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THE SHOCK AND VIBRATION DIGEST

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Dr. R.L. Eshleman
Vibration Institute
Suite 206
101 West 55th Street
Clarendon Hills, Illinois 60514

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SVIC NOTES

Many dynamics problems require the use of repetitive numerical calculations for their solution. In the past analysts were limited to a choice between tedious hand computations, aided by a desk calculator, or the digital computer for solving these problems. This has changed. The same advances in the electronics technology that have made it possible to build more powerful digital computers have also led to the development of calculating devices with a broad range of capabilities. Thus it might be possible to match the size of the problem to the capability of the calculating device.

The pocket programmable calculator is one of the less powerful calculating devices that is available, nevertheless it is a useful tool for solving certain types of dynamics problems in spite of some limitations. First these calculators are programmed in their own machine language by keying in functions or numbers, and because their programming is machine dependent, programs that are written for one brand of calculator cannot be run on a different brand unless they are modified. The second limitation is related to the previously discussed keystroke method for programming. Some users may find that the process of keying in and de-bugging a program is tedious, especially if a large number of programming steps are necessary. This limitation is even more severe if the calculator doesn't have provisions for storing programs that will be used repeatedly.

The programmable calculator has advantages that tend to outweight its limitations. It can be faster and more cost effective when it is used as a tool for numerical solutions of smaller and less complex dynamics problems, where closed form solutions either don't exist or are cumbersome to obtain. Typical situations might involve preliminary designs or cases where simplified analyses are performed in an attempt to understand the influence of certain variables on the behavior of systems. The "hands on" aspect of computations for small problems is another advantage. This means that the analyst can monitor the results of the computations, as they proceed, and verify their validity. If errors show up in the results, the analysis or in the program they can be detected and corrected in a more timely manner. Because it is portable the programmable calculator is very handy for solving small dynamics problems in the field when access to a digital computer isn't available.

As I pointed out in the beginning, repetitive numerical calculations are used to solve many dynamics problems. The determination of the mode shapes and natural frequencies of multi degree of freedom spring-mass systems is a good example and several numerical calculation techniques are available for use with programmable calculators. The size or the capability of the programmable calculators that might be used to solve these problems is not an important consideration because at least one model is available that can be programmed to determine the natural frequencies and mode shapes of a lumped parameter model with 17 springs and masses. In my opinion nobody would consider running such a large problem on one of these calculators just from the labor and the tedium of keying in and de-bugging the program alone. In addition, its use would not be cost effective especially since more convenient alternative computing devices such as the small "home computer", minicomputers and, more recently, the pocket computer are available. All of these machines are more convenient because they can be programmed in some higher level language and because they are more convenient they might eventually make the programmable calculator obsolete. But when it is used within its limitations the programmable calculator is handy for solving certain shock and vibration problems.

R.H.V.

EDITORS RATTLE SPACE

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COMPUTERS AND MATHEMATICAL ANALYSIS

With the increasing availability of all sizes and types of computers (see DIGEST Volume 13, No. 2) and the evolution of practical numerical techniques, more engineers have turned to the computer as an aid in the design, development, manufacturing, and problem diagnosis and correction of equipment. It is heartening to see this powerful tool developed and used. For there were signs several years ago that computers would not be accepted. The fact that more complex problems can be solved faster increases productivity and competence.

It is satisfying to view the positive side of the computer acceptance, yet there is the fact that, as is true with any other tool, abuses exist. Engineers must realize the limitations of computers – most important is that they do not do the thinking. From computer-generated results must come engineering judgments and decisions.

Two major limitations in using the computer are the validity of input data and the possibility of computational error. Computer results are only as good as the input data. More work has gone into developing computational techniques than in obtaining physical data for modeling. Thus in many cases models of damping and/or excitation in vibration problems are at best approximations; vibration response calculations are therefore questionable. Each numerical technique has its limitations in roundoff error and numerical instability (which can be mistaken for mechanical instability). It is thus important that the engineer has some appreciation for the nature of the computational technique. "Check problems" sometime satisfy this requirement.

Many engineers generate endless volumes of computer data and get into the never-never land of numbers, thereby losing touch with the physics of the hardware. Computer-generated results should be related to a problem rather than provide an abstract answer.

Awareness of the proper use and capabilities of the computer would go a long way toward avoiding overblown expectations among new users and complacency among veterans. In my opinion the computer should be used as a tool to obtain processed data that will allow us to solve problems and make decisions on the basis of rational facts.

R.L.E.

AIRCRAFT CRASH DYNAMICS: SOME MAJOR CONSIDERATIONS

G. Wittlin*

Abstract. This article describes three major considerations in aircraft crash dynamics. The considerations are aircraft crash environments, available analytical methods, and occupant protection. The aircraft crash environment varies depending on aircraft size, configuration, and usage. Current crash design requirements for military and civil helicopters, small airplanes, and large airplanes are presented. Analytical modeling of crash behavior requires three levels of capability: simple, intermediate, and detailed. Brief descriptions of methods and reference simulations are provided. Occupant protection, which is the goal of the crash design effort, is related to a design in which the load capability of the various systems -- i.e., landing gear, airframe, seats, and occupants -- is compatible with the crash environment. Occupant protection is dependent on many crash-related factors.

It has often been said that aircraft are made to fly, not crash. The paramount concern in aircraft design is that the aircraft perform specified operations, or missions, safely and, in the case of commercial flying, economically. However, accidents do happen to all types of airplanes - commercial transports, general aviation craft, and military fixed-wing or rotary-wing aircraft. This article is a review of the post-crash behavior of structures. Crash dynamics involves different principles from those involved in normal operational design considerations. One fundamental difference between crash design and operational design is that the latter provides margins of safety in an effort to preclude attainment of ultimate strength capacity; crash design presumes that failure will occur. The task in a crash design is to channel the failures in a controlled manner so that energy is absorbed through strain, friction, damping, and crushing, thus minimizing hazards to an occupant. The elastic behavior of a structure and, to some extent its plastic behavior, has been well researched and documented. By contrast, little is known about large deformation behavior, particularly as it relates to the crash environment. This article briefly describes three areas of aircraft crash dynamics crash environment, analytical methods, and occupant protection.

CRASH ENVIRONMENT

The definition of the crash environment is essential before any aircraft crash dynamics capability can be ascertained. Unfortunately, no single crash environment is applicable to all aircraft. Size, speed, configuration, and operational aspects associated with aircraft influence the crash environment.

A review of crash design requirements for military and commercial aircraft reveals no universal definition of a survivable crash environment. The elements that describe a survivable crash environment can include descriptions of velocity envelopes, crash pulses, and crash load factors as well as crash impact sequence and airplane attitude and configuration at impact. For example, the U.S. Army defines the crash environment for rotary-wing and fixed-wing aircraft in terms of a survivable design envelope that specifies directional and combined impact velocities [1-3]. The Federal Aviation Administration (FAA), in its regulations for commercial aircraft [4-7], uses the term emergency landing conditions. By this is meant that the structure must be designed to protect each occupant and to provide each occupant every reasonable chance of escaping serious injury in a minor crash landing when proper use is made of seatbelts. The regulations specify a limit on the ultimate inertia forces the occupant and major mass items must withstand. In addition, various military specifications [8, 9] provide crash load factors for different systems, mass items, and equipment as a means of assuring crashworthiness design.

*Senior Research Specialist, Lockheed-California Company, Burbank, CA 91520

Rotary wing aircraft. The crash environment for helicopters differs substantially from that of airplanes. The crash environment for military helicopters as defined by 95th percentile survivable crash pulses in different directions was established for U.S. Army helicopters on the basis of 373 accidents that occurred between July 1960 and June 1965 [1]. In a recent update of the U.S. Army Crash Survival Design Guide [2] the recommended design environment was presented as the design pulse. Although the crash environments are identical to the historical 95th percentile survivable crash pulse, the U.S. Army recognizes that improved crashworthiness increases the severity of the survivable crash, thereby producing a never-ending increase in the level of crashworthiness at the expense of aircraft performance. The U.S. Army defines a survivable accident [2] as "an accident in which the forces transmitted to the occupant through his seat and restraint system do not exceed the limits of human tolerance to abrupt accelerations and in which the structure in the occupants' immediate environment remains substantially intact to the extent that a livable volume is provided for the occupants throughout the crash sequence." The U.S. Army further defines a survival envelope [2] as "the range of impact conditions -- including magnitude and direction of pulses and the duration of forces occurring in an aircraft accident -- wherein the occupiable area of the aircraft remains substantially intact, both during and following the impact, and the forces transmitted to the occupants do not exceed the limits of human tolerance when current state-of-the-art restraint systems are used."

Military Standard 1290 [3] defines such general requirements as design pulses (Table 1). U.S. Army design pulses are applicable to all aircraft in a given category (rotary wing or fixed wing) regardless of weight and operational requirements.

Current emergency landing requirements for civil helicopters are described in FAR 27.561 [6] and FAR 29.561 [7] for normal category and transport category rotorcraft, respectively. Maximum inertia forces relative to the surrounding structure that an occupant can experience are shown in Table 2. The supporting structure must also be designed to restrain, under any loads up to those shown in Table 2, any item of mass that could injure an occupant if it came loose in a minor crash landing.

General aviation airplanes. Light fixed-wing (general aviation) aircraft weighing ≤ 12,500 pounds operate at speeds up to 280 knots, carry 1 to 17 people, have one or two engines, and have a low- or high-wing configuration [10]. Aircraft of this type can be involved in stalls, ground collisions, and collisions with obstacles. Accidents have occurred on terrains that are flat (≈40%), rolling (≈22%), mountainous (≈11%), hilly (≈8%), or dense with trees

Table 1. Summary of Design Pulses for Rotary- and Light Fixed-Wing Aircraft

IMPACT DIRECTION	VELOCITY CHANGE (fps)	PEAK G*	AVERAGE G	PULSE DURATION "T" SECOND
Longitudinal (Cockpit)	50	30	15	0.104
Longitudinal (Passenger Compartment)	50	24	12	0.130
Vertical	42	48	24	0.054
Lateral (Fixed Wing)	25	16	8	0.097
Lateral (Rotary-Wing)	30	18	9	0.104

* Imposed at the floor level, near the center of gravity of the aircraft

Table 2. Summary of FAA Emergency Landing Requirements

DIRECTION	ULTIMATE INERTIA FORCES				
	FAR 23.561 (4)		FAR 25.561 (5)	FAR 27.561 (6)	FAR 29.561 (7)
	Small Airplanes				
	Normal Utility Category	Aerobatic Category	Transport Category Airplanes	Normal Category Rotorcraft	Transport Category Rotorcraft
Upward	3.0 g	4.5 g	2.0 g	1.5 g	1.5 g
Forward	9.0 g	9.0 g	9.0 g	4.0 g	4.0 g
Sideward	1.5 g	1.5 g	1.5 g	2.0 g	2.0 g
Downward	..	..	4.5 g (1)	4.0 g (2)	4.0 g (2)

(1) "Or any lessor force that will not be exceeded when the airplane absorbs the landing loads resulting from impact with an ultimate descent velocity of five f.p.s. at design landing weight."

(2) "Or any lower force that will not be exceeded when the rotorcraft absorbs the landing loads resulting from impact with an ultimate descent velocity of five f.p.s. at design maximum weight."

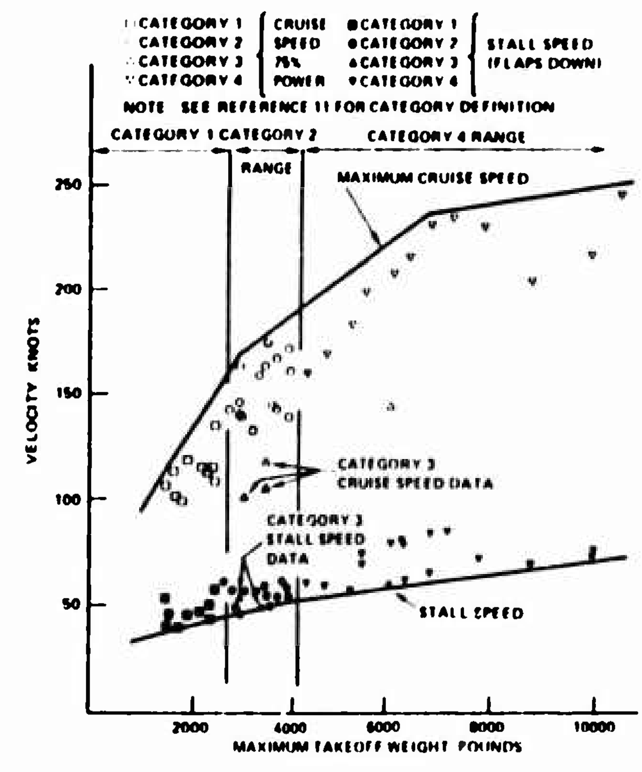

Figure 1. Operational Velocity Weight Envelope for Current General Aviation Airplanes [11]

(≈ 9%) and at airports (≈ 2%). Figure 1 [11] shows the operational velocity weight envelope for current general aviation airplanes.

Since the early 1970s NASA has performed a series of crash tests involving single-engine and twin-engine light fixed-wing aircraft at the NASA LaRC Impact Dynamics Research Facility. Several of these test sequences have been described [12-15]. The data from this series of tests can be utilized to define a general aviation airplane crash environment. In addition, the results of the FAA-sponsored study, utilizing CAMI* and NTSB* accident data, as well as four full-scale crash tests of single-engine, high-wing general aviation fixed-wing aircraft [11, 23], can provide valuable data regarding potential crash impact conditions.

The current emergency landing conditions for airplanes categorized as normal, utility, and acrobatic are described in FAR 23.561 [4]. The maximum inertia forces relative to the surrounding structure that an occupant can experience are shown in Table 2. Except as provided in P.23.787** [4], the supporting structure must be designed to restrain, under loads up to those shown in Table 2, each item of mass that could injure an occupant if it came loose in a minor crash landing.

Transport category airplanes. The current emergency landing conditions for Transport Category Airplanes are described in FAR 25.561 [5]. The maximum inertia forces, relative to the surrounding structure that occupants are to experience, are listed in Table 2. The supported structure must be designed to restrain, under all loads up to those shown in Table 2, each item of mass that could injure an occupant if it came loose in a minor crash landing.

Comparison of the survivable crash environment and the responses of the structures indicates significant differences between small and large airplanes. The survivable large transport accident usually occurs around airports at flight path velocities below 150 knots and vertical descent rates at impact of less than 20 feet per second. These conditions are normally associated with such landing and takeoff operations as landing short, overruns, and skidding off the runway. Such smaller aircraft as helicopters and general aviation airplanes have lower longitudinal velocities but higher vertical rates of descent that can be associated with accidents, they include stall/spin and emergency landings on unprepared terrain. The percentage of occupiable space in large transports greatly exceeds that of smaller aircraft. Furthermore, the occupants of small aircraft are much closer to the airframe/terrain impact point due to obvious airframe construction differences. A review of NTSB accident records [16] for the years 1964-1969 indicates that for 447 U.S. Air Carrier accidents during this period, 56% occurred during landing, taxi, and/or take-off operations; 37%, 7%, and 12% respectively. The types of accidents associated with transport aircraft during these phases of operation are given below.

Impact Condition	Accident Type
Severe Impact	Controlled Collision with Ground/Water Uncontrolled Collision with Ground/Water Undershoot Stall
Moderate-High Sink Speed	Hard Landing Gear Collapse Wheels-Up Retracted Gear
Low Sink Speed	Overshoot Swerve
Collisions with Obstacles	Trees Fence Approach Light

* ***CAMI, FAA Civil Aeromedical Institute, Okalhoma City, Oklahoma***
NTSB, National Transportation Safety Board, Washington, D.C.

** ***P.23.787(c) states "There must be means to protect the occupants from injury by the contents of any cargo compartment when the ultimate forward inertia forces is 4.5g".***

Transport aircraft accident data for the period 1959-1979 are being reviewed by the three major widebody airframe manufacturers, under FAA/NASA sponsorship [17] and with the assistance of NTSB and ICAO* organizations, for the purpose of developing survivable crash scenarios. These scenarios will include definitions of the following.

Impact Conditions	Airplane Configuration
Sink Speed	Weight
Forward Velocity	Cg
Airplane Attitude	Gear(s) Position
Terrain Description	Control Settings

For transport category aircraft, as with light fixed-wing airplanes, several categories are being considered based on weight, operational speed, and size.

ANALYTICAL METHODS

Prior to 1970 available analytical capability was limited for crash conditions involving large structural deformation. Methods and test data were seldom correlated. A popular approach in the 1960s was to perform full-scale crash tests [18, 19]. Obviously tests of this nature are extremely expensive, particularly as the test article increases in size. However, more significant than cost is the fact that the tests are not repeated and are highly dependent on test conditions and measurement selection, consequently, essentially one test parameter data set per test is available. In the late 1960s, as a result of expanding computer capability, more detailed models of aircraft structures became a reality. Such techniques as hybrid and finite element/difference approaches were used, and in a survey of analytical techniques, three levels of analyses were possible [20], as shown below.

Most of the simple capability programs are associated with automotive collision studies. The most prominent simple capability model used in aircraft crash analysis simulates the fuselage as rigid masses connected by nonlinear axial and rotary springs [21].

The most widely used intermediate hybrid program, KRASH, utilizes a three-dimensional arbitrary framework of point masses connected to beams to simulate airframe structure. KRASH has been correlated with test data on several occasions for various impact conditions (see Table 3). KRASH development, correlation, and usage has been comprehensively documented [11, 22-29]. The other intermediate capability programs use finite element computer codes. Two of these three-dimensional intermediate capability models have been described [30, 31] as has a two-dimensional intermediate capability model [32].

The detailed crash simulations are all three dimensional finite element codes capable of modeling stringers, beams, and such structural surfaces as skins and bulkhead panels. Several of these crash

Capability	Structural Models	Masses and Degrees-of-Freedom (DOF)	Geometry and Motions
Simple	Large structural assemblies modeled as single crash item	$\leq$ 10 masses $\leq$ 50 DOF	One- or two-dimensional
Intermediate	Structural assemblies modeled separately	$\leq$ 100 masses $\leq$ 500 DOF	Two- or three-dimensional
Detailed	Individual structural components	> 100 masses > 500 DOF	Three-dimensional

***ICAO, International Civil Aviation Organization, Montreal, Canada**

Table 3. KRASH Experimental Verification

Aircraft	Gross Weight (lbs)	Impact Velocities (ft/sec)		
		Vertical	Longitudinal	Lateral
Rotary Wing, Utility Type	8600	23	-	18.5
Single-Engine, High-Wing	2400	46	70	-
Single-Engine, High-Wing	2400	22	71.3	-
Single-Engine, High-Wing	2400	49	70	-
*Single-Engine, High-Wing	2400	43	69.5	-
Twin-Engine, Low-Wing Substructure	545	27.5		-
Rotary-Wing, Cargo Type	24,300	42	27.1	-

*Test performed on soil; all other tests on rigid surface

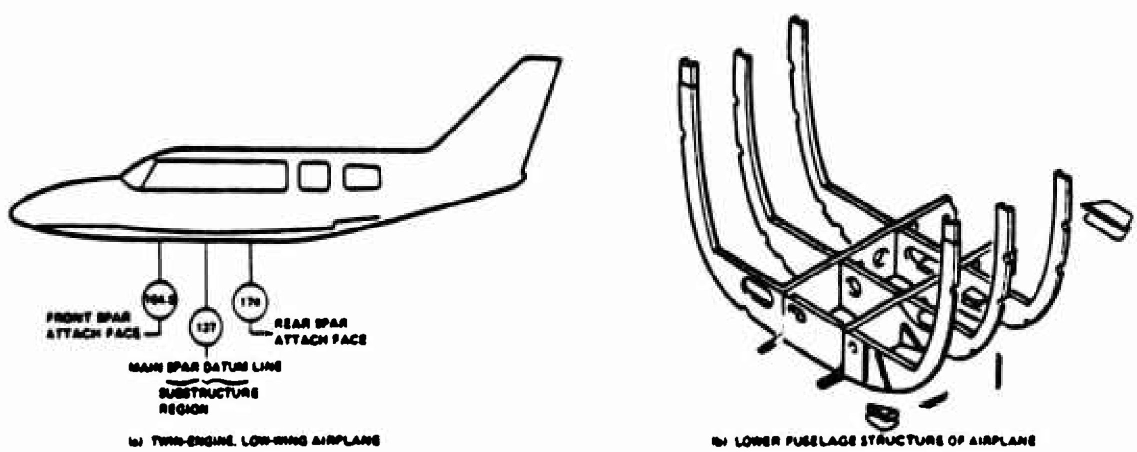

Figure 2. Piper-Navajo Substructure

simulations WHAM [33], WRECKER [34], ACTION [35], and DYCAST [36] are available in various stages of development.

A recent comparison of the use of DYCAST, ACTION, and KRASH has been published [37]. A Piper NAVAJO substructure (Figure 2) was modeled by each method using the same computer. The structure analyzed was a typical twin-engine, low-wing airplane, the section extended from fuselage stations 134 to 181 and included the two passenger seats behind the crew. The section was drop-tested at the NASA LaRC Impact Dynamics Research Facility. The total weight of the specimens, including two 165 lb dummies, was 545 lbs. The test article impacted the ground with a 27.5 ft/sec vertical velocity.

Figures 3, 4 and 5 show some comparative responses for KRASH, DYCAST, and ACTION with test data. Quantitative results for the particular substructure and impact condition analyzed by the three methods were comparable for the primary outboard floor acceleration magnitudes and times of occurrence. KRASH results were closer to test results for primary floor inboard and occupant pelvic accelerations than were results with DYCAST or ACTION. The finite element models and solution method were two orders of magnitude higher in cost than the lumped mass hybrid approach (see Table 4). Thus, there is an economic advantage to the use of a hybrid model to study gross vehicle response, design trends, structural design, and impact parameters, the finite element techniques are useful for detailed component behavior.

