR

1985

OCTOBER

2-4 International Acoustics Symposium, Pretoria, South Africa (Symposium Secretariat IRS, CSIR, P.O. Box 395, Pretoria 0001, South Africa)

6-8 Diesel and Gas Engine Power Technical Conference [ASME] West Middlesex, PA (ASME)

8-10 Lubrication Conference [ASLE/-ASME] Atlanta, GA (ASLE/ASME)

8-11 Stapp Car Crash Conference [SAE] Arlington, VA (SAE)

14-17 Aerospace Congress and Exposition [SAE] Los Angeles, CA (SAE)

20-24 Power Generation Conference [ASME] Milwaukee, WI (ASME)

22-24 14th Turbomachinery Symposium [Turbomachinery Labs.] Houston, TX (Dara Childs, Turbomachinery Labs., Dept. of Mech. Engrg., Texas A&M Univ., College Station, TX 77843)

22-24 56th Shock and Vibration Symposium [Shock and Vibration Information Ctr., Washington, D.C.] Monterey, CA (Dr. J. Gordan Showalter, Acting Director, SVIC, Naval Res. Lab., Code 5804, Washington, D.C. 20375-5000 - (202) 767-2220)

NOVEMBER

4-8 Acoustical Society of America, Fall Meeting [ASA] Nashville, TN (ASA)

11-14 Truck and Bus Meeting and Exposition [SAE] South Bend, IN (SAE)

17-22 American Society of Mechanical Engineers, Winter Annual Meeting [ASME] Miami Beach, FL (ASME)

24-26 Australian Acoustical Society Annual Conference, Leura, Australia (A. Lawrence, Graduate School, University of N.S.W., Box 1, Kensington, N.S.W. 2033, Australia)

DECEMBER

11-13 Western Design Engineering Show [ASME] Anaheim, CA (ASME)

1986

JANUARY

28-30 Reliability and Maintainability Symposium [ASME] Las Vegas, NV (ASME)

MARCH

5-7 Vibration Damping Workshop II [Flight Dynamics Laboratory of the Air Force Wright Aeronautical Labs.] Las Vegas, NV (Mrs. Melissa Arrajj, Administrative Chairman, Martin Marietta Denver Aerospace, P.O. Box 179, Mail Stop M0486, Denver, CO 80201 - (303) 977-8721)

24-27 Design Engineering Conference and Show [ASME] Chicago, IL (ASME)

APRIL

8-11 International Conference on Acoustics, Speech, and Signal Processing [Acoustical Society of Japan, IEEE ASSP Society, and Institute of Electronics and Communication Engineers of Japan] Tokyo, Japan (Hiroya Fujisaki, EE Department, Faculty of Engineering, University of Tokyo, Bunkyo-ku, Tokyo 113, Japan)

13-16 American Power Conference [ASME] Chicago, IL (ASME)

29-1 9th International Symposium on Ballistics [Royal Armament Research and Development Establishment] RMCS, Shrivenham, Wiltshire, UK (Mr. N. Griffiths, OBE, Head/XT Group, RARDE, Fort Halstead, Sevenoaks, Kent TN14 7BP, England)

MAY

12-16 Acoustical Society of America, Spring Meeting [ASA] Cleveland, OH (ASA Hqs.)

JUNE

3-6 Symposium and Exhibit on Noise Control [Hungarian Optical, Acoustical, and Cinematographic Society; National Environmental Protection Authority of Hungary] Szeged, Hungary (Mrs. Ildiko Baba, OPAKFI, Anker koz 1, 1061 Budapest, Hungary)

4-6 Machinery Vibration Monitoring and Analysis Meeting [Vibration Institute] Las Vegas, NV (Dr. Ronald L. Eshleman, Director, The Vibration Institute, 101 W. 55th St., Suite 206, Clarendon Hills, IL 60514 - (312) 654-2254)

JULY

20-24 International Computers in Engineering Conference and Exhibition [ASME] Chicago, IL (ASME)