Some of the techniques currently in use, although directly applicable to small general aviation aircraft, are not always appropriate for large widebody aircraft. Small aircraft involved in crashes tend to deform along the entire airframe so that the crash environment for all occupants can be similar. However, in many instances larger aircraft experience only local deformation; the crash environment for the occupants can thus vary drastically, depending on the individual's proximity to the impact. In addition, many large airplane accidents occur around airports and in a manner that allows the pilot to exercise such control as spoiler, rudder, aileron, and/or thrust reversal to minimize post-impact damage. Small aircraft accidents generally occur away from airports, and the pilot has less influence

Table 4. Cost Comparison of KRASH, ACTION, and DYCAST

Program	(a) CPU Time Per .01 Sec Response	(b) $ Cost Per .01 Sec Response
KRASH	76.34	9.44
ACTION	874.46	$963.00
DYCAST	1861.06	$790.00

(a) CYBER 175 computer at NASA Langley

(b) Based on cost algorithm at NASA Langley

on post-impact consequences. Selection of the crash analysis technique also depends on the intended purpose. Objectives of crash analysis include:

- preliminary design
- detailed design
- quantitative vs qualitative assessment
- trend studies
- sensitivity evaluation

OCCUPANT PROTECTION

The generally accepted goal of a satisfactory crash design is one in which

- the occupant experiences crash forces that are below human tolerance limits
- the occupant is protected from lethal blows
- the occupiable volume remains sufficiently intact to allow the occupants every reasonable chance of survival
- safe post-crash egress is provided

The ultimate crash design concern is the occupant. The protection of the occupant is related to the ability of the structure to absorb energy during deformation. The landing gear, airframe, floor structure, seats, and restraints could be involved in a particular crash consideration. Consequently, to some degree, it can be said that consistency in design is required. For example, the design of a seat system to transmit loads in excess of the human tolerance to withstand loads might not be satisfactory. Nor would it be satisfactory to design the seat substantially

Table 5. Summary of General Aviation Airplane Crash Test Impact Conditions

	Test Number*			
	2	3	4	5
Impact Velocities (MPH)				
Along Flight Path	55.5	50.8	58.1	55.9
Longitudinal	47.4	48.6	47.6	48.4
Vertical	28.7	14.8	33.2	31.9
Angles (Degrees)				
Flight Path (γ)	-30.72	-17	-34.86	-32.
Impact (θ)	-30.17	13.5	-39.4	-34.8
Attack (α)	.57	+30.5	-4.54	-2.8
Roll (ϕ)	+4.13	+3.25	+18.75	< 1.0
Yaw (ψ)	-3.27	-11.5	-7.9	< 1.0
Rotational Velocities (Deg/Sec)				
Pitch ($\dot{\theta}$)	46.4	6.9	14.3	18.2
Roll ($\dot{\phi}$)	Negligible	Negligible	Negligible	Negligible
Yaw ($\dot{\psi}$)	Negligible	Negligible	Negligible	Negligible

γ is negative in dive
$\theta, \dot{\theta}$ are positive nose up relative to ground
α is positive nose up relative to flight path
$\phi, \dot{\phi}$ are positive right wing down
$\psi, \dot{\psi}$ are positive tail left
and $\theta = \gamma + \alpha$
Ft/Sec = 1.467 x MPH

*See Table 3 for Test Article Description

stronger than the capability of the airframe that supports the seat because seat strength would not be utilized if the supporting structure collapsed around it. The crash design of aircraft is dependent on the following considerations:

- location, direction, and magnitude of impact
- load path to occupant
- aircraft configuration
- structural systems involved
- failure modes and energy absorption capability of the structure
- terrain and surroundings

A series of crash tests of a general aviation single-engine, high-wing aircraft under different impact

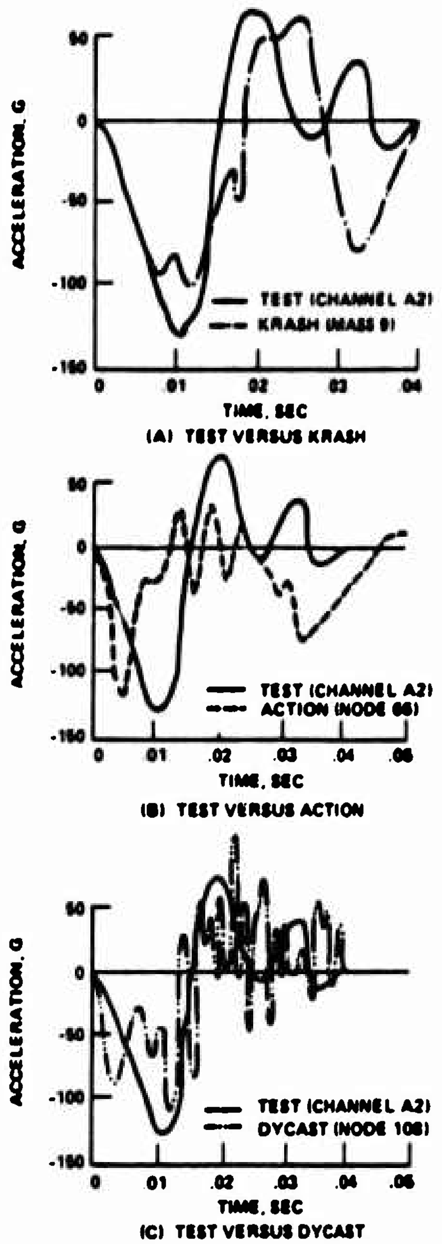

Figure 3. Comparison of Fuselage Floor Outboard Vertical Accelerations, F.S. 151

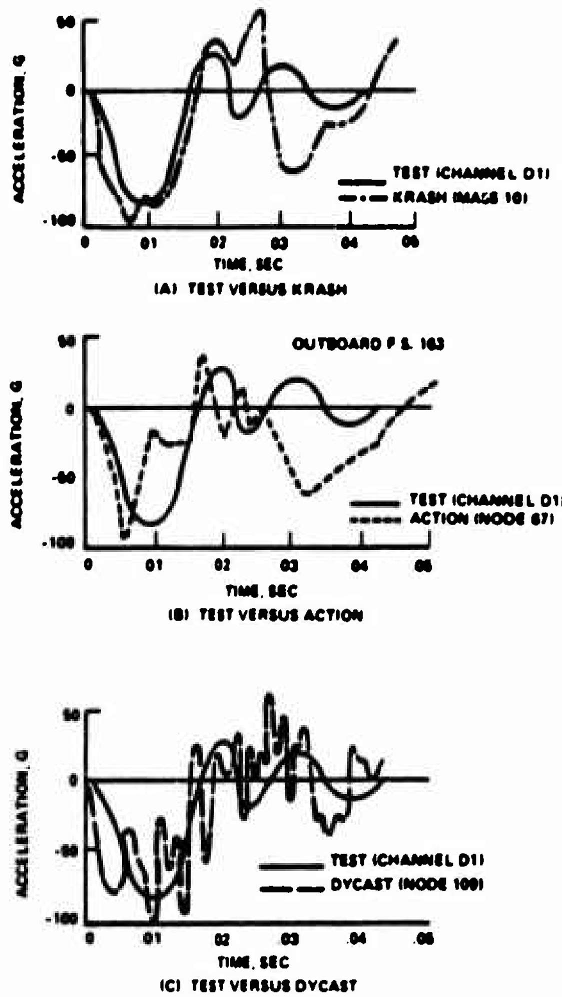

Figure 4. Comparison of Fuselage Floor Outboard Vertical Accelerations, F.S. 163

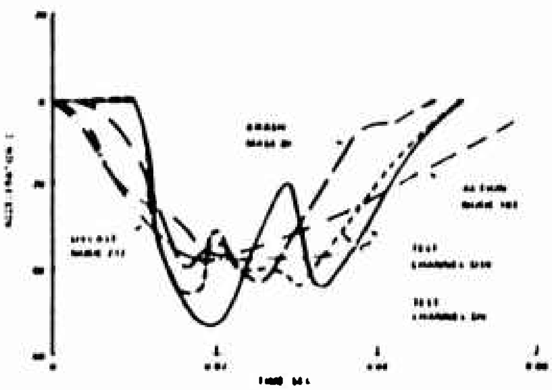

Figure 5. Comparisons of Occupant Pelvis Vertical Accelerations, Test vs Analysis

conditions resulted in different structural damage and potential for occupant injury. The impact conditions and post crash damage for this series of tests [20] are shown in Table 5 and Figure 6, respectively. Test results, analytic results, and correlation between test and analysis have been documented [20].

CONCLUSIONS

The definition of the crash environment is the first step in assessing aircraft crash dynamics. The crash environment is not the same for different classes of aircraft primarily due to differences in size, weight, configuration, operational modes and speeds, and terrain.

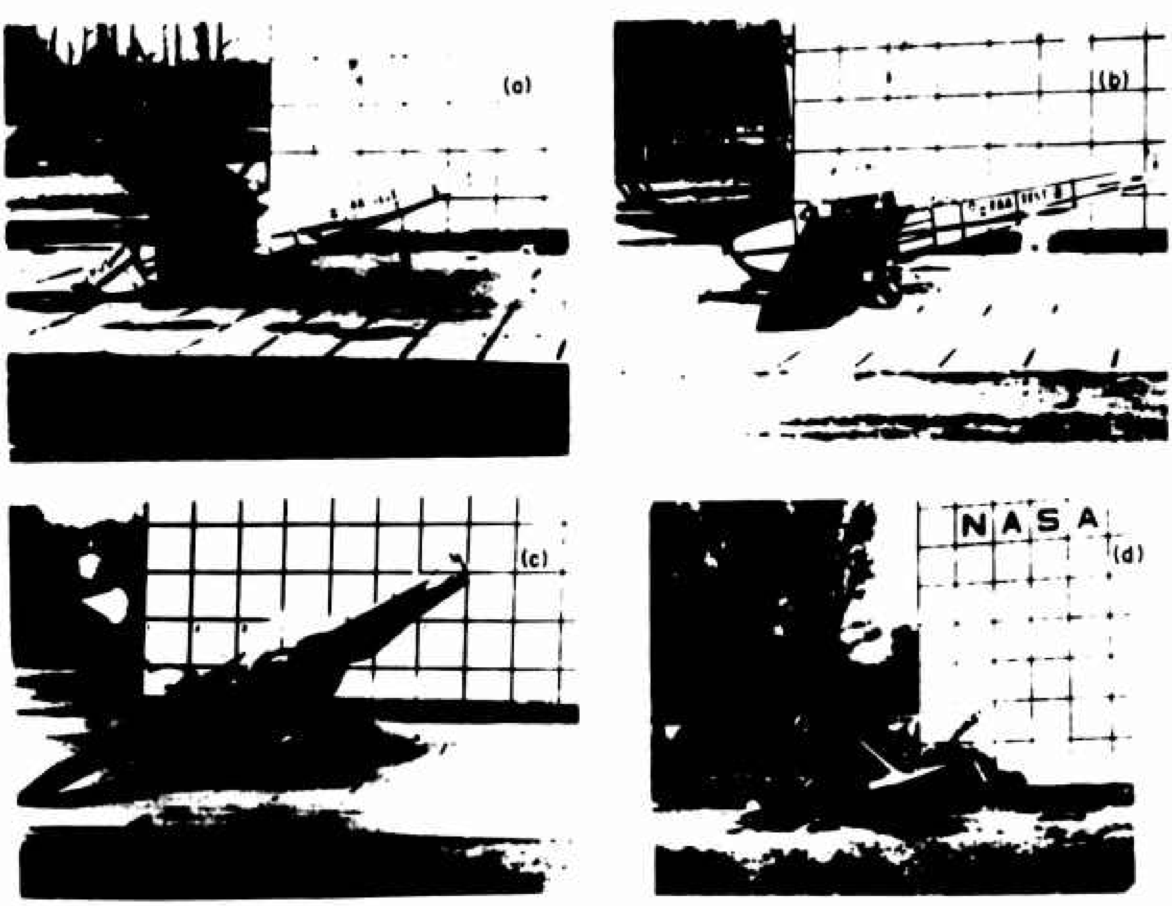

Figure 6. Post Impact Views of Full-Scale Crash Test Specimen

Analytical programs in various stages of development and usage are available. Hybrid and finite element techniques are the most popular approaches. The results of hybrid methods, particularly KRASH, have been substantially correlated with test data. Finite element methods offer the potential for more detail analysis but require further verification and can be expected to be two orders of magnitude more costly to run than hybrids.

The safety of the occupant is the most important concern in crash analysis of aircraft. Occupant safety can be evaluated with regard to loads, restraint of movement, surrounding structural integrity, and unimpaired egress. The optimum design for occupant safety requires consistency in design to ensure that the capability of the various systems – landing gear, airframe, floor, seat and attachments, and restraint systems – is compatible and cost-effective.

Other significant crash-related areas have not been discussed in this article, e.g., post-crash fires contribute significantly to injuries and fatalities in aircraft accidents. Crashworthy fuel cells have helped reduce post-crash injuries and fatalities in military helicopters. Reduction of the post-crash fire hazard is being investigated for transport category aircraft. The development of anti-misting fuels would be an important method for resolving this hazard [38]. Human tolerance is certainly a factor in evaluating occupant survivability. This complex subject is still being researched. The basis for current tolerance levels has been described [39]. Related to human tolerance are seat models and biomedical modeling and simulation, these are in various stages of development and checkout [40]. Verified models could be useful in assessing occupant response and injury potential.

Crash dynamics is a broad subject encompassing many areas. The 1975 aircraft crashworthiness symposium [41] provides excellent insight into the research that has been conducted in this and related fields.

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

The monthly Literature Review, a subjective critique and summary of the literature, consists of two to four review articles 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.

This issue of the DIGEST contains an article about impedance methods for machine analysis.

Dr. M. Massoud of the University of Sherbrooke, Sherbrooke, Quebec, Canada has written a follow-up of an earlier review in which basic definitions, mathematical background, and test procedures of the impedance of mechanical systems were given. The present review is restricted to literature published from 1977 to the present. The impedance of acoustical phenomena associated with mechanical systems is emphasized.

IMPEDANCE METHODS FOR MACHINE ANALYSIS

M. Massoud*

***Abstract** - This paper is a follow-up of an earlier review in which basic definitions, mathematical background, and test procedures of the impedance of mechanical systems were given. The present review is restricted to literature published from 1977 to the present. The impedance of acoustical phenomena associated with mechanical systems is emphasized.*

Impedance measurements still provide the basis for most test techniques for system identification purposes. These transfer functions measurements, known as mechanical impedance, mobility, and admittance, express the complex ratio of the force acting on a specified area of the mechanical device to the resulting response (displacement, velocity, or acceleration) on the same area (point value) or any other area. The mechanical impedance Z of a linear component excited by a sinusoidal force is given by

$$(\dot{X}) = [Z]^{-1}\ (F)$$

where $[Z] = [\alpha + j\omega]\ [M] + [\beta + \frac{1}{j\omega}]\ [K]$ and, $(\dot{X})$ is the velocity, (F) is the force, [M] is the mass matrix, and [K] is the stiffness matrix. The damping matrix is expressed as $[C] = \alpha\ [M] + \beta\ [K]$.

Impedance methods have been used in the past only for vibration analysis purposes. However, current emphasis on noise pollution resulting from mechanical components, including effects on the environment and public health, has promoted interest in the study of energy radiation from machines, ducts, and vibrating surfaces. Impedance measurements have thus been extended to this important area. This review describes basic defintions and contains a general survey of recent applications of impedance methods in traditional mechanical fields. Sample references for these applications are given.

IMPEDANCE IN AN ACOUSTIC MEDIUM

The impedance Z, in the context of acoustic phenomena, has a definition parallel to that of mechanical impedance; the force is replaced by a sound pressure $p(N/m^2)$ and the linear velocity by a particle velocity u(m/s) or a volume velocity $u(m^3/s)$. In the special case of plane-wave sound propagation, the time dependence of sound pressure is the same as the time dependence of particle velocity; no phase difference exists between the two quantities at any point in the wave.

$$Z_s = \frac{p}{u} = \rho\, C \quad N\text{-}sec/m^3 \quad (\text{mks rayls})$$

where ρ C is sometimes called the characteristic resistance, ρ is the density of the medium, and C the speed of sound in the medium. In general, however, for linear acoustical phenomena in the steady state, a time difference in the time functions of sound pressure and the velocity leads to a phase difference of one relative to the other, and the impedance is given by a complex ratio. Impedance types common in acoustics have been given [2]. They include:

i) Specific Acoustic Impedance Z_s: the complex ratio of the sound pressure $p(N/m^2)$ at a point of an acoustic medium or mechanical device to the particle velocity at that point u(m/sec)

$$Z_s = \frac{p}{u} \quad N \cdot sec/m^3 \quad (\text{mks rayls})$$

ii) Acoustic Impedance Z_A, or acoustic impedance at a given surface: the complex ratio of sound pressure $p(N/m^2)$, averaged over the surface, to volume velocity $u(m^3/s)$ through it. The surface can be either a hypothetical surface in

*Professor, Mechanical Engineering Dept., Faculty of Applied Sciences, University of Sherbrooke, Sherbrooke, Quebec, Canada

an acoustic medium or the moving surface of a mechanical device.

$$Z_A = \frac{p}{u}\ \text{N}\cdot\text{sec/m}^5 \quad \text{(mks acoustic ohms)}$$

iii) Normal Specific Acoustic Impedance Z_{sn}, or unit-area acoustic impedance the complex ratio of the sound pressure p to the normal component of the particle velocity u_n at the boundary between air and a denser medium such as a porous material or a large number of small-diameter tubes packed side by side.

$$Z_{sn} = \frac{p}{u_n}\ \text{N}\cdot\text{sec/m}^3 \quad \text{(mks rayls)}$$

iv) Characteristic Impedance Z_o term used to describe the acoustical properties of porous materials used for the purpose of attenuating sound propagating in ducts and mufflers or for improving sound-transmission loss through acoustical barriers. The definition of characteristic impedance is given in terms of a complex characteristic resistance (ρC) involving the density of the porous material and the complex speed of sound in the porous medium, including the dissipation during propagation. The following is an empirical power law approximation for Z_o.

$$Z_o = R + J\,X$$

where,

$$R = \rho C\,[1 + 0.0571(\rho f/R_1)^{-0.754}]$$

$$X = -\rho C\,[0.0870(\rho f/R_1)^{-0.732}]$$

and, R_1 (flow resistance) $= \frac{\Delta p}{\ell u}$, Δp is the applied air pressure differential measured between the two sides of a layer of thickness ℓ, u is the particle velocity through the layer, and f is a function of the material characteristics.

The complex admittance is the reciprocal of complex impedance. The choice between them sometimes depends upon whether the amplitude of the pressure or the velocity is held constant during a measurement.

ACOUSTIC APPLICATIONS

An important consideration remains improving the measurements of acoustic impedance. The two microphones method for measuring impedance has been studied [3, 4] as has the effect of random and systematic errors associated with certain types of measurements [5]. A new approach for measuring impedance as related to brass instruments has been described [6]. One impedance measurement method emphasizes the lower frequencies as applied to a two-cylinder refrigeration compressor discharge system [7]. Measurements using sine-sweep excitation with known volume velocity have been reported [8]. Tests with constant-velocity sources excited with a constant force shaker were conducted [9] to evaluate the effects of waveguides. A new technique to record mechanical compliance of structure by holographic interferences has been suggested [10].

Special attention is usually given to porous materials for sound isolation purposes, and impedance values of various types of porous liners have been studied [4, 11]. Ducts and tubal structures are also of interest in acoustic studies [12]. Predicted impedance has been compared with measured values in grazing incidence impedance tube [13]. The optimum impedance of a circular duct has been correlated with a cut-off ratio that is a fundamental parameter governing the propagation of sound in a duct [14]. A new method for precision shock wave impedance match has been developed [15], and a problem of noise generation in axial fan has been treated [16].

OTHER APPLICATIONS

System identification and testing techniques. The problem of multiforce sine excitations has been discussed [17], a procedure in which impedance data are used for structural dynamic testing was suggested. N . las [18] suggested that on-line calibration for impact testing yields improved impedance plots. The use of impact tests to measure the dynamic properties of lightweight aircraft has also been reported [19]. The identification of dynamic properties using impedance data continues to be of special interest and have been applied to submerged vehicles [20] and rail track [21]. Admittance testing techniques have also been used [22] to predict mounting point forces of a large air-borne gas dynamic laser.

Machine elements. Applications of transfer function data to typical machine elements include gear teeth analysis [23], centrifugal and positive displacement pumps [24], and roller and journal bearings [25, 26]. Transfer functions are also used in transportation; the solution of lateral vibration problems of railway vehicles has been discussed [27]. Analyses of the steering performance of passenger cars have been compared with measured values [28].

Structures, foundation, and isolation. The effect of blasts and shocks on structures has also been of interest to engineers [29, 30]. Plate analysis-related problems have been reported [21, 32-34]. The impedance method is also used in the quality control of fiber-reinforced plastic structures [35]. Frequency responses of multi-degree systems and continuous systems using transfer functions have been studied [36, 37].

With regard to foundation-soil related problems, Dasgupta [38] developed a numerical formulation based on impedance measurements for a mathematical model for soil regimes bearing a flexible structure. Bachschmid [39] investigated the dynamic behavior of a turbomachinery shaft on a foundation. Mechanical impedance data have also been used [40] to predict vibration isolation efficiency.

Biomechanics. Human comfort continues to dominate cases of man-machine interactions, including the response of human models to vibration [41]. The mechanical impedance of certain human component models has been developed [42, 43].

The reliability of mobility and impedance measurements are constantly evaluated. The Shock and Vibration Center in Washington, D.C., is currently planning a program for assessing these measurements.

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BOOK REVIEWS

ANALYTICAL DYNAMICS OF DISCRETE SYSTEMS

R.M. Rosenberg
Plenum Press, New York, NY, 1977

The author, Professor Rosenberg of the University of California at Berkeley is clearly a master in, and a connoisseur of, the art of dynamics. His book, which is aimed at the senior/first year graduate student level, contains some fresh insights and travels some lightly trodden paths. These features, I suspect, would be much better appreciated by more advanced students. Thus I cannot wholeheartedly recommend use of the book for teaching at the suggested level. However, it would be a valuable addition to any reference library.

The prospective reader should be well versed in the principles and applications of Newtonian mechanics and have a good background in vector and matrix algebra and in ordinary differential equations. The text is organized into 21 chapters. A brief historical introduction is given in Chapter 1. Dynamic systems are discussed in Chapter 2, using, in part the language of set theory (somewhat distracting this reviewer!). A clear distinction is made between Newtonian and strictly Newtonian (no impulses) systems. Notions of configuration, event, state, and state-time spaces are developed in Chapter 3, as well as the concepts of Liapunov and Poincare stability. An excellent, thorough treatment of constraints is given in Chapter 4, this section is a strong feature of the book. The fundamental problems for strictly Newtonian systems are outlined in Chapter 5. An in-depth presentation of the kinematics of rigid bodies is given in Chapter 6. Topics treated include Chasle's theorem, finite rotations, the rotation matrix and its properties, Eulers angles, and the Rodrigues formulas. Chapter 7 is devoted to rigid body kinetics. The material covered is traditional and includes some examples on three-dimensional motions.

Introductory comments on the nature of Lagrangean (Professor Rosenberg insists on this spelling) mechanics are offered in Chapter 8. Chapter 9 is a major chapter in the book and treats at some length virtual displacements and virtual work. D'Alembert's principle is elucidated carefully, and the author offers valuable insights into the nature of the constraint forces. Hamilton's principle is treated in Chapter 10, including a discussion of variations for which time as well as the state variables are varied. The section also includes Lagrange's and Jacobi's principles of Least Action. Generalized coordinates, and expressions for fundamental items in terms of them, are covered in Chapters 11 and 12, respectively. Lagrange's equations are developed, from several different principles in Chapter 13, which also includes discussions on dissipation functions and dynamic coupling.

When a constrained problem is formulated without the use of auxiliary variables, such as Lagrangean multipliers, the constraints are said to be embedded in the problem. Cautionary remarks on the use of such constraints, for both holonomic and nonholonomic systems, are offered in Chapter 14. Problem formulation is the subject of Chapter 15, with emphasis on examples for both a single particle and for systems of particles and rigid bodies. Solution procedures are the main concern of Chapter 16. Initially, first integrals are discussed. Jacobi's integral is treated, as are the momentum integrals associated with ignorable coordinates and Routhian procedures. Solutions in terms of integrals are then explored and the section closes with a brief look at some qualitative methods.

Chapter 17 is involved with stability of motions. The usual results regarding variational equations are presented. Another welcome feature of the book is the inclusion of materials on Liapunov's direct method for both autonomous and nonautonomous systems. Chapters 18, 19, and 20 are devoted to examples. Some aspects of celestial mechanics, including central force motion and brief remarks on many-body problems, are discussed in 19, a traditional treatment of gyrodynamics is given in 20. The work concludes with a chapter on impulsive motion.

The book has 424 pages and contains numerous problems. I highly recommend it as a reference book and as a source of some novel insights and historical developments.

R.A. Scott
Dept. of Appl. Mech. and Engrg. Science
University of Michigan
Ann Arbor, MI 48109

LIFELINE EARTHQUAKE ENGINEERING - BURIED PIPELINES, SEISMIC RISK AND INSTRUMENTATION

T. Ariman, S.C. Liu, and R.E. Nickell, Editors
ASME Special Publ. PVP-34, June 1979
New York, NY

The book is a collection of papers presented at the Third National Congress on Pressure Vessels and Piping, ASME, San Francisco, California from June 25-29, 1979. The 20 papers cover a variety of relevant topics in three major areas: buried pipelines in a seismic environment, seismic risk and criteria for lifelines, and strong-motion studies and instrumentation.

The book starts with a review of the response of buried pipelines under seismic excitations by T. Ariman and G.E. Muleski. Under the heading of buried pipelines in a seismic environment are the following papers. (1) "Estimation of Structural Strains in Underground Lifeline Pipes" by M. Shinozuka and T. Koike, (2) "Seismic Behavior of Buried Pipelines" by M.J. O'Rourke, S. Singh, and R. Pikul, (3) "Effect of Local Inhomogeneity on the Dynamic Response of Pipelines" by I. Nelson and P. Weidlinger, (4) "Some Aspects of Seismic Resistant Design of Buried Pipelines" by Leon R.L. Wang, (5) "A Finite Element Analysis of Buried Pipelines under Seismic Excitations" by C.C. Chen, T. Ariman, and M. Katona, and (6) "Hydraulic Transients in Liquid-Filled Pipelines during Earthquakes" by F.M. Young and S.E. Hunter.

Papers concerned with seismic risk and criteria for lifelines include (1) "Seismic Safety Analysis of Lifeline Systems" by J. Mohammed and A.H.S. Ang, (2) "Seismic Risk and Reliability of California State Project" by A.S. Kiremidjian, (3) "Decision Optimization of Lifelines with Multiple Earthquake Associated Hazards" by J.R. Benjamin and F.A. Webster, and (4) "The Practical Use of Risk Analysis. Yesterday, Today and Tomorrow" by J.H. Wiggins. The section on strong-motion studies and instrumentation contains six papers (1) "On a New Proposal of Seismic Instrumentation and Trigger Systems for Industrial Facilities" by H. Shibata, (2) "Instrument Arrays for Strong Ground Motion" by W.D. Iwan, (3) "Strong Motion Data Management" by A.G. Brady, (4) "Bureau of Reclamation Strong Motion Instrumentation Program" by A. Viksne, (5) "Los Angeles and Vicinity, California Strong Motion Accelerograph Network. - A Progress Report" by A.G. Anderson, M.D. Trifunac, and T.L. Teng, and (6) "Strong Motion Studies in the Central United States" by R.B. Hermann, O.W. Nuttli, C.Y. Wang, M. Goerty, and E.J. Hang.

In addition, the Proceedings include three related papers: (1) "Structural Analysis of Buried Reinforced Plastic Mortar Pipe Using the Finite Element Method" by B.W. Cole, C.J. Ritter, and S. Jordan, (2) "Dynamic Yielding of Tubings under Biaxial Loading" by L.H.N. Lee and D.H.Y. Ng and (3) "Testing and Analysis of Buried Piping under Applied Loads" by B.K. Niyogi and J.S. Sethi.

In summary, the book contains information about many different subjects but is nevertheless one of the more-complete representatives of literature in the modern lifeline earthquake engineering field.

Leon R.L. Wang
Associate Professor of Civil Engineering
Rensselaer Polytechnic Institute
Troy, NY 12181

VIBRATSII v TEKHNIKE (ENGINEERING VIBRATION)

V.N. Chelomei, Editor
Mashinostroenie, Moscow, 1978 (In Russian)

"Engineering Vibration" is a six volume handbook consisting of

Volume 1	Vibration of Linear Systems
Volume 2	Nonlinear Vibration of Mechanical Systems
Volume 3	Vibration Analysis of Elastic Structural Elements and Systems
Volume 4	Beneficial Use of Vibration in Modern Technological Processes
Volume 5	Modern Methods of Experimentally Determining the Characteristics of Vibratory Processes
Volume 6	Methods of Protection Against Exposure to Vibration

These volumes are intended to give sufficiently complete information on vibration problems which can occur during design, manufacturing, testing and operation of various types of machines, devices and structures. The material is presented in such a form that it can readily be used with electronic computers. Leading Soviet vibration experts were involved in the preparation of this handbook. This edition is considered a first experiment in preparing a unique reference handbook. In the future it is intended to supplement it with closely related vibration theory problems such as complex impact, explosion, aerohydroelasticity, and design and investigation of models which correctly reflect the dynamic characteristics of real structures.

This review will only concern itself with Volume I, which was edited by V.V. Bolotin and published in 1978. It consists of 352 pages. Other volumes will be reviewed separately in subsequent issues of the Shock and Vibration Digest.

The first volume covers modern methods of investigating vibratory systems with a finite number of degrees of freedom, and linear systems with distributed parameters. It presents the theory of stability of vibratory systems, and the analytical methods for describing and analyzing vibratory processes. It also presents results of new advances in the methods of obtaining natural frequencies and vibration modes of complex structures. Considerable attention is devoted to parametric and random vibrations, impact processes and propagation of waves and the theory of vibrational reliability.

The first volume consists of three parts covering the following subject matter

Part I. Vibration of Linear Systems with a Finite Number of Degrees of Freedom

Chapter I	Introduction, General Concepts
Chapter II	Mathematical Description of Vibratory Systems with a Finite Number of Degrees of Freedom
Chapter III	Free Vibrations of Conservative Systems
Chapter IV	Methods of Computing Natural Frequencies and Vibration Modes of Systems with a Large Number of Degrees of Freedom
Chapter V	Nonconservative Autonomous Systems with Constant Parameters. Stability of Linear Systems
Chapter VI	Forced Vibrations
Chapter VII	Parametric Vibrations

Part II. Vibration of Linear Distributed Systems

Chapter VIII	Mathematical Description of Distributed Vibratory Systems
Chapter IX	General Characteristics of Natural Frequencies and Vibration Modes of Elastic Systems
Chapter X	Determination of Natural Frequencies and Vibration Modes of Elastic Systems
Chapter XI	Natural Frequencies and Vibration Modes of Elastic Rods and Rod Systems
Chapter XII	Natural Frequencies and Vibration Modes of Elastic Plates
Chapter XIII	Natural Frequencies and Vibration Modes of Elastic Shells
Chapter XIV	Forced Vibrations of Elastic Systems
Chapter XV	Dynamic Stability of Distributed Systems
Chapter XVI	Propagation of Waves and Impact Processes in Elastic Systems

Part III. Vibration of Elastic Systems under Random Disturbances

Chapter XVII Data from the Theory of Random Processes and Fields
Chapter XVIII Random Vibratory Systems with a Finite Number of Degrees of Freedom
Chapter XIX Parametric Vibrations During Random Disturbances
Chapter XX Random Vibration of Distributed Systems
Chapter XXI Fundamental Theory of Vibrational Reliability

The first volume concludes with a bibliography of 143 titles, 98 being from the Soviet Bloc, and 45 being from other countries outside of the Soviet Bloc.

Volume I of the Engineering Vibration handbook is well written. It concisely summarizes numerous important aspects of vibration theory under one cover. It is a valuable addition to published vibration literature.

M. Dublin
General Dynamics/Pomona Division
5940 Glenlea Lane
San Diego, CA 92120

VIBRATSII v TEKHNIKE (ENGINEERING VIBRATION)

V.N. Chelomei, Editor

Vol. 2. Nonlinear Vibration of Mechanical Systems
I.I. Blekhman, Editor
Mashinostroenie, Moscow, 1979 (In Russian)

Volume 2 of "Engineering Vibration" gives general information about nonlinear mechanical oscillatory systems and their classification, it also discusses basic theories of stability. Basic models of nonlinear oscillatory systems are discussed, and mathematical methods for their analysis are presented. Results related to special current problems of the theory of nonlinear oscillations are given.

This volume consists of three parts covering the following subject matter

Part I. General Information About Nonlinear Mechanical Systems, Mathematical Analysis Methods

Chapter I General Information About Nonlinear Mechanical Systems
Chapter II Mathematical Methods of Analyzing Nonlinear Oscillatory Systems

Part II. Basic Models of Nonlinear Oscillatory Systems, Their Analysis and Characteristics

Chapter III Conservative Systems
Chapter IV Dissipative Systems
Chapter V Systems with External Excitation
Chapter VI Self-excited Systems

Part III. Special Problems of the Theory of Nonlinear Oscillations

Chapter VII Interaction of the Excitation Source with the Oscillatory System
Chapter VIII Synchronization and Entrainment
Chapter IX Effect of Vibration on Nonlinear Mechanical Systems (Mechanics of Small Motion, Vibrating Motion, Vibration Rheolgy)
Chapter X Nonlinear Oscillations of Solid Bodies in Potential Field Forces
Chapter XI Oscillation and Stability of Solid Bodies with Liquid Filled Cavities
Chapter XII Vibratory-impact Systems
Chapter XIII Oscillation of Electro-mechanical Systems

Of the bibliography of 369 titles, 315 are from the Soviet Bloc, 54 are from other countries.

The second volume of "Engineering Vibration" contains a concise but lucid and comprehensive treatment of nonlinear vibration of mechanical systems. To illustrate, Chapter II presents a clear exposition of the 15 different mathematical methods currently used to analyze nonlinear oscillatory systems.

Some minor typographical errors appear in the non-Soviet Bloc bibliography.

M. Dublin
General Dynamics/Pomona Division
5940 Glenlea Lane
San Diego, CA 92120

SHORT COURSES

MARCH

ADVANCED GIFTS 5 USER WORKSHOP AND GIFTS 5 SYSTEMS WORKSHOP

Dates. March 9-13, 1981
Place Tucson, Arizona
Objective. Two parallel sessions are planned, an advanced user workshop (AW), intended for users already familiar with GIFTS, and a systems workshop (SW), aimed at the programmer who intends to modify, implement or add to the system. The last day of the week will be devoted to a GIFTS Users Group Meeting in which GUG members may present papers and interact on various issues.

Contact. Dr. Hussein A. Kamel, Professor in Aerospace and Mechanical Engineering, College of Engineering, University of Arizona, Tucson, AZ 85721 - (602) 626-1650/626-3054.

MEASUREMENT SYSTEMS ENGINEERING

Dates. March 9-13, 1981
Place. Phoenix, Arizona

MEASUREMENT SYSTEMS DYNAMICS

Dates. March 16-20, 1981
Place. Phoenix, Arizona
Objective. Program emphasis is on how to increase productivity, cost effectiveness and data-validity of data acquisition groups in the field and in the laboratory. Emphasis is also on electrical measurements of mechanical and thermal quantities.

Contact: Peter K. Stein, 5602 East Monte Rosa, Phoenix, AZ 85018 - (602) 945-4603/946-7333.

MECHANICAL ENGINEERING

Dates. March 30 - April 3, 1981
August 31 - September 4, 181
Place Carson City, Nevada
Objective. This course is designed for the mechanical or maintenance engineer who has responsibility for the proper operation and analysis of rotating machinery. Working knowledge of transducers, data acquisition instrumentation and fundamental rotor behavior is a prerequisite. The course includes a guest speaker in the field of machinery malfunctions, descriptions and demonstrations of machinery malfunctions, discussions of the classification, identification, and correction of various machine malfunctions, a one day rotor dynamics lab with individual instruction and operation of demonstration units, and emphasis on the practical solution of machinery problems rather than rotor dynamic theory.

Contact Kathy Fredekind, Bently-Nevada Corporation, P.O. Box 157, Minden, Nevada 89423 - (702) 782-3611, Extension 224.

APRIL

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

Dates. April 6-10, 1981
Place: Boston, Massachusetts
Dates. May 18-22, 1981
Place. Syosset, New York
Dates. August 24-28, 1981
Place. Santa Barbara, California
Dates: October 5-9, 1981
Place. Bournemouth, England
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 St., Santa Barbara, CA 93105 - (815) 682-7171.

CORRELATION AND COHERENCE ANALYSIS FOR ACOUSTICS AND VIBRATION PROBLEMS

Dates. April 6-10, 1981
Place: Los Angeles, California
Objective This course covers the latest practical techniques of correlation and coherence analysis

(ordinary, multiple partial) for solving acoustics and vibration problems in physical systems. Procedures currently being applied to data collected from single, multiple and distributed input/output systems are explained to classify data and systems, measure propagation times, identify source contributions, evaluate and monitor system properties, predict output responses and noise conditions, determine nonlinear and non-stationary effects, and conduct dynamics test programs.

Contact: Department of Engineering and Mathematics, UCLA Extension, P.O. Box 24901, Los Angeles, CA 90024 - (213) 825-4100.

EXPLOSION HAZARDS EVALUATION

Dates: April 6-10, 1981
Place: San Antonio, Texas
Objective: This course covers the full spectrum of problems encountered in assessing the hazards of accidental explosions, in designing the proper containment as necessary, as well as developing techniques to reduce incidence of accidents during normal plant and transport operations. Specific topics to be covered are: fundamentals of combustion and transition to explosion, free-field explosions and their characteristics, loading from blast waves, structural response to blast and non-penetrating impact, fragmentation and missile effects, thermal effects, damage criteria, and design for blast and impact resistance.

Contact: Wilfred E. Baker, Southwest Research Institute, P.O. Drawer 28510, San Antonio, TX 78284 - (512) 684-5111, Ext. 2303.

BASIC INSTRUMENTATION SEMINAR

Dates: April 21-23, 1981
Place: Chicago, Illinois
Dates: April 28-30, 1981
Place: Buffalo, New York
Dates: May 5-7, 1981
Place: Edmonton, Alberta
Dates: September 15-17, 1981
Place: New Orleans, Louisiana
Dates: October 20-22, 1981
Place: Houston, Texas
Dates: October 27-29, 1981
Place: Pittsburgh, Pennsylvania

Objective: This course is designed for maintenance technicians, instrument engineers, and operations personnel - those individuals responsible for installation and proper operation of continuous monitoring systems. An in-depth examination of probe installation techniques and monitoring systems including types, functions, and calibration procedures is provided. Also presented is an overview of some of the instrumentation used to acquire data for vibration analysis, including oscilloscopes, cameras, and specialized filter instruments.

Contact: Kathy Fredekind, Bently-Nevada Corporation, P.O. Box 157, Minden, Nevada 89423 - (702) 782-3611, Extension 224.

EVALUATION OF TESTING METHODS

Dates: April 29 - May 2, 1981
Place: Gatlinburg, Tennessee
Objective: The objective of this course is to teach laboratory personnel of all industries the fundamentals of collecting, analyzing and interpreting test data. The course addresses itself to the behavior of measurements and presents practical statistical techniques for their proper interpretation. The course is predominately problem oriented. It avoids the cook-book approach and leads rapidly from an understanding of ideas underlying statistical methods to their direct application to practical problems.

Contact: ASQC, Industrial Seminars, c/o R.E. DeBusk, Box 3803, Kingsport, Tennessee 37664 - (615) 245-6793.

MAY

OPTIMIZATION TECHNIQUES

Dates: May 6-9, 1981
Place: Gatlinburg, Tennessee
Objective: The ultimate goal of the industrial experimenter is optimum operating conditions in the laboratory and in the plant. This course will deal with the problem of maximizing product quality while minimizing product cost. The various experimental designs discussed in the course will enable the experimenter to do this both efficiently and

economically. Industrial applications with industrial examples will be emphasized throughout the course.

Contact: ASQC, Industrial Seminars, c/o R.E. DeBusk, Box 3803, Kingsport, Tennessee 37664 - (615) 245-6793.

ROTORDYNAMICS OF TURBOMACHINERY

Dates: May 18-20, 1981

Place: College Station, Texas

Objective: To provide a bridge between dynamics theory and the typical hands-on vibrations/instrumentation short course for the engineer who needs a basic understanding of practical turbomachinery rotordynamics. The course will treat balancing, rotordynamic instability, and torsional vibration problems. Fundamentals of each area will be followed up by case histories from engineering practice.

Contact: Dr. John M. Vance, Dept. of Mechanical Engineering, Texas A&M University, College Station, TX 77843 - (713) 845-1251.

COMPUTER SIMULATION OF HIGH VELOCITY IMPACT

Dates: May 26-28, 1981

Place: Baltimore, Maryland

Objective: Seminar provides an overview of physical response of materials and structures to intense impulsive loading and surveys computer programs for wave propagation and impact studies. Numerous applications are discussed together with guidelines for program selection, implementation and effective use.

Contact: Computational Mechanics Assoc., P.O. Box 11314, Baltimore, Maryland 21239.

JUNE

VIBRATION DAMPING

Dates: June 1-4, 1981

Place: Dayton, Ohio

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

Contact: Michael L. Drake, University of Dayton Research Institute, Dayton, Ohio 45469 - (513) 229-2644.

MACHINERY DATA ACQUISITION

Dates: June 1-5, 1981
August 3-7, 1981
September 28 - October 2 1981
December 7-11, 1981

Place: Carson City, Nevada

Objective: This seminar is designed for people whose function is to acquire machinery data for dynamic analysis, using specialized instrumentation, and/or that person responsible for interpreting and analyzing the data for the purpose of corrective action on machines. Topics include measurement and analysis parameters, basic instrumentation review, data collection and reduction techniques, fundamental rotor behavior, explanation and symptoms of common machinery malfunctions, including demonstrations and case histories. The week also includes a lab workshop day with hands-on operation of the instrumentation and demonstration units by the participants.

Contact: Kathy Fredekind, Bently-Nevada Corporation, P.O. Box 157, Minden, Nevada 89423 - (702) 782-3611, Extension 224.

MECHANICS OF HEAVY-DUTY TRUCKS AND TRUCK COMBINATIONS

Dates: June 22-26, 1981

Place: Ann Arbor, Michigan

Objective: The heavy truck or truck combination is a complex pneumatic-tired system. This course presents analysis programs, parameter measurement methods and test procedures useful in understanding and designing a vehicle. The course describes the physics of heavy-truck components that determine the braking, steering and riding performance of the total system.

Contact: University of Michigan, College of Engineering, Continuing Engineering Education, 300 Chrysler Center, North Campus, Ann Arbor, Michigan 48109 - (313) 764-8490.

FUNDAMENTALS OF NOISE AND VIBRATION CONTROL

Dates: June 22-26, 1981

Place: Cambridge, Massachusetts

Objective: This one week program is designed to provide a background in those aspects of sound and vibration that are important to noise control engineering. The general approach will be based on engineering concepts rather than theoretical analysis. The program is designed for the working engineer who has become involved in noise problems and seeks to deepen his/her understanding of the subject.

Contact: Director of Summer Session, Room E 19-356, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139.

JULY

INSURANCE INDUSTRY SEMINAR

Dates: July 7-9, 1981

Place: Carson City, Nevada

Objective: This course is designed for personnel from the insurance industry or self-insured companies who are responsible for inspection of plants that use large, high-speed rotating machinery. Features in the seminar include discussion of the economics of machine monitoring and predictive maintenance, presentation of machine types that should be considered, and minimum standards necessary for effective machine protection diagnosis, information and the presentation of catastrophic failure by use of proper maintenance methods and malfunction diagnosis techniques; and survey of state-of-the-art methodology.

Contact: Kathy Fredekind, Bently-Nevada Corporation, P.O. Box 157, Minden, Nevada 89423 - (702) 782-3611, Extension 224.

AUGUST

FOUNDATIONS OF ENGINEERING ACOUSTICS

Dates: August 10-21, 1981

Place: Cambridge, Massachusetts

Objective: This summer program is a specially developed course of study which is based on two regular MIT subjects (one graduate level and one undergraduate level) on vibration and sound in the Mechanical Engineering Department. The program emphasizes those parts of acoustics – the vibration of resonators, properties of waves in structures and air – the generation of sound and its propagation that are important in a variety of fields of application. The mathematical procedures that have been found useful in developing the desired equations and their solutions, and the processing of data are also studied. These include complex notation, fourier analysis, separation of variables, the use of special functions, and spectral and correlation analysis.

Contact: Director of Summer Session, Room E 19-356, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139.

SEPTEMBER

TENTH ADVANCED NOISE AND VIBRATION COURSE

Dates: September 14-18, 1981

Place: Southampton, England

Objective: The course is aimed at researchers and development engineers in industry and research establishments, and people in other spheres who are associated with noise and vibration problems. The course, which is designed to refresh and cover the latest theories and techniques, initially deals with fundamentals and common ground and then offers a choice of specialist topics. The course comprises over thirty lectures, including the basic subjects of acoustics, random processes, vibration theory, subjective response and aerodynamic noise, which form the central core of the course. In addition, several specialist applied topics are offered, including aircraft noise, road traffic noise, industrial machinery noise, diesel engine noise, process plant noise and environmental noise and planning.

Contact: Mrs. O.G. Hyde, ISVR Conference Secretary, The University, Southampton SO9 5NH, England - (0703) 559122 X 2310/752, Telex 47661.

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

Call For Papers

MECHANICAL FAILURES PREVENTION GROUP
34th SYMPOSIUM
October 21-23, 1981
"Designing for Damage Prevention in the Transportation Environment"

The Mechanical Failures Prevention Group (MFPG), under the sponsorship of the National Bureau of Standards, will hold its 34th Symposium at the National Bureau of Standards, Gaithersburg, Maryland, October 21-23, 1981.

This symposium is seeking papers that will discuss:

- The damage sustained by transported goods during shipment on the ground and in the air arising from the dynamic transportation environment (shock, vibration, temperature, pressure, humidity, etc.)
- Control of the environment through improvements in vehicle and road design, mechanical handling gear, personnel training
- Measurements of the dynamic environment
- Stowing and packaging techniques and design
- Human factors
- Economics - damage prevention and insurance

Proceedings will be published by the National Bureau of Standards. Closing date for abstracts is June 1, 1981. Abstracts should be sent to Jesse E. Stern, Trident Engineering Associates, 1507 Amherst Road, Hyattsville, MD 20783 (301-422-9506), or to Dr. J.C. Shang, General American Research Division, General American Transportation Corporation, 7449 North Natchez Avenue, Miles, IL 60648 (312-647-9000).

Call For Papers

FLOW-INDUCED VIBRATIONS

Special sessions of Flow-Induced Vibrations are being organized in conjunction with the 1982 Pressure Vessels and Piping Conference to be held June 27-July 2, 1981 in Orlando, Florida.

Papers in the general area of flow-induced vibrations are invited. Special emphasis will be placed on flow-induced vibrations in cylindrical structures, and especially in problems related to tubular heat exchangers, nuclear fuel pins and other problems involving arrays of cylinders in flow.

Both theoretical and experimental high quality papers are welcomed. Accepted papers will be printed in a bound ASME booklet, available at the Conference. Those papers of permanent interest will also be recommended for publication in the Journal of Pressure Vessel Technology.

Full papers conforming to ASME MS-4, an ASME paper, are due by November 1, 1981. Two page summaries of the work should reach one of the coordinators by August 1, 1981:

Michael P. Paidoussis
Dept. Mech. Engineering
McGill University
817 Sherbrooke St. W.
Montreal, Que., H3A 2K6
Canada
(514) 392-5474

or

Shoei-sheng Chen
Components Technology Division, Bldg. 335
Argonne National Laboratory
9700 South Cass Avenue
Argonne, IL 60439
U.S.A.
(312) 972-6147

INTERNATIONAL CONFERENCE ON STEEL IN MARINE STRUCTURES
Organized by
Commission of the European Communities
Institut de Recherches de la Siderurgie Francaise (IRSID)
Paris, France
5-8 October 1981

General Information

From 1975 to 1980, the Commission of the European Communities co-sponsored a large research program on the in-service behavior of welded marine structures under fatigue and corrosion-fatigue loading.

This co-operative program was undertaken in five countries of the EEC (France, Germany, Italy, Netherlands, United Kingdom) and in close association with similar work being undertaken in Norway. More than 40 laboratories participated in the overall program the objective of which was a better understanding of the performance of tubular joints in offshore structures. The cost of the overall program exceeded $20 million.