21-23 INTER-NOISE 86 [Institute of Noise Control Engineering] Cambridge, MA (Professor Richard H. Lyon, Chairman, INTER-NOISE 86, INTER-NOISE 86 Secretariat, MIT Special Events Office, Room 7-111, Cambridge, MA 02139)

24-31 12th International Congress on Acoustics, Toronto, Canada (12th ICA Secretariat, P.O. Box 123, Station Q, Toronto, Ontario, Canada M4T 2L7)

SEPTEMBER

14-17 International Conference on Rotordynamics [IFToMM and Japan Society of Mechanical Engineers] Tokyo, Japan (Japan Society of Mechanical Engineers, Sanshin Hokusei Bldg., 4-9, Yoyogi 2-chome, Shibuyak-ku, Tokyo, Japan)

22-25 World Congress on Computational Mechanics [International Association of Computational Mechanics] Austin, Texas (WCCM/TICOM, The University of Texas at Austin, Austin, TX 78712)

OCTOBER

5-8 Design Automation Conference [ASME] Columbus, OH (ASME)

5-8 Mechanisms Conference [ASME] Columbus, OH (ASME)

19-23 Power Generation Conference [ASME] Portland, OR (ASME)

20-22 Lubrication Conference [ASME] Pittsburgh, PA (ASME)

NOVEMBER

30-5 American Society of Mechanical Engineers, Winter Annual Meeting [ASME] San Francisco, CA (ASME)

CALENDAR ACRONYM DEFINITIONS AND ADDRESSES OF SOCIETY HEADQUARTERS

AHS American Helicopter Society
1325 18 St. N.W.
Washington, D.C. 20036

AIAA American Institute of Aeronautics and Astronautics
1633 Broadway
New York, NY 10019

ASA Acoustical Society of America
335 E. 45th St.
New York, NY 10017

ASCE American Society of Civil Engineers
United Engineering Center
345 E. 47th St.
New York, NY 10017

ASLE American Society of Lubrication Engineers
838 Busse Highway
Park Ridge, IL 60068

ASME American Society of Mechanical Engineers
United Engineering Center
345 E. 47th St.
New York, NY 10017

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

ICF International Congress on Fracture
Tohoku University
Sendai, Japan

IEEE Institute of Electrical and Electronics Engineers
United Engineering Center
345 E. 47th St.
New York, NY 10017

IES Institute of Environmental Sciences
940 E. Northwest Highway
Mt. Prospect, IL 60056

IMechE Institution of Mechanical Engineers
1 Birdcage Walk, Westminster
London SW1, UK

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

INCE Institute of Noise Control Engineering
P.O. Box 3206, Arlington Branch
Poughkeepsie, NY 12603

ISA Instrument Society of America
67 Alexander Dr.
Research Triangle Pk., NC 27709

SAE Society of Automotive Engineers
400 Commonwealth Dr.
Warrendale, PA 15096

SEE Society of Environmental Engineers
Owles Hall, Buntingford, Hertz.
SG9 9PL, England

SESA Society for Experimental Mechanics (formerly Society for Experimental Stress Analysis)
14 Fairfield Dr.
Brookfield Center, CT 06805

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

SPE Society of Petroleum Engineers
6200 N. Central Expressway
Dallas, TX 75206

SVIC Shock and Vibration Information Center
Naval Research Laboratory
Code 5804
Washington, D.C. 20375-5000

U.S. GOVERNMENT PRINTING OFFICE: 19[illegible]

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:

Milda Z. Tamulionis
Research Editor
Vibration Institute
101 W. 55th Street, Suite 206
Clarendon Hills, Illinois 60514

DEPARTMENT OF THE NAVY

NAVAL RESEARCH LABORATORY, CODE 5804
SHOCK AND VIBRATION INFORMATION CENTER
Washington, DC 20375-5000

DEFENSE DOCUMENTATION CENTER
CAMERON STATION
ALEXANDRIA, VA 22314

THE SHOCK AND VIBRATION DIGEST

Volume 17, No. 9 September 1985