The research program was divided into three parts:

- Study of the fatigue limits and crack propagation laws in base metal and welded joints. Influence of material properties, welding procedures, type of loading (frequency, load spectrum, R-ratio, hold time, biaxiality, overloading, wave shape) and environment (sea water, temperature, applied potential)
- Study of the fatigue behavior of tubular joints. Nearly 300 tubular joints of varying sizes were tested. The influence of geometry (X, K, K, Y, T joints with or without overlapping), diameter ratio between brace and chord, thickness, post weld heat treatments, corrosive medium, stiffeners
- Determination of stresses in tubular joints finite element calculations, photoelastic measurements, measurements on acrylic models or actual joints from strain gauges

The aim of the Conference is to present the results obtained in the Community research program and the conclusions to be drawn for the design, the construction and assessment of the in-service behavior of offshore structures.

General Organization

Papers will be presented in different sessions

- 7 plenary sessions presented by rapporteurs, which will give the main results, conclusions and practical relevance of the information obtained during the collaborative program. Considerable time will be allowed after each session for discussion and the presentation of additional contributions.
- 2 special sessions presented by the chairman of the ECSC Corrosion and Fracture Executive Committees giving an outline of the research projects within these Committees of relevance to the design and safety of offshore structures.
- 10 technical sessions, in which the main scientific and technical details of specific projects will be presented by the research workers who have participated in the program. Several short contributions will be presented during each session.

Venue and Date

Palais des Congrés, Place de la Porte-Maillot, Paris, France. 5-8 October, 1981.

Language

Simultaneous translation into English, French and German will be available throughout the conference.

Publication

The papers presented in the plenary and special sessions will be published in three languages (English, French and German) and sent to participants prior to the conference.

A volume of the conference proceedings containing the opening addresses, discussions and conclusions drawn during the last session will be published in the three languages after the conference and sent to participants by the Directorate General Information Market and Innovation of the European Communities in Luxembourg.

Copies of the papers presented in the technical sessions will be available to the participants in one of the three conference languages as submitted by the author.

Social Program

A program for the persons accompanying the conference participants will be organized during the conference. The social program will also include a cocktail party and a conference dinner.

Additional Information

For further information, please contact

- Mme H. Prüfer, Commission of European Communities, Steel Directorate, 200, rue de la Loi, 1040 Bruxelles, Belgium, Tél. (2) 735 80-40.
- Mr. G. Sanz, IRSID, 185, rue du Président-Roosevelt, 78105 Saint-Germain-en-Laye Cedex, France, Tél. (3) 451 24-01.

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

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

ABSTRACTS FROM THE CURRENT LITERATURE

Copies of articles abstracted in the DIGEST are not available from the SVIC or the Vibration Institute (except those generated by either organization). Inquiries should be directed to library resources. Government reports can be obtained from the National Technical Information Service, Springfield, VA 22151, by citing the AD-, PB-, or N- number. Doctoral dissertations are available from University Microfilms (UM), 313 N. Fir St., Ann Arbor, MI. U.S. Patents from the Commissioner of Patents, Washington, D.C. 20231. Addresses following the authors' names in the citation refer only to the first author. The list of periodicals scanned by this journal is printed in issues 1, 6, and 12.

ABSTRACT CONTENTS

MECHANICAL SYSTEMS

ROTATING MACHINES

(Also see Nos. 588, 589, 603, 604, 605, 606, 653, 656, 669, 676, 697, 698, 700, 701, 708, 716)

81-484

Lateral Instability During Spin Tests of a Pendulously Supported Disc

F.H. Wolff, A.J. Molnar, G.O. Sankey, and J.H. Bitzer
Westinghouse R & D Ctr., Pittsburgh, PA, Shock Vib. Bull., U.S. Naval Res. Lab., Proc., No. 50, Pt. 3, pp 201-208 (Sept 1980) 8 figs, 1 table, 4 refs

Key Words: Shafts (machine elements), Test facilities, Lateral vibrations

Shaft failures were experienced at a spin test facility while studying crack growth properties in a low cycle fatigue disc specimen. Failures were attributed to lateral vibrations of a low frequency whirl instability occurring because of shaft hysteresis, looseness of bolts connecting mating components of the rotor, and insufficient external damping. Theory and experimental verification are presented which permit lateral instabilities of pendulously supported disc systems to be calculated.

81-485

Non-Synchronous Whirling Due to Fluid-Dynamic Forces in Axial Turbo-Machinery Rotors

S.' . Shen and V.G. Mengle
Cornell Univ., Ithaca, NY, In: NASA Lewis Res. Ctr. Rotordyn. Instability Probl. in High-Performance Turbomachinery, pp 267-284 (1980)
N80-29721

Key Words: Turbomachinery, Fluid-induced excitation, Whirling, Turbomachinery blades

The role of fluid forces acting on the blades of an axial turborotor with regard to whirling is analyzed. The dynamic equations are formulated for the coning mode of an overhung rotor. The exciting forces due to the motion are defined through a set of rotor stability derivatives, and analytical expressions of the aerodynamic contributions are found for the case of small mean stream deflection, high solidity and equivalent flat plate cascade.

81-486

Limit Cycles of a Flexible Shaft with Hydrodynamic Journal Bearings in Unstable Regimes

R.D. Brown and H.F. Black
Mech. Engrg. Dept., Heriott-Watt Univ., Edinburgh, Scotland, In: NASA Lewis Res. Ctr. Rotordyn. Instability Probl. in High-Performance Turbomachinery, pp 331-343 (1980)
N80-29725

Key Words: Rotors (machine elements), Flexible rotors, Shafts, Bearings, Journal bearings

A symmetric 3-mass rotor supported on hydrodynamic bearings is described. An approximate method of representing finite bearings is used to calculate bearing forces. As the method sums forces from a number of independent circular lobes lemon 3 and 4 lobe bearings are taken into account. The calculations are based on an axial groove bearing. Linear analysis precedes nonlinear simulation of some unstable conditions.

81-487

On the Role of Oil-Film Bearings in Promoting Shaft Instability: Some Experimental Observations

R. Holmes
School of Engrg. and Appl. Sciences, Sussex Univ., Brighton, UK, In: NASA Lewis Res. Ctr. Rotordyn. Instability Probl. in High-Performance Turbomachinery, pp 345-357 (1980)
N80-29726

Key Words: Rotors (machine elements), Rigid rotors, Flexible rotors, Oil film bearings, Oil whirl phenomena

The occurrence of oil whirl instability in rigid and flexible rotor systems is investigated. The effect of various bearing parameters on the oil whirl frequency and amplitude of rigid and flexible shafts supported on fluid film bearings is also studied.

81-488

Fluid Forces on Rotating Centrifugal Impeller with Whirling Motion

H. Shoji and H. Ohashi
Tokyo Univ., Tokyo, Japan, In: NASA Lewis Res. Ctr., Rotordyn. Instability Probl. in High-Performance Turbomachinery, pp 317-328 (1980)
N80-29724

Key Words: Rotors (machine elements), Impellers, Fluid induced excitation, Oil-whirl phenomena

Fluid forces on a centrifugal impeller, whose rotating axis whirls with a constant speed, are calculated by using unsteady potential theory. Calculations are performed for various values of whirl speed, number of impeller blades and angle of blades. Specific examples as well as significant results are given.

81-489

Self-Excited Rotor Whirl Due to Tip-Seal Leakage Forces

B. Leie and H.-J. Thomas
Institut f. thermische Kraftanlagen, Technische Univ., Munich, West Germany, In NASA Lewis Res. Ctr. Rotordyn. Instability Probl. in High-Performance Turbomachinery, pp 303-316 (1980)
N80-29723

Key Words: Rotors (machine elements), Turbomachinery, Self-excited vibrations, Whirling

The limitations in the performance of turbomachines which arise as a result of self-excited vibration are investigated. Bearing forces, elastic hysteresis, and forces from fluid flow through clearances are considered as possible origins. A theoretical evaluation is made to determine the dependence of the forces from the leakage losses and from rotating flow in radial gaps.

81-490

The Parameters and Measurements of the Destabilizing Actions of Rotating Machines, and the Assumptions of the 1950's

D.E. Bently
Bently Nevada Corp., Minden, In NASA Lewis Res. Ctr. Rotordyn. Instability Probl. in High-Performance Turbomachinery, pp 95-106 (1980)
N80-29712

Key Words: Rotors (machine elements), Self-excited vibrations, Oil-whip phenomena

The measurability of destabilizing actions is demonstrated for a rotor built to produce a forward circular, self-excited malfunction (gas whip). It is argued that the continued use of past modeling techniques is unfortunate in that it has led to the use of inappropriate words to express what is happening and a lack of full understanding of the category of forward circular whip instability mechanisms.

81-491

Resonance Pass Through of Unbalanced Flexible Rotors (Resonanzdurchfahrt unwuchtiger biegeelastischer Rotoren)

R. Markert
Fortschritt Berichte der VDI Zeitschriften, Reihe 11, No. 34, 178 pp, 40 figs (1980). Avail VDI Verlag GmbH, Postfach 1139, 400 Düsseldorf 1., Germany, Price 93.00 DM, VDI Z., 122 (17), p 688 (Sept 1, 1980)
(In German)

Key Words: Rotors (machine elements), Flexible rotors, Resonance pass through

The start-up or deceleration response of a simply engaged rotor, particularly during resonance pass through, is investigated. The response is affected by the value of starting moment and eccentricity. The method of successive approximations is used for the determination of the motion of rotor, especially rotor deflection, including the effect of the coupling of deflection and rotation. The method is also applicable to multiply engaged rotors.

81-492

Finite Element Analysis of Natural and Forced Flexural Vibrations of Rotor Systems

Z. Dżygadlo
Warszawa, Poland, J. Tech. Phys., Polish Acad. of Sci., 21 (1), pp 63-75 (1980) 2 figs, 15 refs

Key Words: Rotors (machine elements), Natural vibrations, Forced vibrations, Flexural vibration, Finite element technique

Flexural vibrations and critical speeds of rotors are studied by considering various models. Systems with concentrated parameters or systems in which the parameters are distributed in a continuous manner along the rotor axis are considered. As a result of introduction of the method of finite elements, new powerful means have become available for the analysis of static and dynamic problems of complex structures with variable parameters. A dynamic model of a rotor, composed of segments with continuous mass and elasticity distribution and rigid elements (discs) is presented, the method of finite elements being employed.

81-493

Experimental Study of Three Journal Bearings with a Flexible Rotor

M.L. Leader, R.D. Flack, and P.E. Allaire
Univ. of Virginia, Charlottesville VA 22901, ASLE Trans., 23 (4), pp 363-369 (Oct 1980) 11 figs, 3 tables, 15 refs

Key Words: Rotor-bearing systems, Rotors (machine elements), Flexible rotors, Journal bearings, Unbalanced mass response

The unbalance response and stability of a simple flexible rotor is tested over a speed range with three different types of journal bearings: axial groove, pressure dam and tilting pad. Measurements are made of total rotor response, synchronous response and frequency spectrums at various running speeds and at selected locations along the shaft.

81-494

On the Axial Symmetry of the Revolving Complicated Systems

A. P. Kavolėlis
Dynamics and Strength of Structures (Konstrukciju dinamika ir atsparumas). Collection of Papers in Mechanics, No. 21. Ministry of Higher Education of Lithuanian SSR and Vilnius Civil Engrg. Inst. Vilnius, Lithuanian SSR, 1980, pp 52-56, 1 fig, 3 refs
(In Russian, summaries in Lithuanian and English)

Key Words: Rotating structures

A generalized mechanical system rotating at a constant angular velocity is investigated. Its axial symmetry corresponds to a definite stable dynamic equilibrium. The hypothesis that a maximum definite kynetic potential at a given point must correspond to a stable dynamic equilibrium is used in the investigation. Four possible cases are analyzed. The minimization principles for the system displacement from the axis are given.

81-495

Axynchronous Vibration Problem of Centrifugal Compressor

T. Fujikawa, N. Ishiguro, and M. Ito
Kobe Steel Ltd. (Japan), In. NASA Lewis Res. Ctr. Rotordyn. Instability Probl. in High-Performance Turbomachinery, pp 109-118 (1980)
N80-29713

Key Words: Rotors (machine elements), Compressors, Vibration control

An unstable asynchronous vibration problem in a high pressure centrifugal compressor and the remedial actions against it are described. A computer program is used which calculates the logarithmic decrement and the damped natural frequency of the rotor bearing systems. The analysis of the log-decrement is concluded to be effective in preventing unstable vibration in both the design stage and remedial actions.

81-496

Damping Synchronous Motor Vibrations

A.S. Herman
Koppers Co., Inc., Power Transmission Div., P.O. Box 1696, Baltimore, MD 21203, Proc., National Conf. on Power Transmn., Cleveland Convention Ctr., Cleveland, OH, pp 203-207 (Oct 1980) 4 figs, 4 refs

Key Words: Synchronous motors, Vibration damping, Compressors

A description of the problem associated with the starting of synchronous motors is given, and a case history involving high speed centrifugal compressors is described, in which analysis of the system predicted excessive torque fluctuations as the motor accelerates to synchronous speed. Introduction of a highly damped coupling provides a solution, and the analysis is verified by instrumenting the drives.

81-497

Subsynchronous Instability of a Geared Centrifugal Compressor of Overhung Design

J.H. Hudson and L.J. Wittman
Allis-Chalmers Mfg. Co., Milwaukee, WI, In: NASA Lewis Res. Ctr. Rotordyn. Instability Probl. in High-Performance Turbomachinery, pp 67-83 (1980)
N80-29711

Key Words: Rotors (machine elements), Compressors, Vibration control

The original design analysis and shop test data are presented for a three stage air compressor with impellers mounted on the extensions of a twin pinion gear, and driven by an 8000 hp synchronous motor. Also included are field test data, subsequent rotor dynamics analysis, modifications, and final rotor behavior.

81-498

Feasibility of Active Feedback Control of Rotordynamic Instability

J.W. Moore, D.W. Lewis, and J.Heinzman

Virginia Univ., Charlottesville, VA, In NASA Lewis Res. Ctr., Rotordyn. Instability Probl. in High-Performance Turbomachinery, pp 467-476 (1980)

N80-29733

Key Words: Rotors (machine elements), Dynamic stability, Active control

Some of the considerations involved in the use of feedback control as a means of eliminating or alleviating rotordynamic instability are discussed. A simple model of a mass on a flexible shaft is used to illustrate the application of feedback control concepts.

81-499

Stabilization of Aerodynamically Excited Turbomachinery with Hydrodynamic Journal Bearings and Supports

L.E. Barrett and E.J. Gunter

Dept. of Mech. and Aerospace Engrg., Virginia Univ., Charlottesville, VA, In. NASA Lewis Res. Ctr., Rotordyn. Instability Probl. in High-Performance Turbomachinery, pp 429-452 (1980)

N80-29731

Key Words: Rotor-bearing systems, Rotors (machine elements), Flexible rotors, Bearings, Journal bearings, Supports, Damping effects

A method of analyzing the first mode stability and unbalance response of multimass flexible rotors is presented whereby the multimass system is modeled as an equivalent single mass model model including the effects of rotor flexibility, general linearized hydrodynamic journal bearings, squeeze film bearing supports and rotor aerodynamic cross coupling. Expressions for optimum bearing and support damping are presented for both stability and unbalance response. The method is intended to be used as a preliminary design tool to quickly ascertain the effects of bearing and support changes on rotor-bearing system performance.

81-500

Instability Thresholds for Flexible Rotors in Hydrodynamic Bearings

P.E. Allaire and R.D. Flack

Dept. of Mech. and Aerospace Engrg., Virginia Univ., Charlottesville, VA, In NASA Lewis Res. Ctr., Rotordyn. Instability Probl. in High-Performance Turbomachinery, pp 403-427 (1980)

N80-29730

Key Words: Rotor-bearing systems, Rotors (machine elements), Flexible rotors, Bearings, Geometric effects

Two types of fixed pad hydrodynamic bearings (multilobe and pressure dam) are considered. Optimum and nonoptimum geometric configurations are tested. The optimum geometric configurations are determined by using a theoretical analysis and the bearings are then constructed for a flexible rotor test rig. It is found that optimizing bearings using this technique produce a 100% or greater increase in rotor stability.

81-501

Parametric Instabilities of Rotor-Support Systems with Application to Industrial Ventilators

Z. Parszewski, T. Krodkiemski, and K. Marynowski

Politechnika Lodzka, Poland, In NASA Lewis Res. Ctr., Rotordyn. Instability Probl. in High-Performance Turbomachinery, pp 383-400 (1980)

N80-29729

Key Words: Rotors (machine elements), Supports, Parametric vibration, Parametric resonance

Rotor support systems interaction with parametric excitation is considered for both unequal principal shaft stiffness (generators) and offset disc rotors (ventilators). Instability regions and types of instability are computed in the first case, and parametric resonances in the second case. Computed and experimental results are compared for laboratory machine models. A field case study of parametric vibrations in industrial ventilators is reported.

81-502

Physical Explanations of the Destabilizing Effect of Damping in Rotating Parts

S.H. Crandall

Massachusetts Inst. of Tech., Cambridge, MA, In NASA Lewis Res. Ctr. Rotordyn. Instability Probl. in High Performance Turbomachinery, pp 369-382 (1980)

N80-29728

Key Words: Rotating structures, Damping effects

The destabilizing effect of rotating damping is investigated. When rotation is faster than whirl, rotating damping drags the orbiting particle forward. When stationary damping is also present, the stability borderline is readily determined by balancing the backward and forward drags. The growth rate of unstable whirls, or the decay rate of stable whirls, is readily estimated by a simple energy balance.

81-503

Experimental Results Concerning Centrifugal Impeller Excitations

J.M. Vance and F.J. Landadio

Dept. of Mech. Engrg., Texas A&M Univ., College Station, TX, In: NASA Lewis Res. Ctr. Rotordyn. Instability Probl. in High-Performance Turbomachinery, pp 361-367 (1980)
N80-29727

Key Words: Rotors (machine elements), Impellers, Fluid-induced excitation

The effect of working fluid on the dynamics of an impeller with radial vanes is investigated. The impeller is supported vertically from a very flexible quill shaft in order to produce a low critical speed, and to allow the fluid dynamic effects on the impeller to predominate. The shaft is supported from ball bearings, so there is no possibility of oil whip from fluid film bearings as a destabilizing influence. The impeller is run both in the atmosphere, and submerged in working fluids contained in a cylindrical housing, open at the top.

81-504

Dynamic Analysis of Hydro-Turbine Machine Designs

J.R. Degnan

Allis-Chalmers Hydro-Turbine Div., York, PA, Proc. Machinery Vibrations IV seminar, Nov 11-13, 1980, Cherry Hill, NJ, 16 pp, 10 figs, 6 refs
Sponsored by Vibration Institute, Clarendon Hills, IL

Key Words: Rotating structures, Turbine components, Pumps, Forced vibration, Free vibration

Certain components of hydro-turbine equipment have been susceptible to problems associated with resonance ranging from excessive noise to failure. Only those components that are partially or completely embedded in the powerhouse concrete can be designed independent of dynamic criteria. Basic design criteria and advanced analytical methods used to predict the resonance as well as the forcing frequencies associated with those components most susceptible to vibration problems are discussed. Pump/turbine components are chosen to illustrate the methodology.

81-505

Application of the Finite Element Method to Vibration Problems

C.C. Roberts, Jr.

27W776 Greenview Ave., Warrenville, IL 60555, Proc. Machinery Vibrations IV seminar, Nov. 11-13, 1980, Cherry Hill, NJ, 5 pp 5 refs
Sponsored by Vibration Institute, Clarendon Hills, IL

Key Words: Rotors (machine elements), Finite element technique

The finite element method, a numerical method for approximating the solution of complex physical problems, is now being utilized in the areas of structural mechanics, heat transfer, fluid flow and dynamics. Recently, the finite element method was accepted as a rotor dynamics analysis tool. Typical applications in the area of rotor dynamics analysis are described.

81-506

The State of Knowledge in the Field of Bearing Influenced Rotor Dynamics

D. Dowson and C.M. Taylor

Inst. of Tribology, Dept. of Mech. Engrg., The Univ. of Leeds, Leeds LS2 9JT, UK, Tribology Intl., 13 (5), pp 196-198 (Oct 1980) 1 fig

Key Words: Rotor-bearing systems, Bearings, Vibration response

A report on the findings of a survey of the state of knowledge in the field of bearing influenced rotor dynamics is presented. The survey aims to ascertain the nature of the problems, the extent to which the basic features of rotor dynamics and bearing operating characteristics and the interactions between the two were understood, the need for further experimental or analytical studies in this field, and the extent to which industrial problems could be tackled by existing procedures.

81-507

An Introduction to the Influence of the Bearings on the Dynamics of Rotating Machinery

A.V. Ruddy and D. Summers-Smith

Dept. of Mech. Engrg., The Univ. of Leeds, Leeds LS2 4JT, UK, Tribology Intl., 13 (5), pp 199-203 (Oct 1980) 2 figs, 2 tables, 7 ref

Key Words: Rotor-bearing systems, Bearings, Oil film bearings, Rotors (machine elements)

The effect of the dynamic characteristics of bearing oil films on the lateral vibrational behavior of rotating machines in a descriptive, non-mathematical way is discussed. The influence of the dynamic properties of the bearing oil film on the natural frequencies of the rotor to both internal and external forcing systems is discussed. Attention is drawn to the importance of considering the complete system of rotor, bearings and bearing supports when dealing with vibration behavior.

81-508

Rotor-Bearing Dynamics of Modern Turbomachinery

D.P. Fleming

NASA Lewis Res. Ctr., Cleveland, OH 44135, Tribology Intl., 13 (5), pp 221-224 (Oct 1980) 4 figs, 12 refs

Key Words: Rotor-bearing systems, Pumps, Turbomachinery, Space shuttles

High speed, high power-density machinery is subject to a number of vibration-producing forces. The fuel pump for the space shuttle is an example of such an advanced technology turbomachine. The low viscosity of the working fluid (liquid hydrogen) dictates novel solutions to the vibration problems which arise in the development of this pump.

81-509

Rotor Dynamics on the Minicomputer

E.J. Gunter

Dept. of Mech. and Aerospace Engrg., Univ. of Virginia, Charlottesville, VA 22901, Proc. Machinery Vibrations IV seminar, Nov 11-13, 1980, Cherry Hill, NJ, 47 pp, 13 figs

Sponsored by Vibration Institute, Clarendon Hills, IL

Key Words: Rotor-bearing systems, Rotors (machine elements), Fluid-film bearings, Journal bearings, Critical speeds, Unbalanced mass response, Computer-aided techniques

Investigation, using a minicomputer, of the theoretical and experimental behavior of a multimass test rotor mounted in fluid film journal bearings is described. The minicomputer is used to analyze the rotor critical speeds, bearing coefficients, unbalance response, and stability characteristics. It is also employed to sample, collect and reduce the experimental rotor characteristics to obtain the rotor amplification factor at the first critical speed. The use of a minicomputer system to both analyze the theoretical rotor behavior and to evaluate the experimental rotor motion has added a new dimension to the state of the art in machinery analysis.

81-510

Instrumented Couplings: The What, The Why and The How of the Indikon Hot-Alignment Measuring System

A.E. Finn

The Indikon Co., Cambridge, MA, Proc. 9th Turbomachinery Symposium, Gas Turbine Labs., Shamrock Hilton, Dec 9-11, 1980, pp 135-136, 1 fig

Sponsored by Mech. Engrg. Dept., Texas A&M Univ.

Key Words: Couplings, Flexible couplings, Alignment

The Indikon System which measures the misalignment at each end of a flexible coupling set is described. The system can also measure related variables such as the axial vibration of the spacer piece, the sliding mesh-velocity of the gear, or, with bonded strain gages, the bending moment imposed upon the spacer by misalignment. All measurements are made while the machines are running, as they warm up, as they pick-up load, and through the months and years of operation.

81-511

Benchmark Gauges for Hot Alignment of Turbomachinery

J.N. Essinger

Acculign, Inc., Houston, TX, Proc. 9th Turbomachinery Symposium, Gas Turbine Labs., Shamrock Hilton, Dec 9-11, 1980, pp 127-133, 13 figs, 2 refs

Sponsored by Mech. Engrg. Dept., Texas A&M Univ.

Key Words: Alignment, Turbomachinery

The use of benchmark gauges for securing hot alignment data for turbomachinery trains is described. The gauges measure the movement of machines relative to the foundation. Reduction of the data to determine running alignment of the couplings is most readily done by using programs developed for hand-held, programmable calculators. A graphical solution is also illustrated.

81-512

Total Alignment Can Reduce Maintenance and Increase Reliability

V.R. Dodd

Chevron U.S.A., Inc., Pascagoula, MS, Proc. 9th Turbomachinery Symposium, Gas Turbine Labs., Dec 9-11, 1980, Shamrock Hilton, pp 123-126, 5 figs, 3 refs

Sponsored by Mech. Engrg. Dept., Texas A&M Univ.

Key Words: Alignment, Turbomachinery, Shafts (machine elements)

The DynAlign bar method is described for attaining an accurate shaft alignment at equilibrium (normal running) conditions and for continuous tracking to ensure that alignment is maintained during actual operation. The bars make is possible to measure and compensate for the thermal growth that occurs in equipment from the cold state to normal operating conditions.

81-513

Reverse-Indicator Alignment and Related Subjects

M.G. Murray, Jr.

Exxon Chemical Co., U.S.A., Baytown, TX, Proc. 9th Turbomachinery Symposium, Gas Turbine Labs., Dec 9-11, 1980, Shamrock Hilton, pp 145-147, 8 refs

Sponsored by Mech. Engrg. Dept., Texas A&M Univ.

Key Words: Alignment, Rotating structures

A discussion of reverse-indicator measurement and other alignment subjects are discussed. The basic steps in doing an alignment job and some of the tooling that can be used is described.

81-514

Alignment Using Water Stands and Eddy Current Proximity Probes

C. Jackson

Monsanto Chemical Intermediates Co., Texas City, TX, Proc. 9th Turbomachinery Symposium, Gas Turbine Labs., Dec 9-11, 1980, Shamrock Hilton, pp 137-143, 12 figs

Sponsored by Mech. Engrg. Dept., Texas A&M Univ.

Key Words: Alignment, Rotating structures

A system for use in monitoring the alignment of machinery is described. It comprises water stands; e.g., two inch pipe with cooling tower water flowing through the pipe stand and holding two eddy current probes which sense the movement of a machine (turbine, compressor, pump, gear).

81-515

The Analysis of Surge

R.H. Sentz

Union Carbide Corp., Linde Div., Tonawanda, NY, Proc. 9th Turbomachinery Symposium, Gas Turbine Labs., Dec 9-11, 1980, Shamrock Hilton, pp 57-61, 4 figs, 8 refs

Sponsored by Mech. Engrg. Dept., Texas A&M Univ.

Key Words: Compressors, Pumps, Surges

Considerable attention has recently been given to the phenomenon of surge in compressors and pumps. The model under study is a Helmholtz resonator and driver where the flow in the delivery duct to the resonator is assumed incompressible. The objective of this analytical study is to extend this model to one more applicable to field situations and to discuss the impact of some of the added effects such as heat transfer in the exhaust chamber, the action of the momentum flux on the fluid bounderies in the duct and the compressibility of the gas in the delivery duct.

81-516

Lateral Vibration Reduction in High Pressure Centrifugal Compressors

R. Jenny and H.R. Wyssmann

Sulzers Brothers Ltd., Thermal Turbomachinery, Zurich, Switzerland, Proc. 9th Turbomachinery Symposium, Gas Turbine Labs., Dec 9-11, 1980, Shamrock Hilton, pp 45-56, 23 figs, 13 refs

Sponsored by Mech. Engrg. Dept., Texas A&M Univ.

Key Words: Compressors, Self-excited vibration

It is the purpose of this paper to discuss the different types of excitation that occur in a multistage centrifugal compressor with shrouded impellers and to evaluate their importance with respect to lateral vibrations. The main source for self-excitation is found to be the labyrinth seals. A simple one-dimensional aerodynamic theory to calculate the destabilizing lateral forces of the labyrinths is presented. Stability tests for a number of different centrifugal compressors have been carried out on a test bed. The stability limits have been determined by increasing the pressure level at constant speed until subsynchronous vibration occurs.

81-517

Unique Fan Vibration Problems: Their Causes and Solutions

D.R. Smith and H.R. Simmons

Applied Physics Div., Southwest Res. Inst., San Antonio, TX, Proc. 9th Turbomachinery Symp., Gas Turbine Labs., Dec 9-11, 1980, Shamrock Hilton, pp 33-43, 19 figs, 4 refs

Sponsored by Mech. Engrg. Dept., Texas A&M Univ.

Key Words: Fans, Vibration control

A multi-disciplinary approach to evaluate existing fan system designs for root causes of overall vibration problems and the development of methods to solve them are discussed. Actual case histories are presented which cover the latest field instrumentation and evaluation techniques in the analysis of fan vibration problems.

81-518

Effect of Fluid Forces on Rotor Stability of Centrifugal Compressors and Pumps

J. Colding-Jorgensen

Technical Univ. of Denmark, Copenhagen, In: NASA Lewis Res. Ctr. Rotordyn. Instability Probl. in High-Performance Turbomachinery, pp 249-265 (1980) N80-29720

Key Words: Rotors (machine elements), Compressors, Pumps, Fluid-induced excitation, Stiffness coefficients, Damping coefficients

A simple two dimensional model for calculating the rotor dynamic effects of the impeller force in centrifugal compressors and pumps is presented. It is based on potential flow theory with singularities. Equivalent stiffness and damping coefficients are calculated for a machine with a vaneless volute formed as a logarithmic spiral. It is shown that for certain operating conditions, the impeller force has a destabilizing effect on the rotor.

81-519

A Test Program to Measure Fluid Mechanical Whirl-Excitation Forces in Centrifugal Pumps

C.E. Brennen, A.J. Acosta, and T.K. Caughey

California Inst. of Tech., Pasadena, CA, In: NASA Lewis Res. Ctr. Rotordyn. Instability Prob. in High-Performance Turbomachinery, pp 229-247 (1980) N80-29719

Key Words: Centrifugal pumps, Pumps, Fluid-induced excitation, Whirling

The details of a test program for the measurement of the unsteady forces on centrifugal impellers are discussed. Various hydrodynamic flows are identified as possible contributors to these destabilizing forces.

81-520

New Methods of Reducing Noise in External Gear Pumps

J. Hobbs and H. Fricke

Robert Bosch Corp., U.S., SAE Paper No. 801005, 8 pp, 9 figs

Key Words: Pumps, Noise reduction, Gears

The noise from external gear pumps has been significantly reduced by a new design which consists of two sets of gears, half the width of a standard gear, and offset about ½ pitch. The new pump makes use of a housing which is externally basically the same as a standard pump. This paper presents test stand and field measurements of the pump.

81-521

Field Verification of Lateral-Torsional Coupling Effects on Rotor Instabilities in Centrifugal Compressors

J.C. Wachel and F.R. Szenasi

Southwest Res. Inst., San Antonio, TX, In: NASA Lewis Res. Ctr. Rotordyn. Instability Probl. in High-Performance Turbomachinery, pp 15-34 (1980) N80-29708

Key Words: Rotors (machine elements), Compressors, Vibration control, Lateral vibration, Torsional vibration

Lateral and torsional vibration data obtained on a centrifugal compressor train which had shaft instabilities and gear failures is examined. The field data verifies that the stability of centrifugal compressors can be adversely affected by coincidence of torsional natural frequencies with lateral instability frequencies. The data also indicates that excitation energy from gear boxes can reduce stability margins if energy is transmitted either laterally or torsionally to the compressors.

81-522

Practical Experience with Unstable Compressors

S.B. Malanoski

Mechanical Technology, Inc., Latham, NY, In NASA Lewis Res. Ctr. Rotordyn. Instability Probl. in High-Performance Turbomachinery, pp 36-43 (1980)
N80-29709

Key Words: Rotors (machine elements), Compressors, Vibration response

Using analytical mathematical modeling techniques for the system components, an attempt is made to gauge the destabilizing effects in a number of compressor designs. In particular the overhung compressor designs and the straddle-mounted compressor designs are examined. Recommendations are made, based on experiences with stable and unstable compressors, which can be used as guides in future designs.

81-523

Analysis and Identification of Subsynchronous Vibration for a High Pressure Parallel Flow Centrifugal Compressor

R.G. Kirk, J.C. Nicholas, G.H. Donald, and R.C. Murphy

Ingersoll-Rand Co., Easton, PA, In. NASA Lewis Res. Ctr. Rotordyn. Instability Probl. in High-Performance Turbomachinery, pp 45-63 (1980)
N80-29710

Key Words: Rotors (machine elements), Compressors, Vibration response

The summary of a complete analytical design evaluation of an existing parallel flow compressor is presented and a field vibration problem that manifested itself as a subsynchronous vibration that tracked at approximately 2/3 of compressor speed is reviewed. The comparison of predicted and observed peak response speeds, frequency spectrum content, and the performance of the bearing-seal systems are presented as the events of the field problem are reviewed. Conclusions and recommendations are made as to the degree of accuracy of the analytical techniques used to evaluate the compressor design.

81-524

Vibrations of a Marine Propeller Operating in a Nonuniform Inflow

J.E. Brooks

David W. Taylor, Naval Ship Res. and Dev. Ctr., Bethesda, MD, Rept. No. DTNSRDC-80/056, 140 pp (Apr 1980)
AD A086 482/7

Key Words: Marine propellers, Propeller blades, Blades, Fundamental frequency, Hydrodynamic damping

The effect of blade vibration on the unsteady forces developed by an elastic marine propeller is investigated for a controlled laboratory situation. The study involves the development of a theory for a flexible propeller operating in a spatially nonuniform inflow velocity field and a series of experimental tests.

81-525

Fuel Savings and Noise Reduction with the Fan Drive

J.J. Pisarski

Schwitzer, Wallace Murray Corp., Indianapolis, IN, SAE Paper No. 801013, 16 pp, 11 figs, 1 table, 3 refs

Key Words: Fans, Noise reduction

Cooling fan engagement times were recorded on a front-end loader used in heavy duty operation at varying ambient temperatures to determine the effectiveness of a temperature controlled fan drive on off-highway equipment. The benefits of the fan drive are presented in terms of fuel savings and noise reduction.

81-526

Dynamic Characteristics of an Induced-Draft Fan and Its Foundation

S.P. Ying and E.E. Dennison

Gilbert/Commonwealth, Jackson, MI 49201, Shock Vib. Bull., U.S. Naval Res. Lab., Proc., No. 50, Pt. 2, pp 121-128 (Sept 1980), 10 figs, 6 refs

Key Words: Fans, Foundations, Vibration analyzers, Fast Fourier transform, Balancing techniques

Vibration problems of large induced-draft fans and dynamic responses of their foundations are investigated experimentally. The work includes analyses of fan vibration spectra and determinations of vibration mode shapes. The natural resonant frequencies of the foundation were measured by using the transfer function technique with a dual channel Fast Fourier Transform analyzer.

RECIPROCATING MACHINES

(Also see No. 602)

81-527

Vibration Analysis of a High Horsepower Driveline

J.H. Ball

Bucyrus Erie Co., South Milwaukee, WI 53172, Proc. National Conf. Power Transmn., Oct 1980, Cleveland, OH, pp 93-101, 15 figs, 5 tables, 8 refs

Key Words: Diesel engines, Drive line vibrations, Torsional vibration

A high horsepower turbo charged diesel engine powers a hydraulic system for excavating, swing, and propel functions on an excavator. Simulation of the mass-elastic driveline system includes four cases: the driveline system including engine, clutch, pump box, and pumps; the system with a torsional damper; the system with a torsionally flexible coupling between the engine and clutch, and the system with damper and coupling.

81-528

Vibrational Problems of Large Vertical Pumps and Motors

J.E. Corley

Arabian American Oil Co., Dhahran, Saudi Arabia, Proc. 9th Turbomachinery Symp., Gas Turbine Labs., Dec 9-11, 1980, Shamrock Hilton, pp 75-82, 9 figs Sponsored by Mech. Engrg. Dept., Texas A&M Univ.

Key Words: Pumps, Motors, Natural frequencies

A large vertical pump with its associated motor driver constitutes a very complex dynamic system. The apparent simplicity of the visible cantilever portion of the machine belies the complex interaction of the unit with its piping, foundation, soil and process fluid, all of which must be considered in order to achieve a successful design. This system approach is presented by an analytical and experimental study of a 3000 hp crude oil loading pump. The study shows the large number of possible vibrational modes which can exist near the operational speed of a typical system and the factors which should be considered in predicting resonant frequencies. Also included are several case histories which illustrate some of the dynamic problems which are common to vertical machines.

81-529

Silent Check Slide Valve Pumps (Gerauscharme Sperrschieberpumpen)

W. Damm

VEB Kombinat ORSTA Hydraulik, Leipzig, Maschinenbautechnik, 29 (8), pp 358-360 (1980) 6 figs (In German)

Key Words: Pumps, Noise reduction

The development and mode of operation of a new type silent check valve pump is described.

POWER TRANSMISSION SYSTEMS

81-530

New Approach for Analyzing Transmission Noise

R.J. Drago

Boeing Vertol Co., Philadelphia, PA, Mach. Des., 52 (27), pp 114-115 (Nov 20, 1980) 10 figs

Key Words: Power transmission systems, Noise reduction, Design techniques

A new analytical procedure is described which controls transmission noise by modifying the dynamic characteristics of the drive in the design stage. The analysis involves mathematical modeling of vibratory excitation of the gears, the response of shaft-support system to this excitation, the manner in which these responses are transferred to the housing through their bearings, and the response of the housing to these various stimuli.

METAL WORKING AND FORMING

81-531

An Investigation of the Transient Effects During Variable Speed Cutting

J.S. Sexton and B.J. Stone

Univ. of Bristol, J. Mech. Engr. Sci., 22 (3), pp 107-118 (June 1980) 10 figs, 2 tables, 8 refs

Key Words: Machine tools, Chatter, Transient response

Conventionally the stability analysis of machine tools is restricted to determining if a particular operation will become unstable. The transient behavior is not examined in any further detail. However, under certain conditions larger transient vibrations occur even though the process may ultimately be stable. A method of prediction of transient behavior is presented and applied to variable speed cutting on a lathe where such transients are significant.

ELECTROMECHANICAL SYSTEMS

81-532

Using Analog Simulation to Analyze Electric Drive Stability Problems in Large Machines

W.C. Schmidt

Reliance Electric Co., Cleveland, OH 44117, Proc. National Conf. Power Transmn., Oct 1980, Cleveland, OH, pp 193-199, 12 figs

Key Words: Analog simulation, Electric drives

The dynamic performance of controlled machinery, i.e., its ability to respond to changing conditions in a predictable and controlled manner and its ability to regulate and control the machine process as intended is investigated. Also discussed is its ability to operate within the defined limits of precision and to respond to changes within a specified time frame. Causes and control of transient disturbances, instability, and resonant phenomenon are described.

STRUCTURAL SYSTEMS

BUILDINGS

81-533

On the Calculation of the Damping of Air-Borne Sound by Laminated Building Components (Zur Berechnung der Luftschalldammung von doppelschaligen Bauteilen (ohne Verbindung der Schalen))

K. Gosele

Grundstrasse 32, D-7022, Leinfelden-Echterdingen 3, Germany, Acustica, 45 (4), pp 218-227 (Aug 1980) 12 figs, 12 refs

(In German)

Key Words: Buildings, Noise reduction, Structural members, Layered materials

A simple method for approximate calculation of the damping of air-borne sound by laminated building components is given using a mass-spring-mass model in which reduced masses replace the actual surface-bound masses. These are chosen in such a way that they lead to the same amount of acoustic damping for a single layer as has been measured or calculated for the particular wall structure. Agreement between calculation and measurement is good, apart from the range of frequencies in the immediate neighborhood of the cut-off frequency of the layers.

TOWERS

81-534

Structural-Dynamic Characterization of an Experimental 1200-Kilovolt Electrical Transmission-Line System

L. Kempner, Jr., S. Smith, and R.C. Stroud

Bonneville Power Admn., Portland, OR, Shock Vib. Bull., U.S. Naval Res. Lab., Proc., No. 50, Pt. 3, pp 113-123 (Sept 1980) 14 figs, 3 refs

Key Words: Transmission lines, Towers, Modal analysis, Modal tests

An investigation was conducted to establish, by correlation of analytically and experimentally derived results, credibility for structural and structural-dynamic modeling procedures for a 1200 kilovolt electrical transmission line system. The approach was to formulate an analytical model of one of the suspension towers and compare the modal characteristics of that idealization with measured properties obtained with a modal survey.

FOUNDATIONS

(Also see Nos. 526, 641)

81-535

Machine-Foundation-Soil (Maschine-Fundament-Baugrund)

Fortschritt Berichte der VDI Zeitschriften Reihe 1, No. 67, 134 pp, 63 figs, 1 table (1980). Avail. VDI Verlag GmbH, Postfach 1139, 400 Dusseldorf 1, Germany, Price: 26.30 DM, VDI Z. 122 (18) (Sept 11, 1980)

(In German)

Key Words: Machine foundations, Machinery vibration, Vibrating foundations

A procedure for a rough calculation of the dynamic and static response of machine-foundation-soil system is presented.

81-536
Piling Foundations for Reciprocating Compressors
W.M. Kauffman
Parma, Ohio, Plant Engr., 34 (23), pp 145-147 (Nov 13, 1980) 2 figs, 1 table

Key Words: Pile foundations, Foundations, Compressors, Reciprocating compressors

Suggestions for a successful design of reciprocating compressor pile foundations over land fill, swamps and noncohesive soils are presented.

CONSTRUCTION EQUIPMENT

81-537
Riding Mower Development by Dynamic Design Techniques
H.T. Knudson, P.T. Shupert, and P.N. Sheth
Simplicity Mfg. Co., Allis-Chalmers Subsidiary SAE Paper No. 800933, 32 pp, 13 refs, 3 tables, 21 figs

Key Words: Agricultural machinery, Vibration effects, Human response

A rear engine rider mower is utilized to illustrate the engineering development process for achieving improved operator comfort. It is shown that a proposed ISO standard for hand-arm vibrations offers one method to quantify the subjective feel of the operator toward various vibration levels. The dynamic design techniques of modal and Fourier analysis, dynamic testing, and finite element analysis are shown to provide improved design of the system for structural and vibration performance. Specific finite element models of the frame and of the steering wheel are described and their use for improved vibration design discussed.

81-538
Bulldozer Noise Control
J.G. Kovac, R.C. Bartholomae, G.R. Bockosh, R. Madden, and M. Rubin
U.S. Dept. of the Interior, Bureau of Mines, Pittsburgh Res. Ctr., Pittsburgh, PA, SAE Paper No. 800935, 8 pp, 2 figs, 3 tables, 3 refs

Key Words: Construction equipment, Noise reduction

Retrofit noise control treatments which reduce the noise that reaches the bulldozer operator were specifically designed to be readily installed in the field at low cost. These treatments were installed on two Caterpillar D9G's in surface coal mines to demonstrate the noise reduction that can be achieved under actual production conditions. Results of the field demonstrations are presented here.

PRESSURE VESSELS

81-539
Efficient Computational Techniques for the Analysis of Some Problems of Fracture in Pressure Vessels and Piping
T. Nishioka and S.N. Atluri
Ctr. for the Advancement of Computational Mechanics, Georgia Inst. of Tech., Atlanta, GA, Rept. No. GIT-CACM-SNA-20, TR-4, 30 pp (June 1980) AD-A087 225/9

Key Words: Pressure vessels, Plates, Beams, Crack propagation, Finite element technique

Results of a numerical investigation, based on an energy consistent moving-singularity dynamic finite element procedure of fast crack propagation in a finite plate, numerical simulation of experimental data on fast crack propagation and arrest in a double-cantilever-beam specimen; and stress-intensity factor solutions in a thermally shocked cylindrical vessel containing an inner surface (meridional) elliptical flaw, are presented. Comparison of these results with other available solutions, and pertinent discussions, are included.

POWER PLANTS

(Also see Nos. 623, 688)

81-540
Comparison of Experimental and Analytic Simulations of Reactor Structural Response to a Hypothetical Core Disruptive Accident
A.M. Christie, N.W. Brown, and B.W. Joe
Westinghouse Electric Corp., Advanced Reactors Div., Madison, PA 15663, Nucl. Engr. Des., 60 (2), pp 257-266 (Sept 1980) 16 figs, 4 refs

Key Words: Nuclear reactor safety, Dynamic tests, Computer programs, Model testing

A series of scale model tests assessing the ability of a reactor to withstand the loads resulting from a hypothetical core disruptive accident were performed. Supporting analytic simulations of these tests and comparisons of the analytic and experimental results are described.

81-541

Structural Response of 1/20-Scale Models of the CRBR to a Simulated HCDA

C.M. Romander and D.J. Cagliostro

SRI International, 333 Ravenswood Ave., Menlo Park, CA 94025, Nucl. Engr. Des., 60 (2), pp 239-256 (Sept 1980) 18 figs, 1 table, 7 refs

Key Words: Nuclear reactor safety, Dynamic tests, Model testing

The structural integrity of scale models of a reactor vessel and head under a simulated hypothetical core disruptive accident is evaluated experimentally. Tests of three 1/20-scale models of the reactor, each of increasing complexity, show the effects of the upper internals structure, a thermal liner, and other structural details on vessel and head response. A fourth model demonstrated experimental reproducibility.

81-542

Structural Damping Values as a Function of Dynamic Response Stress and Deformation Levels

J.D. Stevenson

Structural Mechanics Associates, Cleveland, OH, Nucl. Engr. Des., 60 (2), pp 211-237 (Sept 1980) 3 figs, 7 tables, 34 refs

Key Words: Nuclear power plants, Damping values, Statistical analysis

Damping data existing in the open literature applicable to nuclear power plant structures and equipment is summarized and statistically analyzed. Results of this analysis are used to develop damping trend curves which predict applicable damping values to be used in design at various levels of stress or deformation.

81-543

Comparison of Experimental and Analytic Responses of Scaled LMFBR Heads Under Simulated Hypothetical Core Disruptive Accident Loads

A.M. Christie, M.A. Todd, and S. Ranatza

Westinghouse Electric Corp., Advanced Reactors Div., Madison, PA 15663, Nucl. Engr. Des., 60 (2), pp 267-279 (Sept 1980) 20 figs, 2 tables, 6 refs

Key Words: Nuclear reactor safety, Dynamic tests, Model testing

A series of scale model tests assessing the ability of a reactor to withstand the loads resulting from a hypothetical core disruptive accident were performed. Experimental responses of the vessel heads of the models were compared with the corresponding responses resulting from analytic simulation. These comparisons show that relatively simple computer models of the vessel heads can predict head response quite well. Computer simulation of cover-gas compression was also performed.

81-544

Fluid-Structure Interactions in Light Water Reactor Systems

T. Belytschko and U. Schumann

Dept. of Civil Engrg., Technological Inst., Northwestern Univ., Evanston, IL 60201, Nucl. Engr. Des., 60 (2), pp 173-196 (Sept 1980), 27 figs, 1 table, 34 refs

Key Words: Interaction: structure-fluid, Nuclear reactors

A report is given on the First International Seminar on Fluid-Structure Interaction in Light Water Reactors which took place in Berlin, August 20-21, 1979 in conjunction with the 5th International Conference on Structural Mechanics in Reactor Technology. The seminar focused on the pressurized water reactor loss of coolant accident and the boiling water reactor suppression pool analysis. The discussion concentrated on the importance of various phenomena, appropriate computational methods and experiments.

81-545

Dynamic Analysis Method for a Large Complicated Structure and Application to a Fusion Device

H. Takatsu and M. Shimizu

Japan Atomic Energy Res. Inst., Tokai-mura, Naka-gun, Ibaraki-ken, Japan, Nucl. Engr. Des., 60 (2), pp 297-309 (Sept 1980) 8 figs, 4 tables, 11 refs

Key Words: Nuclear reactor components, Seismic response

A dynamic analysis method is proposed which is especially powerful for such a large complicated structure as a fusion device. An analysis model constructed by the present method provides information of not only overall behavior but local vibration of the real structure with fewer nodal points.

81-546

Fluid Power System Noise Abatement - 1980

G.E. Maroney

W.H. Nichols Co., Waltham, MA, SAE Paper No. 801007, 12 pp, 3 figs, 2 tables, 23 refs

Key Words: Noise reduction, Fluid drives, Hydraulic systems

This paper discusses the motivation for fluid power noise abatement programs, establishment of program milestones, mathematical models for understanding and controlling fluid power system noise, guidelines for obtaining reproducible acoustical measurements, system modification techniques to achieve noise reduction, and the important role of management in the conduct of an effective noise abatement program.

OFF-SHORE STRUCTURES

(Also see Nos. 688, 706)

81-547

The Effects of Wave Spreading on the Exciting Forces on a Tension Leg Platform

R.A. Dietrich

Naval Postgraduate School, Monterey, CA, 73 pp (May 1979)

AD-A086 642/6

Key Words: Off-shore structures, Water waves

Oil exploration in water deeper than 1000 feet has motivated the development of drilling platforms with dynamic responses superior to those of the conventional jacket structures. One of the most promising of these is the tension leg platform, a semi-submersible platform held in place by tension members connected to the ocean bottom. An evaluation of the wave force transfer function for the tension leg platform in heave, pitch, and roll motions is given.

VEHICLE SYSTEMS

GROUND VEHICLES

(Also see Nos. 557, 578, 690, 691, 716)

81-548

Increased Rail Transit Vehicle Crashworthiness in Head-On Collision. Volume II. Primary Collision

E.E. Hahn, S.C. Walgrave, and I. Liber

IIT Res. Inst., Chicago, IL, Rept. No. DOT-TSC-UMTA-80-17-2, UMTA-MA-06-0025-80-2, 80 pp (June 1980)

PB80-205743

Key Words: Collision research (railroad), Crashworthiness, Test equipment and instrumentation, Testing techniques

An analytical model in two dimensions, longitudinal and vertical, of the primary collision of two impacting urban railcar consists is formulated. This model is capable of determining the extent of crushing and/or override suffered by the individual cars in the consists, as well as the time histories of displacement, velocity, and acceleration in both the longitudinal and vertical directions. Methods are developed for generating the dynamic force-deformation relationships for structural sub-assemblages comprising the critical modules of railcars.

81-549

Increased Rail Transit Vehicle Crashworthiness in Head-on Collisions. Volume I. Initial Impact

E.E. Hahn

IIT Res. Inst., Chicago, IL, Rept. No. DOT-TSC-UMTA-80-17-1, UMTA-MA-06-0025-80-1, 70 pp (June 1980)

PB80-205727

Key Words: Crashworthiness, Simulation, Collision research (railroad), Railroad trains

A two-dimensional analytic simulation model of the leading cars of two impacting transit car consists is formulated. This model is capable of simulating the mechanics of head-on initial impact of two transit cars on straight level track. The model is capable of establishing the critical parameters which govern whether the cars crush, override, or crush with subsequent override. This simulation model is used to assess impact control devices currently in service, such as anticlimbers, couplers, and draft gear.

81-550

Contributions to the Dynamic Analysis of Maglev Vehicles on Elevated Guideways

K. Popp
Technical University Munich, West Germany, Shock Vib. Bull., U.S. Naval Res. Lab., Proc., No. 50, Pt. 3, pp 39-61 (Sept 1980) 11 figs, 3 tables, 52 refs

Key Words: Ground effect machines, Magnetic suspension techniques, Periodic response

Feedback control methods for the dynamic analysis of Maglev vehicles moving on flexible guideways are reviewed. From models for the vehicle, suspension and guideway, the mathematical open-loop description is obtained systematically. The result is a high order linear state equation with periodic time-varying coefficients and jumping states.

81-551

Pickup and Van Side Structure Baseline Assessment. Test No. 4, Vehicle-to-Vehicle 60 Degree Right Side Impact

M. Pozzi
Dynamic Science, Inc., Phoenix, AZ, Rept. No. 3053-80-080, DOT-HS-805-999, 89 pp (Mar 1980) PB80-204951

Key Words: Collision research (automotive)

A test was performed to provide baseline data for an unmodified pickup truck when involved in a 60 degree right side vehicle-to-vehicle impact crash.

SHIPS

81-552

Whipping Analysis Techniques for Ships and Submarines

K.A. Bannister
Naval Surface Weapons Ctr., White Oak, Silver Spring, MD 20910, Shock Vib. Bull., U.S. Naval Res. Lab., Proc., No. 50, Pt. 3, pp 83-98 (Sept 1980) 11 figs, 2 tables, 24 refs

Key Words: Ships, Submarines, Interaction: structure-fluid, Underwater explosions, Explosion effects

An important and difficult example of fluid-structure interaction is the whipping of ships and submarines caused by an underwater explosion. Models of whipping must treat structural response, explosion bubble hydrodynamics, and fluid-structure interaction. The existing models and their computational realizations are reviewed, and illustrative calculations are given on, for example, predictions of the strong influence of submergence depth.

AIRCRAFT

(Also see Nos. 569, 608, 680, 704, 706)

81-553

Reduction of Helicopter Vibration Through Control of Hub-Impedance

S.P. Viswanathan and A.W. Myers
Bell Helicopter Textron, Ft. Worth, TX, J. Amer. Helicopter Soc., 25 (4), pp 3-12 (Oct 1980) 10 figs, 1 table, 15 refs

Key Words: Helicopter vibration, Vibration control

A simple pylon support system is described that results in low cabin vibrations at all airspeeds. Devices that reduce vibration are divided into five categories, and it is shown that their characteristics in all these five categories have to be considered in arriving at an optimum solution for helicopter vibration control.

81-554

Vibration Analysis of a Helicopter Plus an Externally-Attached Structure

D.J. Ewins, J.M.M. Silva, and G. Maleci
Imperial College of Science and Tech., London, UK, Shock Vib. Bull., U.S. Naval Res. Lab., Proc., No. 50, Pt. 2, pp 155-171 (Sept 1980) 18 figs, 6 refs

Key Words: Helicopters, Wing stores, Forced vibration, Vibration response, Mathematical models

A vibration analysis is made of a complex structure comprising a helicopter airframe, external carrier platform and a store, in order to construct a mathematical model for use in a design optimization exercise. The model formed is based on impedance coupling of component substructures, using experimentally-derived modal data for the airframe and store, and a finite-element theoretical model of the carrier.

81-555

Influence of Propeller Design Parameters on Far-Field Harmonic Noise in Forward Flight

D.B. Hanson

Hamilton Standard Div., United Technologies Corp., Windsor Locks, CT, AIAA J., 18 (11), pp 1313-1319 (Nov 1980) 15 figs 3 refs

Key Words: Propellers, Geometric effects, Noise generation

A theory for harmonic noise radiation is studied for general guidance to the designer and is applied to some propeller noise problems of current interest. Only the linear sources are studied in detail. The frequency domain results clarify the role of acoustic noncompactness (noise cancellation due to finite chord and span effects). Nondimensional parameters arising from the analysis give design guidance by showing the potential for noise reduction due to changes in airfoil section and blade sweep, twist, and taper as functions of operating conditions.

81-556

Evaluation of Airborne Laser Beam Jitter Using Structural Dynamics Computer Codes and Control System Simulations

C.L. Budde, P.H. Merritt, and C.D. Johnson

Air Force Weapons Lab., Kirtland AFB, NM, Shock Vib. Bull., U.S. Naval Res. Lab., Proc., No. 50, Pt. 3, pp 179-187 (Sept 1980) 15 figs, 2 tables, 4 refs

Key Words: Airborne equipment response, Vibration response, Finite element technique, NASTRAN (computer programs), Frequency domain method

Beam stabilization for the Airborne Laser Laboratory (ALL) is accomplished by inertially stabilizing an annular reference mirror attached to the beam expanding telescope on the Airborne Pointing and Tracking System (APT). The analysis documents the calculation of the residual beam jitter due to vibrations of the ALL and requires the use of the NASTRAN finite element computer code to determine the motion of the various optical elements in the beam expanding telescope. These motions are then combined in an analytical expression to calculate the optical path motion for both the high energy laser and auto-alignment beams.

MISSILES AND SPACECRAFT

(Also see Nos. 576)

81-557

Analysis and Design of the Shuttle Remote Manipulator System Mechanical Arm for Launch Dynamic Environment

D.M. Gossain, L. Quittner, and S.S. Sachdev

Spar Aerospace Ltd., Toronto, Canada, Shock Vib. Bull., U.S. Naval Res. Lab., Proc., No. 50, Pt. 3, pp 125-149 (Sept 1980), 11 figs, 6 tables, 10 refs

Key Words: Spacecraft components, Space shuttles, Launching response

An overview is presented of the design and analysis studies undertaken for the stowed Manipulator Arm, the problems encountered and their solutions.

81-558

Structural Dynamic Characteristics of the Space Shuttle Reaction Control Thrusters

G.L. Schachne and J.H. Schmidt

The Marquardt Co., Van Nuys, CA, Shock Vib. Bull., U.S. Naval Res. Lab., Proc., No. 50, Pt. 3, pp 151-161 (Sept 1980) 16 figs, 6 tables, 2 refs

Key Words: Spacecraft components, Space shuttle, Mode shapes, Natural frequencies, Damping values, Random vibration, Finite element technique

Several configurations of the reaction control thrusters for the space shuttle orbiter were structurally analyzed using finite element models. Acceleration responses and frequencies from these analyses were compared with those recorded during random vibration tests. Various methods for determining structural damping were considered. The resulting analytical dynamic characterization of the structure led to successfully designed and qualified thrusters.

81-559

Single-Point Random and Multi-Shaker Sine Spacecraft Modal Testing

M. Ferrante, C.V. Stahle, and D.G. Breskman

General Electric Co., Space Div., King of Prussia, PA, Shock Vib. Bull., U.S. Naval Res. Lab., Proc., No. 50, Pt. 2, pp 191-198 (Sept 1980), 12 figs, 1 table, 7 refs

Key Words: Spacecraft, Launching response, Dynamic tests, Testing techniques

The modal test of the launch configuration of the DSC-III spacecraft which consists of a tandem spacecraft configuration with a DSCS-II atop a DSCS-III is described. Single-point random was used as the basic test technique, and a new multi-shaker sine testing technique was used to validate it by measuring selected modes.

81-560

Modification of Flight Vehicle Vibration Modes to Account for Design Changes

C.W. Coale and M.H. White

Lockheed Missiles and Space Co., Sunnyvale, CA, Shock Vib. Bull., U.S. Naval Res. Lab., Proc., No. 50, Pt. 3, pp 163-177 (Sept 1980), 6 figs, 4 tables

Key Words: Spacecraft, Flight vehicles, Mode modification method, Mass coefficients, Stiffness coefficients

A method of incorporating spacecraft structural changes by modifying existing flight vehicle modes is presented. The method is applicable for arbitrary changes of mass, stiffness, and structural configuration in a limited area of the vehicle.

81-561

Vibration Environment of the Space Shuttle Solid Rocket Booster Motor During Static Tests

D.R. Mason and M.A. Behring

Thiokol Corp./Wasatch Div., P.O. Box 524, Brigham City, UT 84302, Shock Vib. Bull., U.S. Naval Res. Lab., Proc., No. 50, Pt. 2, pp 241-245 (Sept 1980) 8 figs, 1 table, 5 refs

Key Words: Booster rockets, Solid propellant rocket engines, Spacecraft components, Space shuttles, Self-excited vibration, Vibration measurement

During motor development, four space shuttle booster solid rocket motors were static tested. On these motor tests, the self-induced vibration environment was monitored at numerous locations on the motor. The results of this vibration environment survey are summarized and compared to flight criteria established by NASA for locations on the motor.

81-562

Low Frequency Structural Dynamics of the Space Shuttle Solid Rocket Booster Motor During Static Tests

M.A. Behring and D.R. Mason

Thiokol Corp./Wasatch Div., Brigham City, UT 84302, Shock Vib. Bull., U.S. Naval Res. Lab., Proc., No. 50, Pt. 2, pp 235-239 (Sept 1980) 11 figs, 1 table, 3 refs

Key Words: Booster rockets, Solid propellant rocket engines, Spacecraft components, Space shuttles, Oscillation, Low frequencies

Low frequency oscillations in measured thrust have occurred during static testing of the space shuttle solid rocket booster motor. These measured thrust oscillations are believed to be associated with oscillations in chamber pressure, but are much larger than can be directly attributed to observed pressure oscillations from a ballistic consideration only. This paper describes the development of a mathematical model simulating the motor in the test stand and describes analytical studies into the effects of small amplitude, chamber pressure oscillations on measured thrust.

81-563

Predicting the Motion of Flyer Plates Drive by Light-Initiated Explosive for Impulse Loading Experiments

R.A. Benham

Explosives Testing Div. 1533, Sandia Labs., Albuquerque, NM 87185, Shock Vib. Bull., U.S. Naval Res. Lab., Proc., No. 50, Pt. 4, pp 191-198 (Sept 1980) 10 figs, 12 refs

Key Words: Plates, Reentry vehicles, Impact response (mechanical), Explosives

The possibility of using light-initiated high explosive to accelerate thin flyer plates to high velocities for impulse loading which may produce both material and structural response is explored. A simplified model of the explosive multipoint detonation and expansion process is developed which leads to a calculation of the motion of the flyer plate. Comparisons are made between calculations and measurements from experiments.

81-564

An Experimental Investigation of Noise Attenuating Techniques for Space-Shuttle Canisters

L. Mirandy, F. On, and J. Scott

General Electric Co., Space Div., P.O. Box 8555, Philadelphia, PA, Shock Vib. Bull., U.S. Naval Res. Lab., Proc., No. 50, Pt. 4, pp 77-89 (Sept 1980) 19 figs, 1 table, 5 refs

Key Words: Space shuttles, Noise reduction

A model of the space shuttle thermal canister has been acoustically tested to determine the amount of noise attenuation which could be derived using a simple, single-wall canister construction having rectangular shape. Acoustic testing was performed on the basic canister and with the following noise-attenuating design modifications: an interior baffle, with varying degrees of absorptive material covering on the interior surfaces, and with constrained-layer visco-elastic damping strips bonded to the canister exterior.

81-565

Elimination of a Discrete Frequency Acoustical Phenomenon Associated with the Space Shuttle Main Engine Oxidizer Valve-Duct System

L.A. Schutzenhofer, J.H. Jones, R.L. Jewell, and R.S. Ryan

NASA/George C. Marshall Space Flight Ctr., Marshall Space Flight Ctr., AL 35812, Shock Vib. Bull., U.S. Naval Res. Lab., Proc., No. 50, Pt. 2, pp 247-255 (Sept 1980) 10 figs, 2 refs

Key Words: Space shuttles, Ducts, Acoustic properties

In the development of the space shuttle main engines, various unpredictable dynamical phenomena were experienced which have resulted in engine shutdown or failures; e.g., fires. One such dynamical phenomenon consisted of an acoustical buzz at 7200 Hz in the vicinity of the main oxidizer valve. The method of isolating the buzz phenomenon, identifying the mechanism, and developing a fix to eliminate the buzz is presented together with supporting data.

81-566

Some Space Shuttle Tile/Strain-Isolator-Pad Sinusoidal Vibration Tests

R. Miserentino, L.D. Pinson, and S.A. Leadbetter

NASA Langley Res. Ctr., Hampton, VA, Rept. No. NASA-TM-81853, 27 pp (July 1980)

N80-29766

Key Words: Space shuttles, Spacecraft components, Isolators, Vibration tests

Vibration tests were performed on the tile/strain-isolator-pad system used as thermal protection for the space shuttle orbiter. Experimental data on normal and in-plane vibration response and damping properties are presented.

81-567

Shock Induced in Missiles During Truck Transport

D.B. Meeker and J.A. Sears

Pacific Missile Test Ctr., Point Mugu, CA, Shock Vib. Bull., U.S. Naval Res. Lab., Proc., No. 50, Pt. 2, pp 103-120 (Sept 1980) 10 figs, 4 tables, 2 refs

Key Words: Missiles, Transportation effects

The response of three different types of missiles during four truck trips was measured. The shock response peaks were found to have an exponential distribution in amplitude. The spectrum of the shocks was defined in terms of the level which is exceeded at a given rate.

BIOLOGICAL SYSTEMS

HUMAN

(Also see Nos. 537, 689)

81-568

The Effect of 3-25 Hz Vibration on the Legibility of Numeric Light Emitting Diode Displays

M.L. Johnston and J.H. Wharf

Royal Aircraft Establishment, Farnborough, UK, In: AGARD High-Speed, Low-Level Flight, 9 pp (Mar 1980)

N80-30003

Key Words: Vibration excitation, Human response

The effects of 3-25 Hz sinusoidal vibration at an rms acceleration level of 2.5 m/s2 in both the vertical and lateral axes on the performance of a reading task are described. The task was to read aloud numeric characters presented on a yellow high luminance light emitting diode display which was designed for the military cockpit.

81-569

The Effects of Aircraft Vibration on Vision

G.R. Barnes

Royal Air Force Inst. of Aviation Medicine, Farnborough, UK, In: AGARD High-Speed, Low-Level Flight, 11 pp (Mar 1980)

N80-30002

Key Words: Aircraft vibration, Human response

Movements of the head resulting from aircraft vibration were investigated in terms of their effects on visual performance. Major emphasis was placed on the limitations in the response of the pursuit reflex and the vestibulo-ocular reflex.

81-570

Head Movements Induced by Vertical Vibrations

L. Vogt, E. Schwartz, and H. Mertens
Inst. f. Flugmedizin, Deutsche Forschungs- und Versuchsanstalt f. Luft- und Raumfahrt, Bonn, W. Germany, In: AGARD High-Speed, Low Level Flight, 14 pp (Mar 1980)
N80-30000

Key Words: Vibration excitation, Human response

Eleven subjects were vibrated on a shake-table in the frequency range of 2 Hz to 19 Hz to assess the complex head motion induced by z-axis mechanical vibration. Acceleration amplitude was sinusoidal and held constant at 0.35 g (rms). The results are given as different transmissibility curves for vertical and horizontal head motion.

ANIMAL

81-571

Shock and Vibration Environment in a Livestock Trailer

M.T. Turczyn, D.G. Stevens, and T.H. Camp
U.S. Dept. of Agriculture, Beltsville, MD, Shock Vib. Bull., U.S. Naval Res. Lab., Proc., No. 50, Pt. 2, pp 91-101 (Sept 1980) 5 figs, 4 tables, 12 refs

Key Words: Animal response, Transportation effects

Measurements indicate that the intensity of the shock and vibrational inputs to cattle being transported by livestock trailer are dependent upon tire pressure, load weight, and position within the trailer. Cattle positioned at the rear of the trailer will experience the highest shock and vibrational amplitudes.

MECHANICAL COMPONENTS

ABSORBERS AND ISOLATORS

(Also see No. 635)

81-572

In-Fluid Cylindrical Beam Vibration with Multi-Degree of Freedom Absorbers

B.E. Sandman and J.S. Griffin
Naval Underwater Systems Ctr., Newport, RI 02840, Shock Vib. Bull., U.S. Naval Res. Lab., Proc., No. 50, Pt. 3, pp 11-20 (Sept 1980) 6 figs, 10 refs

Key Words: Vibration absorption (equipment), Beams, Fluid-induced excitation, Multi-degree of freedom systems

A theoretical study of the effects of vibration absorbers with two-point attachments and possessing both translation and rotational degrees of freedom is considered. The analysis demonstrates the dual tuning of rocking and translating absorber resonances to produce attenuation of two low-order beam mode resonances. Cantilevered and free-free hollow Timoshenko beam configurations are utilized as the basis for the presentation of results.

81-573

A New Method of Improving Spectra Shaping in Reverberant Chambers

J.N. Scott and R.L. Burkhardt
NASA Goddard Space Flight Ctr., Greenbelt, MD 20771, Shock Vib. Bull., U.S. Naval Res. Lab., Proc., No. 50, Pt. 2, pp 207-215 (Sept 1980) 13 figs, 1 table, 9 refs

Key Words: Acoustic linings, Ducts, Reverberation chambers

The use of acoustic suppression to line the horn duct of a reverberant noise chamber in an effort to enhance the spectrum shaping capability of the chamber is studied. Construction of the liner and the evaluation of the liner to determine its attenuation characteristics are described.

81-574

Modeling a Temperature Sensitive Confined Cushioning System

V.P. Kobler, R.M. Wyskida, and J.D. Johannes

U.S. Army Missile Command, Huntsville, AL 35809, Shock Vib. Bull., U.S. Naval Res. Lab., Proc., No. 50, Pt. 4, pp 25-33 (Sept 1980) 7 figs, 8 tables, 10 refs

Key Words: Packaging materials, Impact response (mechanical), Drop tests

This paper reports on the modeling of the impact response for the Minicel cushioning material in the confined state. This objective was satisfied through the development of an experimental drop test design, conducting an extensive drop test program, and then modeling the resultant test data. A general mathematical model for a confined cushioning system and a general mathematical model for the exterior container which surrounds the confined corner void configured cushions are presented.

81-575

How to Make an Air Shock Absorber

L.M. Polentz

Plant Engr., 34 (23), pp 129-132 (Nov 13, 1980) 2 figs

Key Words: Shock absorbers

The air shock absorber kickback may be prevented by allowing the pressurized air to leak out at a controlled rate through the slots in the cylinder as the piston is driven back. A method for the calculation of the dimensions of the piston, cylinder and the orifices for such a shock absorber is presented and illustrated by an example.

81-576

Preliminary Hardness Evaluation Procedure for Identifying Shock Isolation Requirements

R.J. Bradshaw and P.N. Sonnenburg

U.S. Army Engineer Div., Huntsville, Huntsville, AL, Shock Vib. Bull., U.S. Naval Res. Lab., Proc., No. 50, Pt. 4, pp 35-57 (Sept 1980) 8 figs, 59 refs

Key Words: Shock isolation, Hardened installations, Missiles, Shock tests, Data processing

A procedure based on past test experience that can be used during the early design phase to identify shock isolation requirements is presented. It is based on the shock test results for the equipment installed in the SAFEGUARD Ballistic Missile Defense System. These shock tests cover over 300 commercial items of equipment found in mechanical and electrical systems. The procedure is written to and for designers of future land-based hardened facilities (nuclear or non-nuclear) that use commercial equipment for which no fragility data exists.

81-577

Agricultural Tractor Chassis Suspension System for Improved Ride Comfort

P.W. Claar, II, F. Buchele, S.J. Marley, and P.N. Sheth

Iowa State Univ., SAE Paper No. 801020, 36 pp, 32 figs, 4 tables, 21 refs

Key Words: Agricultural machinery, Tractors, Suspension systems (vehicles)

An exploratory concept for a chassis suspension system for improving the operator ride comfort of an agricultural tractor is presented. The criteria and concepts incorporated into the design of a hybrid leading and trailing arm chassis suspension system are described. Evaluation of this suspension system and its parameters are discussed by simulating nine different tractor and nine different tractor-plow models, derived from the various combination of suspension configurations and operator cab locations. A generalized mechanical system simulation program is utilized to predict the dynamic linear transfer function behavior of each vehicle model.

TIRES AND WHEELS

81-578

Optimizing Tire/Vehicle Relationships for Best Field Performance

F.C. Hausz and H. Akins

Firestone Tire & Rubber Co., SAE Paper No. 801021, 16 pp, 14 figs, 2 refs

Key Words: Interaction: vehicle-tire, Tractors, Agricultural machinery

Traction performance testing is conducted comparing various tire combinations on a large two-wheel drive farm tractor. The testing compares different size tires and dual applications of bias ply tires. A direct comparison between radial and bias ply tires in the same size is given. Additional testing is performed to determine fuel efficiency comparisons of the radial ply tire versus the bias ply tire.

BLADES

(Also see No. 624)

81-579

Vibrations of a Compressor Blade with S at the Root

D.I.G. Jones

Air Force Wright Aeronautical Labs., Wright Patterson AFB, OH, Rept. No. AFWAL-TR-80-4003, 144 pp (Apr 1980)

AD-A086 852/1

Key Words: Blades, Compressor blades, Turbine blades, Slip amplitude

A simple discrete analytical model is developed to represent the vibration response behavior of a jet engine compressor or turbine blade, primarily in the fundamental mode, allowing for slip at the root. The analysis is compared with experiment, and agreement is found to be satisfactory, indicating that some of the phenomena involved can be modeled in a simple way.

BEARINGS

(Also see Nos. 493, 499, 506, 507, 508)

81-580

Review of Analytical Methods in Rotor-Bearing Dynamics

J.W. Lund

Dept. of Machine Des., Bldg. 403, The Technical Univ. of Denmark, DK-2800 Lyngby, Denmark, Tribology Intl., 13 (5), pp 233-236 (Oct 1980) 1 fig, 11 refs

Key Words: Bearings, Rotor-bearing systems, Fluid-film bearings, Damping

In the analysis of rotor dynamics the influence of fluid film bearings often plays a decisive role. The bearings provide the major source of damping, thereby controlling the peak amplitude response, and their stiffness properties affect the critical speeds and the stability of the rotor.

81-581

Stability of Profile Bore Bearings: Influence of Bearing Type Selection

D.R. Garner, C.S. Lee, and F.A. Martin

Res. and Dev. Organisation, The Glacier Metal Co. Ltd., Alperton, Wembley, Middlesex HAO 1HD, UK, Tribology Intl., 13 (5), pp 204-210 (Oct 1980) 9 figs, 1 table, 4 refs

Key Words: Bearings, Fluid film bearings, Rotors (machine elements)

Fluid film bearings play an important part in determining and controlling the vibrations of a rotor system. Under certain conditions, however, the bearings can effectively cause vibrations. Information is presented on the resistance of several common bearing types to self-excited whirl, and on the dynamic coefficients of the oil film which influence the rotor system. Certain simplifying assumptions are necessary in producing generalized information, but the data allow realistic bearing selections to be made.

81-582

Bearing Failure Case History

J.I. Taylor

Gardinier, Inc., P.O. Box 3269, Tampa, FL, Proc. Machinery Vibration Monitoring and Analysis seminar, Apr 8-10, 1980, New Orleans, LA, pp 157-161, 5 figs

Sponsored by Vibration Institute, Clarendon Hills, IL

Key Words: Bearings, Failure analysis, Pumps

A case history of a bearing failure is presented. It contains the data when the bearing defects were first identified through failure or removal from the equipment. Techniques used to predict the life span of a defective bearing are discussed.

81-583

Nutating Thrust Bearings for Oscillatory Applications

G.M. Blair

Rollway Bearing Div., P.O. Box 4827, Syracuse, NY 13221, Proc., National Conf. on Power Transmn., Oct 1980, Cleveland, OH, pp 167-168, 1 fig

Key Words: Bearings, Thrust bearings, Vibratory tools

The nutating cylindrical roller thrust bearing is designed for use in oscillating applications under normal loads. The design provides for a controlled precession of the roller assembly during the oscillatory duty cycle which precludes fretting damage and wear caused by continuous loading of localized areas.

81-584

The Role of Oil-Film Bearings in Promoting Shaft Instability and the Remedial Effect of Damping

R. Holmes

School of Engrg. and Appl. Sciences, Univ. of Sussex, Falmer, Brighton, Sussex, UK, Tribology Intl., 13 (5), pp 243-248 (Oct 1980) 11 figs, 7 refs

Key Words: Bearings, Oil whirl phenomena, Damping effects

Oil-whirl instability is examined in the context of rigid and flexible rotor systems and the use of external damping to militate against such instability is discussed.

81-585

The Effect of Grooving and Bore Shape on the Stability of Journal Bearings

M. Akkok and C.M.McC. Ettles

Imperial College of Science and Tech., London SW7 2BX, UK, ASLE, Trans., 23 (4), pp 431-441 (Oct 1980) 12 figs, 24 refs

Key Words: Bearings, Journal bearings, Dynamic stability

The stability thresholds of four basic journal bearing types are found. Increasing groove size (up to 90°) is found to exert a strong destabilizing effect. Increasing aspect ratio (L/D) also has a destabilizing effect. The stability of each type was found to improve progressively with preload.

81-586

Stiffness and Damping Coefficients for Finite Length Step Journal Bearings

J.C. Nicholas, P.E. Allaire, and D.W. Lewis

Ingersoll-Rand Co., Phillipsburg, NJ 08865, ASLE, Trans., 23 (4), pp 353-362 (Oct 1980) 15 figs, 8 tables, 15 refs

Key Words: Bearings, Journal bearings, Stiffness coefficients, Damping coefficients

Stiffness, damping and rigid rotor stability curves are presented for 13, finite-step (pressure dam), journal bearings of different geometries. Step inertia effects are neglected, but the axial and circumferential effects of turbulence over the entire bearing surface are included. Experimental results are compared to a theoretical stability analysis for a single-mass, flexible rotor. Good correlation is obtained between the predicted theoretical stability threshold speed and the experimental threshold speed for three test cases.

81-587

An Analysis of the Effect of Journal Bearings with Helical Grooves on the Stability of a Vertically Mounted Canned Motor Pump

A.V. Ruddy

Inst. of Tribology, Dept. of Mech. Engrg., The Univ. of Leeds, Leeds LS2 9JT, UK, Tribology Intl., 13 (5), pp 237-241 (Oct 1980) 4 figs, 2 tables, 8 refs

Key Words: Bearings, Journal bearings, Rotor-bearing systems, Pumps

An analysis of a vibration problem encountered on a vertically mounted, canned motor pump is describe l. Details are given of the flush water lubrication system and the two laminated pf resin journal bearings with helical grooves. The vibrational behavior is described and attributed to bearing instability. A stability analysis based upon a finite element model of the rotor and finite difference solution to the bearing equations is discussed.

81-588

Influence of Misalignment of Support Journal Bearings on Stability of a Multi-Rotor System

Y. Hori and R. Uematsu

Dept. of Mech. Engrg., Univ. of Tokyo, Bunkyo-ku, Tokyo, 113, Japan, Tribology Intl., 13 (5), pp 249-252 (Oct 1980) 9 figs, 1 table, 4 refs

Key Words: Bearings, Journal bearings, Rotor-bearing systems, Alignment

For simplicity, two rotor, four bearing systems are considered. From numerical analysis of typical examples, it is deduced that when the two rotors are the same, the best stability is obtained for zero-misalignment; in cases where they are different, the best stability results from, in general, a certain amount of misalignment. In the latter case, a suitable intentional misalignment can be useful for better stability. Quasi-catenary alignment is assumed.

81-589

Stability and Rotordynamics for Gas Lubricated Bearings

H. Marsh
Dept. of Engrg. Science, Durham Univ., South Road, Durham DH1 3LE, UK, Tribology Intl., 13 (5), pp 219-221 (Oct 1980) 3 figs, 8 refs

Key Words: Rotor-bearing systems, Bearings, Gas bearings, Whirling

Recent research on rotor-bearing dynamics with gas lubricated bearings is reviewed. The behavior of a flexibly mounted bearing system is described and a detailed investigation has been made of whirl onset and whirl cessation.

81-590

Dynamic Behavior of Aerostatic Rectangular Thrust Bearings

A.K. Mishra
Dept. of Mech. Engrg., Regional Engrg. College, Rourkela 769008, Indian, Wear, 63 (2), pp 219-229 (June 1980) 9 figs, 5 refs

Key Words: Bearings, Thrust bearings, Stiffness coefficients, Damping coefficients

A theoretical study to determine the dynamic stiffness and damping characteristics of an aerostatic rectangular thrust bearing is presented. The governing non-linear partial differential equation of film pressure is linearized using a first-order perturbation method. The perturbed equations are solved numerically to determine the dynamic load, which in turn gives the stiffness and damping characteristics. The effect of various parameters on stiffness and damping is also investigated.

81-591

Pump Bearings: Some Design Considerations

A.B. Duncan
Large Pumps Dept., Weir Pumps Ltd., Cathcart Works, Glasgow G44 4EX, UK, Tribology Intl., 13 (5), pp 253 (Oct 1980) 4 figs

Key Words: Pumps, Bearings, Design techniques

Recently more attention has been given to selecting optimum bearing types and determining the required characteristics for pump applications. The trend has been to generate higher heads per stage from higher operating speeds for economic reasons and because of the greater reliability achievable with fewer stages associated with shorter bearing centers and a stiff shaft design concept. Availability of computer evaluation of multi-bearing pump rotor critical speeds prompted research on the stiffness and damping characteristics of the hydrostatic bearings formed by pump internal clearances as well as on the characteristics of the hydrodynamic journal bearings proper.

GEARS

(See No. 520)

COUPLINGS

(Also see No. 510)

81-592

Estimation of Durability for Corrugated Slip Couplings

R. Kagan and V. Kagan
Mathematical Models and Algorithms in Applied Mechanics Problems (Taikomosios mechanikos uždaviniy matematiniai modeliai ir algoritmai). Collection of Papers in Mechanics, No. 19, Ministry of Higher Education of Lithuanian SSR and Vilnius Civil Engrg. Inst. Vilnius, Lithuanian SSR, c 1979, pp 91-96, 2 figs, 6 refs
(In Russian, summaries in Lithuanian and English)

Key Words: Couplings, Cyclic loading

The paper considers problems of stress-strained corrugated slip couplings. A method for the estimation of the cyclic strength of 36HXTI-O ste l slip coupling is presented.

81-593

Compensating Characteristics of Elastic-Dynamic Couplings Based on Spring Rings

A.-P. Kavolelis and J. Jurevicius
Dynamics and Strength of Structures (Konstrukciju dinamika ir atsparumas). Collection of Papers in Mechanics, No. 21, Ministry of Higher Education of Lithuanian SSR and Vilnius Civil Engrg. Inst. Vilnius, Lithuanian SSR, c 1980, pp 83-88, 4 figs, 4 refs
(In Russian, summaries in Lithuanian and English)

Key Words: Couplings, Springs (elastic), Rings

Compensating characteristics of an elastic coupling are determined by the quantity of additional support compression at

radial, angular and axial misalignment of the joining shafts or by three stiffness components. In the given case every kind of stiffness is considered to consist of two components: elastic recovering forces, and centrifugal forces of the revolving mass. The radial stiffness component of the elastic forces is determined by expressing potential energy of rings and the deformation component is expressed by fictitious forces and the coefficients of influence and by stiffness coefficients.

81-594

The Study of Complex Vibrations of Spring Rings of Special Couplings

A.-P. Kavolelis

Dynamics and Strength of Structures (Konstrukciju dinamika ir atsparumas), Collection of Papers in Mechanics, No. 21, Ministry of Higher Education of Lithuanian SSR and Vilnius Civil Engrg. Inst. Vilnius, Lithuanian SSR, c 1980, pp 57-62, 2 figs, 3 refs (In Russian, summaries in Lithuanian and English)

Key Words: Couplings, Ring springs

Ring vibrations of annular resilient centrifugal couplings excited by high frequencies are investigated. Bending moments, normal (tensile or compressive) loadings, the fields of centrifugal forces and concrete fastenings of ring section ends are considered. Natural frequencies, mode shapes, and parametric resonance zones of ring sections are calculated. Some simplified expressions for natural frequencies for more complicated cases are obtained.

81-595

Evaluation of Vibro-Insulating Effects in Resilient Centrifugal Couplings by the Dynamic Identification of Semi-Couplings

A.-P. Kavolelis, V. Kaminskas, R. Pupeikis, and L. Zubavicius

Dynamics and Strength of Structures (Konstrukciju dinamika ir atsparumas), Collection of Papers in Mechanics, No. 21, Ministry of Higher Education of Lithuanian SSR and Vilnius Civil Engrg. Inst. Vilnius, Lithuanian SSR, c 1980, pp 40-51, 4 figs, 8 refs

(In Russian, summaries in Lithuanian and English)

Key Words: Parameter identification technique, Couplings

Experimental parameter estimation of specific coupling units is considered. Initial data are gained from the dynamic signals of the leading and rear parts of the coupling, under a given rotation vibration level. The signals are discretized and interpreted as implementations of random signals, and their spectral correlation analysis is performed. The amplitude-frequency parameters are estimated by means of parameter identification.

81-596

The Use of Diaphragm Couplings in Turbomachinery

C.B. Gibbons

Electrical & Fluid Power Div., The Bendix Corp., Utica, NY, Proc. Machinery Vibration Monitoring and Analysis seminar, Apr 8-10, 1980, New Orleans, LA, pp 99-116, 16 figs

Sponsored by Vibration Institute, Clarendon Hills, IL

Key Words: Couplings, Diaphragm couplings, Turbomachinery, Alignment, Balancing techniques, Natural frequencies

The historical development of shaft couplings with emphasis on the diaphragm coupling is reviewed. Stresses in couplings due to misalignment are also reviewed. Finally the aspects of balancing and axial, torsional, and lateral natural frequencies important to system design are discussed. Examples of diaphragm coupling installations are included.

FASTENERS

81-597

Dynamic Fail-Safe Behaviour of Steel Skeleton Structures Having Bolted Connections

U.A. Girhammar

Swedish Council for Bldg. Res., Stockholm, Sweden, Rept. No. D13 1980, ISBN-91-540-3215-6, 80 pp (1980)

PB80-200769

Key Words: Joints (junctions), Steel, Catenaries, Failure analysis

The dynamic behavior of steel skeleton structures in the area of primary damage is evaluated, taking into account the real properties of different beam-to-column connections under catenary action. The dynamic damage endurance capacity of usual steel structures is studied. The dynamic analyses are verified by experiments.

81-598
Dynamic Loading of Metal Riveted Joints
R.L. Sierakowski, C.A. Ross, J. Hoover, and W.S. Strickland
Dept. of Engrg. Sciences, Univ. of Florida, Gainesville, FL 32611, Shock Vib. Bull., U.S. Naval Res. Lab., Proc., No. 50, Pt. 4, pp 159-174 (Sept 1980) 11 figs, 3 tables, 7 refs

Key Words: Joints (junctions), Dynamic tests

Results of a series of tests to determine the effects of dynamic loading on riveted joints of thin metal structures are presented. Dynamic tests were performed on strain gage instrumented tensile specimens with a precut central hole to determine the effect of stress concentrations. Dynamic tests were also conducted on riveted tensile specimens of various types. Comparison of the results of the dynamic tensile test data with results of blast loaded riveted panels showed very good qualitative agreement.

81-599
On Methods of Screw Threads for Estimation of Couplings Under Cyclic Loading
V. Kagan, M.-K. Leonavicius, and A. Krenevicius
Mathematical Models and Algorithms in Applied Mechanics Problems (Taikomosios mechanikos uzdaviniu matematiniai modeliai ir algoritmai). Collection of Papers in Mechanics. No. 19. Ministry of Higher Education of Lithuanian SSR and Vilnius Civil Engrg. Inst. Vilnius, Lithuanian SSR, c 1979, pp 73-83, 1 fig, 10 refs
(In Russian, summaries in Lithuanian and English)

Key Words: Screws, Couplings, Cyclic loading, Fatigue life

Methods for the computation of the endurance of screw threads under mechanical cyclic loading are presented. The endurance is frequency dependent; however, low-frequency fatigue is not yet adequately investigated experimentally.

81-600
Estimation of Screw Threads Couplings with Regard to Kinetics Fracture
V. Kagan and M.K. Leonavicius
Mathematical Models and Algorithms in Applied Mechanics Problems (Taikomosios mechanikos uzdaviniu matematiniai modeliai ir algoritmai). Collection of Papers in Mechanics. No. 19. Ministry of Higher Education of Lithuanian SSR and Vilnius Civil Engrg. Inst. Vilnius, Lithuanian SSR, c 1979, pp 84-90, 2 figs, 5 refs
(In Russian, summaries in Lithuanian and English)

Key Words: Screws, Fatigue life, Low frequencies

A method for the calculation of the fatigue life of screw threads under low frequency excitation is described. The method is based on fracture kinetics.

LINKAGES

81-601
A Theory of Contact Loss at Resolute Joints with Clearance
R.S. Haines
Univ. of Newcastle-upon-Tyne, J. Mech. Engr. Sci., 22 (3), pp 129-136 (June 1980), 5 figs, 10 refs

Key Words: Joints (junctions), Linkages, Follower forces, Contact vibration

Equations are derived that describe the conditions at a general idealized revolute joint, with clearance but with no hydrodynamic lubrication present. The equations are governed by three dimensionless parameters that depend on the nominal motion, mass distribution and influence coefficients of the linkage in which the joint appears, as well as the clearance magnitude. A series of numerical solutions of the equations is used to predict the conditions under which contact is lost, leading to impacts. Results are presented in the form of a design chart and implications are discussed.

VALVES

81-602
Beating Noise in Fluid Systems
Engr. Matl. Des., 24 (8), pp 44-50 (Sept 1980) 12 figs

Key Words: Pumps, Valves, Noise reduction

Noise generation and reduction in pumps and valves is discussed. The efficiency and installation of several silencers is reviewed.

SEALS

81-603
Testing of Turbulent Seals for Rotordynamic Coefficients
D.W. Childs, J.B. Dressman, and S.B. Childs
Mech. Engrg. Dept., Louisville Univ., Louisville, KY, In NASA Lewis Res. Ctr. Rotordyn. Instability Probl. in High-Performance Turbomachinery, pp 121-138 (1980)
N80-29714

Key Words: Rotors (machine elements), Seals (stoppers), Dynamic tests, Stiffness coefficients, Damping coefficients, Mass coefficients

A test program developed for dynamic testing of straight and convergent-tapered seals, with the capability of separately determining both direct and cross-coupled stiffness, damping, and added mass coefficients is described.

81-604
Evaluation of Instability Forces of Labyrinth Seals in Turbines or Compressors
T. Iwatsubo
Kobe Univ., Kobe, Japan, NASA Lewis Res. Ctr. Rotordyn. Instability Probl. in High-Performance Turbomachinery, pp 139-167 (1980)
N80-29715

Key Words: Rotors (machine elements), Seals (stoppers), Turbine components, Compressors, Fluid-induced excitation

The effects of a force induced by the labyrinth seal on the stability of rotor systems and the factors of the seal which affect the stability are investigated.

81-605
Damping in Ring Seals for Compressible Fluids
D.P. Fleming
NASA Lewis Res. Ctr., Cleveland, OH, NASA Lewis Res. Ctr. Rotordyn. Instability Probl. in High-Performance Turbomachinery, pp 169-188 (1980)
N80-29716

Key Words: Seals (stoppers), Damping effects, Rotors (machine elements)

An analysis is presented to calculate damping in ring seals for a compressible fluid. Results show that damping in tapered ring seals is less than that in straight bore ring seals for the same minimum clearance.

81-606
Flow-Induced Spring Coefficients of Labyrinth Seals for Application in Rotor Dynamics
H. Benckert and J. Wachter
Institut f. Thermische Stroemungsmaschinen, Stuttgart, Univ., West Germany, NASA Lewis Res. Ctr. Rotordyn. Instability Probl. in High-Performance Turbomachinery, pp 189-212 (1980)
N80-29717

Key Words: Rotors (machine elements), Seals (stoppers), Fluid-induced excitation, Spring constants, Rotors (machine elements)

Flow induced aerodynamic spring coefficients of labyrinth seals are discussed and the restoring force in the deflection plane of the rotor and the lateral force acting perpendicularly to it are also considered. The effects of operational conditions on the spring characteristics of these components are examined, such as differential pressure, speed, inlet flow conditions, and the geometry of the labyrinth seals.

STRUCTURAL COMPONENTS

CABLES

81-607
Mooring Dynamics: Computer Models and Experiments at a Sixty Foot Scale
D.B. Dillon
EG and G Washington Analytical Services Ctr., Inc., Rockville, MD, Rept. No. EG/G-TR-4999-0004, 95 pp (July 1980)
AD-A086 854/7

Key Words: Moorings, Cables (ropes), Computer programs

A series of dynamic cable experiments is conducted in order to evaluate computer models of cable systems used in the ocean. The results of an experiment using 60 foot cables are compared to two computer simulations in this report.

81-608
Dynamics of Long Vertical Cables

F.H. Wolff
Westinghouse R&D Ctr., Pittsburgh, PA, Shock Vib. Bull., U.S. Naval Res. Lab., Proc., No. 50, Pt. 3, pp 63-70 (Sept 1980) 7 figs, 3 refs

Key Words: Cables (ropes), Strings, Free vibration

Natural periods of vibration of cables are determined from the homogeneous solution to the equation of motion for a flexible string (with gravity effects) which is fixed at both ends and stretched under applied tension. Curves containing fundamental periods of vibration for cables of various weights per unit length and applied tension conditions are presented as a function of cable length. Comparisons to the solutions of the classical vibrating string are made to illustrate the discrepancies that would occur if the massive cables were modeled as the classical vibrating string.

BEAMS
(Also see Nos. 539, 572, 625, 710)

81-609
Dynamic Large-Displacement Analysis of Curved Beams Involving Shear Deformation

I. Sheinman
Faculty of Civil Engrg., Technion - Israel Inst. of Tech., Haifa, Israel, Intl. J. Solids Struc., 16 (11), pp 1037-1050 (1980) 11 figs, 15 refs

Key Words: Beams, Curved beams, Shear deformation effects, Rotatory inertia effects, Geometric imperfection effects, Viscous damping

A general analytical and numerical procedure, based on large deflection and small rotation, is developed for an arbitrary plane curved beam made of linear elastic material and subjected to arbitrary dynamic loading. The equations of motions admit shear deformation, rotary inertia, geometrical initial imperfections and viscous damping. Three numerical examples involving dynamic buckling are presented and the influence of shear stiffness is considered.

81-610
Attenuation of Structure Borne Sound of Beams by Impedances Attached to the Side (Korperschalldampfung bei Balken durch seitlich angebrachte Widerstande)

M. Heckl
Institut f. Technische Akustik der TU Berlin, Acustica, 45 (4), pp 201-208 (Aug 1980) 4 figs, 8 refs
(In German)

Key Words: Beams, Mechanical impedance, Ducts, Sound attenuation

By analogy to the theory of airborne sound attenuation in ducts the attenuation of structure borne sound is investigated when locally reacting mechanical impedances are attached to a beam. Calculations show some similarities with sound attenuation in ducts. It is shown that for certain complex values of the impedance a rather high attenuation can be achieved.

81-611
Application of an Elasto-Plastic Contact Force Principle in a Simplified Theory for a Bending Impact of a Beam (Vereinfachte Theorie des Biegestosses auf einen Balken bei elastoplastischem Kontaktkraftgesetz)

H. Schwieger and H. Dombrowski
Fortschrift-Ber. VDI-Zeitschr., Series 1, No. 64 (1980) 76 pp, 1 table, 27 figs, Price: 49-DM. Summarized in VDI Zt. 122 (15/16), p 630 (Aug 1980). Avail: VDI Vg, GmbH, Postfach 1139, 4000 Dusseldorf 1, Germany
(In German)

Key Words: Beams, Flexural vibrations, Impact response (mechanical)

The dynamic response of a transversely impacted beam is determined from the parameters of contact force laws for selected impact combinations if the maximum loading occurs in the early stages of alternating action between impacting mass and the beam. A theory for this early stage is presented which provides a simple calculation of the impact force, the tensile strength as well as deflection, taking into account the elasto-plastic contact force laws. The theory uses simple differential equations of beam vibrations; rotatory inertia, transverse shear deformation and damping are not taken into consideration.

CYLINDERS

81-612

Dynamic Stability of Fibrous Composite Cylinders Under Pulse Loading

R.J. Stuart and S. Dharmarajan

College of Engrg., San Diego State Univ., San Diego, CA 92182, Shock Vib. Bull., U.S. Naval Res. Lab., Proc., No. 50, Pt. 3, pp 21-25 (Sept 1980) 1 fig, 8 refs

Key Words: Cylinders, Composite materials, Fiber composites, Pulse excitation

The stability of composite cylindrical shells with general boundary conditions subjected to pressure pulse loads is investigated. The governing differential equations of motion of an orthotropic cylindrical shell subjected to normal pressure are reduced to generalized Donnell's cylindrical shell theory. By neglecting higher order terms, these equations are further reduced to a single eighth-order differential equation in terms of the radial displacement.

PLATES

(Also see Nos. 539, 563, 625)

81-613

The Improvement of Transmission-Loss by Thin Plates in a Certain Distance of Building-Elements (Die Verbesserung der Schalldämmung durch Vorsatzschalen)

W. Kuhl

Anschrift des Verfassers. Am Reisenbrook 7A, D-2000, Hamburg 67, Acustica, 45 (4), pp 228-237 (Aug 1980) 14 figs, 18 refs

(In German)

Key Words: Plates, Sound transmission loss, Acoustic absorption, Buildings, Noise reduction

Thin plates in a certain distance of a thick wall or ceiling improve their transmission-loss, independent of their excitement by air-borne sound or structure-borne sound. When the structure-borne sound coupling of both structures is small, the thin plate is mainly excited through the air-cushion between them. The improvement of transmission-loss is greatest when the air space is almost filled with porous absorbing material. At higher frequencies the improvement is limited by the air-borne sound transmission-loss of the thin plate. Nevertheless it can be increased considerably by the damping of the sound propagating through the absorbing material. It is possible to calculate the overall transmission loss over a very broad frequency range.

81-614

Excitation of Vibrations and of Aerial Sound by the Impact of a Free Turbulent Jet Perpendicularly with an Elastic Plate (Luft- und Korperschallerzeugung bei senkrechter Anstromung einer elastischen Platte durch einen turbulenten Freistrahl in Luft)

W. Bohnke

Institut f. Technische Akustik der Technischen Universitat Berlin, Germany, Acustica, 45 (4), pp 282-293 (Aug 1980) 19 figs, 17 refs

(In German)

Key Words: Plates, Sound propagation, Vibration response, Turbulence

An aluminium plate in a state of vibration is excited by a free-jet. The vibrations are recorded for various relative distances. Major characteristics of the pressure field in the neighborhood of the plate surface are measured. From this data it is possible assuming that the jet velocity and the degree of turbulence along the axis, in the absence of the plate, are equally known, to calculate the mechanical power of the vibrational intensity of the aerial sound radiated by the plate.

81-615

Application of Theory of Optimal Filtering to Boundary Problems of Dynamics of Plates

A. Waberski

Tech. Univ. of Gliwice, Poland, J. Tech. Phys., 21 (1), pp 111-124 (1980) 15 refs

Key Words: Plates, Vibration analysis

The vibration of thin plates in the presence of random disturbances is analyzed. A filtering model is used for optimal filtering of noise disturbing the vibration measurement of such plates under different boundary conditions.

81-616

Free Vibrations of Continuous Rectangular Plates on Oblique Supports

R.K. Gupta

The Papua New Guinea Univ. of Technology, P.O. Box 793, Lae, Papua New Guinea, Intl. J. Mech. Sci., 22 (11), pp 687-697 (1980) 4 figs, 2 tables, 6 refs

Key Words: Plates, Rectangular plates, Free vibration, Finite strip method

The finite strip method is employed in the vibration problem of continuous rectangular plates on oblique supports. The structure is divided into quadrilateral finite strips. The various properties of a quadrilateral finite strip have been derived using the displacement approach. Results are obtained for a two-span rectangular plate with an oblique support at various angles and compared with other solutions.

81-617

The Relative Complexities of Plate and Shell Vibrations

A.W. Leissa

Dept. of Engrg. Mechanics, Ohio State Univ., Columbus, OH, Shock Vib. Bull., U.S. Naval Res. Lab., Proc., No. 50, Pt. 3, pp 1-9 (Sept 1980) 6 figs, 19 refs

Key Words: Plates, Shells, Free vibration

Vibration of plates and shells is a vast and complicated field. Separation of the various complexities which can arise, and identification of those which typically exist in shell vibration problems not usually found in plates, are examined.

81-618

Transverse Vibration of a Rectangular Plate with an Eccentric Circular Inner Boundary

K. Nagaya

Dept. of Mech. Engrg., Faculty of Engrg., Gunma Univ., Kiryu, Japan, Intl. J. Solids Struc., 16 (11), pp 1007-1016 (1980) 5 figs, 5 tables, 13 refs

Key Words: Plates, Rectangular plates, Flexural vibration

A method for solving vibration problems of a rectangular plate with an eccentric circular inner boundary is presented. Numerical calculations are carried out for various combinations of outer and inner boundary conditions, and the nondimensional natural frequencies are given for a number of cases.

81-619

Response and Failure of Underground Reinforced Concrete Plates Subjected to Blast

C.A. Ross, C.C. Schauble, and P.T. Nash

Univ. of Florida Graduate Engrg. Ctr., Eglin Air Force Base, FL, Shock Vib. Bull., U.S. Naval Res. Lab., Proc., No. 50, Pt. 3, pp 71-82 (Sept 1980) 14 figs, 1 table, 10 refs

Key Words: Seals, Plates, Reinforced concrete, Underground structures, Blast response, Explosion effects

Results of an analytical study to determine plate response and subsequent failure of buried reinforced slabs subjected to a small explosive are presented. Failure is described here as actual material fracture of concrete and reinforcing element at some point in the slab. The analysis is based on an assumed plastic hinge or yield line response used previously for metal plates and statically loaded reinforced concrete slabs. Numerical solutions are obtained and results give good qualitative and quantitative agreement with experimental data.

SHELLS

(Also see No. 617)

81-620

Sound Radiation of Thick-Walled Cylindrical Steel Shells in Water (Schallabstrahlung von dickwandigen Stahlzylindern in Wasser)

R. Boisch and D. Guicking

Universitat Gottingen, Germany, Acustica, 45 (4), pp 322-339 (Aug 1980) 14 figs, 27 refs
(In German)

Key Words: Shells, Sound waves, Underwater structures

The distribution of normal surface velocity and the sound radiation of two different free-free cylindrical steel shells have been measured in air and water. The results agree well with theoretical approximations.

RINGS

(See Nos. 593, 594)

PIPES AND TUBES

81-621

Determination of the Wall Impedance in a Kundt's

Tube by Means of a Frequency Modulated Transmitter Signal (Bestimmung der Wandimpedanz im Kundtschen Rohr mit Hilfe eines frequenzmodulierten Sendesignales)
F.J. Lohringer
Institut f. Technische Akustik, TU Berlin, Acustica, 45 (4), pp 274-281 (Aug 1980) 13 figs, 8 refs
(In German)

Key Words: Pipes (tubes), Mechanical impedance, Sound transmission

It is shown, under the assumption of a live sound transmitter of frequency independent velocity and by the neglect of the frequency dependence of the terminal impedance, that through the measurement of the complex relative sound pressure charges at the end of the pipe dependent on the frequency, the complex input resistance of the pipe can be calculated. The terminating impedance of the pipe is obtained after transformation on the pipe end.

81-622
Pipe Lagging - An Effective Method of Noise Control?
T. Smith, J.M. Rae, and P. Lawson
British Gas, Engrg. Res. Station, Newcastle upon Tyne, Great Britain, Appl. Acoust., 13 (5), pp 393-404 (Sept/Oct 1980) 5 figs, 2 tables, 8 refs

Key Words: Pipes (tubes), Noise reduction

There is a lack of reliable information on the application and performance of pipe lagging, even though this method of noise control is widely used to reduce noise radiating from exposed pipework. To provide this information a thorough investigation has been run on pipe lagging materials. The noise-reducing properties of over 120 combinations of material were evaluated.

81-623
Analytical Procedure for Performing Structural Analysis of Nuclear Piping Systems Subjected to Fluid Transients
D.K. Morton
Idaho National Engrg. Lab., Idaho Falls, ID, 160 pp (Feb 1979)
RE-A-79-013

Key Words: Piping systems, Nuclear reactor components, Fluid-induced excitation

An analytical procedure is formulated for the purpose of predicting the structural consequences of various fluid transients in nuclear piping systems. For demonstration purposes, this procedure is utilized to structurally analyze two representative nuclear piping systems subjected to different fluid transients. All procedure details and demonstration problem results are included in the appendices.

DUCTS
(Also see Nos. 586, 573, 610)

81-624
Numerical Techniques in Linear Duct Acoustics
K.J. Baumeister
NASA Lewis Res. Ctr., Cleveland, OH, Rept. No. NASA-TM-81553-E-513, 23 pp (1980)
N80-30154

Key Words: Ducts, Sound propagation, Numerical analysis

Both finite difference and finite element analyses of small amplitude (linear) sound propagation in straight and variable area ducts with flow, as might be found in a typical turbojet engine duct, muffler, or industrial ventilation system, are reviewed. Both steady state and transient theories are discussed. Emphasis is placed on the advantages and limitations associated with the various numerical techniques. Examples of practical problems are given for which the numerical techniques have been applied.

BUILDING COMPONENTS
(Also see No. 667)

81-625
Transfer-Matrix Analysis of Dynamic Response of Composite-Material Structural Elements with Material Damping
M.M. Wallace and C.W. Bert
The Univ. of Oklahoma, Norman, OK, Shock Vib. Bull., U.S. Naval Res. Lab., Proc., No. 50, Pt. 3, pp 27-38 (Sept 1980) 12 figs, 3 tables, 11 refs

Key Words: Plates, Beams, Structural members, Composite materials, Flexural vibration, Torsional vibration, Material damping, Timoshenko theory

A simple one-dimensional finite-element technique utilizing transfer-matrix analysis is used to calculate the flexural and torsional natural frequencies for specimens made from planar anisotropic materials. The theory is based on Lekhnitskii's theory for static torsional-flexural coupling and Timoshenko's beam theory for transverse shear and rotatory inertia.

ELECTRIC COMPONENTS

MOTORS

(See Nos. 528, 532, 699)

ELECTRONIC COMPONENTS

(Also see No. 696)

81-626

Dynamic Integrity Methods Including Damping for Electronic Packages in Random Vibration

J.M. Medaglia
Spacecraft Development Dynamicist, General Electric Space Div., Shock Vib. Bull., U.S. Naval Res. Lab., Proc., No. 50, Pt. 4, pp 91-103 (Sept 1980) 24 figs, 5 tables, 16 refs

Key Words: Electronic instrumentation, Random vibration, Vibration damping

Recent increases in electronic package size and increases in vibration qualification levels have emphasized the importance of design practices for dynamic integrity of printed wiring board and chassis assemblies of electronic piece-parts. Greater throw-weight capabilities of boosters has led to larger, more complex spacecraft with correspondingly larger electronic packages and experiments. Although the large printed wiring boards allow more efficient electronic design, ordinary stiffness design methods often fail to meet the response deflection and acceleration design criteria needed to minimize failure rates. In many cases, constrained layer viscoelastic damping can enhance other design practices by replacing ordinary ribs to produce adequate stiffness plus response magnifications of less than 10.

DYNAMIC ENVIRONMENT

ACOUSTIC EXCITATION

(Also see Nos. 573, 670)

81-627

Noise Control of Jumbo-Mounted Percussive Drills

E.K. Bender, N.R. Dixon, M.N. Rubin, and R.C. Bartholomae
Bolt Beranek and Newman Inc., 50 Moulton St., Cambridge, MA 02238, Noise Control Engr., 15 (13), pp 128-137 (Nov/Dec 1980) 19 figs, 6 refs

Key Words: Mining equipment, Drills, Noise reduction

Control of the noise sources in jumbo-mounted percussive drills used in underground mines is investigated. It is shown how drill noise was attenuated 13 to 18 dB(A) with no loss in drilling rate. Long-term reliability is currently being evaluated through in-mine testing.

81-628

Noise Reduction of a Drawroll Assembly by Design

M.A. Satter
Shiraz Univ., Shiraz, Iran, Noise Control Engr., 15 (3), pp 120-125 (Nov/Dec 1980) 10 figs, 10 refs

Key Words: Noise reduction, Industrial noise, Design techniques

An experimental and analytical study on noise emission from the drawroll assembly of a textile drawtwisting machine is outlined. Specific experimental investigations are made concerning the basic mechanism of noise generation of the assembly. Based on the findings, several design changes aimed at reducing noise emission, have been proposed and the effects of some have been examined. Simple formulas which would enable designers to compute the likely level of noise radiation from the original, as well as the redesigned assembly, are presented.

81-629

Hammer Mill Noise Reduction

C. Ianniello
Istituto di Fisica Tecnica, Facolta di Ingegneria dell'

Universita di Napoli, piazzale Tecchio, 80125 Napoli, Italy, Noise Control Engr., 15 (3), pp 111-113 (Nov/Dec 1980) 4 figs, 2 refs

Key Words: Hammers, Industrial noise, Waste treatment, Noise reduction

A case in which a hammer mill was found to be the major source of noise in a large building containing the machinery of an urban waste treatment plant is investigated. After analysis of sources and paths of noise, noise reduction measures were applied to attain a 20 dB(A) insertion loss at a reference point.

81-630

Transient Effects in Acoustic Sound Reduction Measurements

A.J. Kalinowski

Naval Underwater Systems Ctr., New London, CT, Shock Vib. Bull., U.S. Naval Res. Lab., Proc., No. 50, Pt. 2, pp 29-44 (Sept 1980) 18 figs, 12 refs

Key Words: Noise reduction, Sound reflection, Sound transmission, Viscoelastic damping

Experimental problems associated with the measurement of transmitted and/or reflected sound for test panels coated with a homogeneous viscoelastic layer are treated through the application of analytical techniques. The goal of the experimentalist is to measure the steady state transmitted and/or reflected sound pressure for a coated, submerged flat plate, subject to a train of normally incident harmonic waves.

81-631

Support Roll Noise Reduction Using Elastomer Surfaces

G. Bollinger, R.H. Chan, and J.F. Yerges

Dept. of Mech. Engrg., Univ. of Wisconsin, Madison, WI 53706, Noise Control Engr., 15 (3), pp 114-119 (Nov/Dec 1980) 6 figs, 3 refs

Key Words: Noise reduction, Rolling friction, Elastomers

The idler rolls used to support the long steel tubular rotors of wire stranding machines provide a severe example of rolling contact noise generation. Significant noise reductions can be achieved through the use of elastomer-covered rolls. Considerable care must be exercised in the design, fabrication, installation, and maintenance of these rolls to assure a satisfactory service life. Design considerations are examined.

81-632

Designing for Noise Control at Air Carrier Airports: Runway Layout and Use

A.S. Harris

Bolt Beranek and Newman, Inc., 50 Moulton St., Cambridge, MA 02238, Noise Control Engr., 15 (3), pp 104-109 (Nov/Dec 1980) 5 figs, 2 tables, 6 refs

Key Words: Airport noise, Noise reduction

Some of the opportunities and constraints that face an airport noise abatement planner are given and programs that concentrate on design and use of the runway plan are described. Two case studies, where changes in the airport plan led successfully to reduced noise, are described.

81-633

A Computer Model for Predicting Sound Attenuation by Barrier-Buildings

S. Kurra

Bldg. Res. Ctr., Faculty of Architecture, Istanbul Tech. Univ., Istanbul, Turkey, Appl. Acoust., 13 (5), pp 331-355 (Sept/Oct 1980) 13 figs, 3 tables, 51 refs

Key Words: Sound attenuation, Buildings, Computer programs, Noise barriers

A computer technique involving a procedure for finding the performance values within the shadow zone of a barrier-building is described. Reflections from the ground are taken into account and a control operation is designed for different source and receiver locations related to the building. Consideration is given to the combined effects of wide barriers and finite size screens. Results are confirmed by several experimental measurements carried out in an anechoic room.

81-634

An Experimental and Theoretical Study of the Modelling of Road Traffic Noise and Its Transmission in the Urban Environment

H.W. Jones, D.C. Stredulinsky, and P.J. Vermeulen

Acoustics Group, The Univ. of Calgary, Calgary, Alberta, Canada, Appl. Acoust., 13 (4), pp 251-265 (July/Aug 1980) 11 figs, 3 tables, 24 refs

Key Words: Traffic noise, Scaling, Sound transmission

Experiments conducted on the modeling of traffic noise using a 1/80th scale model of a subdivision of a city are described. Emphasis is placed on the correct evaluation of ground absorption effects. Results are compared with field measurements.

SHOCK EXCITATION

(Also see Nos. 549, 551, 567, 571, 619, 684, 692, 715, 717)

81-635

An Assessment of the Common Carrier Shipping Environment

F.E. Ostrem

GARD, Inc., Niles, IL, Shock Vib. Bull., U.S. Naval Res. Lab., Proc., No. 50, Pt. 2, pp 83-90 (Sept 1980) 14 figs, 12 refs

Key Words: Containers, Shipping containers, Transportation effects, Packaging

Assessment of available data and information describing the common carrier shipping environment is presented. The assessment includes the mechanical shipping hazards of shock and vibration associated with the handling and transportation of typical distribution cycles. Data for these hazards are summarized in a format considered most useful to packaging engineers.

81-636

Shock Measurement During Ballistic Impact Into Armored Vehicles

W.S. Walton

U.S. Army Aberdeen Proving Ground, Aberdeen Proving Ground, MD, Shock Vib. Bull., U.S. Naval Res. Lab., Proc., No. 50, Pt. 2, pp 45-55 (Sept 1980) 15 figs

Key Words: Impact shock, Measurement techniques, Armored vehicles, Velocity, Acceleration

Data from piezoelectric and piezoresistive accelerometers subjected to short duration shocks are analyzed.

81-637

Simulation of Strong Earthquake Motion with Contained-Explosion Line Source Arrays, Single-Source and Array Tests at Camp Parks

J.R. Bruce, H.E. Lindberg, and G.R. Abrahamson

SRI International, Menlo Park, CA, Rept. No. NSF/RA 79027, 155 pp (Dec 1979)
PB80 201445

Key Words: Interaction: soil-structure, Earthquake simulation

The development of a technique using explosives to simulate strong level, earthquake-like ground motion is described. The long range objective is insitu testing of soil-structure interaction and of structures with complex internal equipment systems. The technique can be applied to buildings, nuclear reactors, pipelines, power lines, dams, bridges, and tunnels.

81-638

Longitudinal Wave Propagation in Axisymmetric Structures with Material and/or Discontinuity

F. Barez, W. Goldsmith, and J.L. Sackman

Magnex Corp., San Jose, CA, Exptl. Mech., 20 (10), pp 325-333 (Oct 1980) 9 figs, 6 tables, 20 refs

Key Words: Axisymmetric bodies, Bars, Tubes, Wave propagation, Shock wave propagation

For the purpose of delineating the applicability of simple uniaxial wave-propagation theory to a class of axisymmetric structures, an experimental and a two-dimensional numerical investigation involving the transmission of longitudinal waves produced by impact of steel spheres was conducted.

81-639

Statistical Estimation of Simulated Yield and Overpressure

P.F. Mlakar and R.E. Walker

U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS, Shock Vib. Bull., U.S. Naval Res. Lab., Proc., No. 50, Pt. 2, pp 73-81 (Sept 1980) 4 figs, 10 refs

Key Words: Nuclear weapons effects, Statistical analysis, Least squares method

Estimates of the nuclear weapon yield and overpressure which most closely correspond to the overpressure history observed in an airblast simulation are found using the principle of least squares. Point estimates of these nonlinear parameters are computed with an algorithm based on search by golden section. Approximate confidence intervals are then estimated using a Taylor series expansion about these point estimates.

81-640

Measurement of Blast-Induced Ground Vibrations and Seismograph Calibration

M.S. Stagg and A.J. Engler

Twin Cities Res. Ctr., Bureau of Mines, Twin Cities, MN Bureau of Mines, Rept. RI8506, pp 1-[illegible]2, 13 figs, 5 tables, 28 refs

Key Words: Ground vibration, Blast excitation

Blast-induced ground vibrations from surface coal mine, quarry, and construction blasting were measured and analyzed for frequency content and duration characteristics. Eighteen commercially available ground vibration measurement systems were evaluated in the field and laboratory for linearity, accuracy, and crosstalk. Buried, surface, and sandbagged transducer placement methods were compared, along with peak and vector-sum measurements.

81-641

Structure Response and Damage Produced by Ground Vibration from Surface Mine Blasting

D.E. Siskind, M.S. Stagg, J.W. Kopp, and C.H. Dowding

Twin Cities Res. Ctr., Bureau of Mines, Twin Cities, MN, Bureau of Mines, Rept. RI8507, pp 1-74, 67 figs, 15 tables, 58 refs

Key Words: Ground vibration, Blast excitation, Structural response, Mines (excavations)

Blast-produced ground vibration from surface mining is studied to assess its damage and annoyance potential, and to determine safe levels and appropriate measurement techniques. Direct measurements are made of ground-vibration-produced structure responses and damage in 76 homes for 219 production blasts. These results are combined with damage data from nine other blasting studies.

81-642

Structure Response and Damage Produced by Airblast from Surface Mining

D.E. Siskind, V.J. Stachura, M.S. Stagg, and J.W. Kopp

Twin Cities Res. Ctr., Bureau of Mines, Twin Cities, MN, Bureau of Mines, Rept. RI8485, pp 1-111, 41 figs, 13 tables, 86 refs

Key Words: Structural response, Blast excitation, Measurement techniques, Mines (excavations)

Airblast from surface mining is studied to assess its damage and annoyance potential, and to determine safe levels and appropriate measurement techniques. Research results obtained from direct measurements of airblast-produced structure responses, damage, and analysis of instrument characteristics are combined with studies of sonic boom and human response to transient overpressures.

81-643

Generalized Graphical Solution for Estimating Recoilless Rifle Breech Blast Overpressures and Impulses

P.S. Westine, G.J. Griesenhahn, and J.P. Riegel, III

Southwest Res. Inst., San Antonio, TX, Shock Vib. Bull., U.S. Naval Res. Lab., Proc., No. 50, Pt. 4, pp 175-189 (Sept 1980) 21 figs, 2 tables, 12 refs

Key Words: Gunfire effects, Blast effects

The breech blast from recoilless rifles produces a severe transient blast field that can damage weapon carriers and cause gun crew hearing loss. This paper culminates a three year program in which similitude theory and experimental test results from gun firings have been used to develop a generalized graphical solution for predicting both blast pressures and impulses forward as well as aft of recoilless rifle nozzles. Experimental test data from the literature on various recoilless rifles and a special series of tests on a variable nozzle and chamber recoilless rifle test fixture demonstrate the validity of this solution.

81-644

Breaching of Structural Steel Plates Using Explosive Disks (U)

D.L. Shirey

Explosives Testing Div. 1533, Sandai Labs., Albuquerque, NM 87185, Shock Vib. Bull., U.S. Naval Res. Lab., Proc., No. 50, Pt. 4, pp 223-231 (Sept 1980) 11 figs, 3 tables, 2 refs

Key Words: Plates, Explosives, Penetration, Projectile penetration

Methods for predicting the threshold for explosive breaching of structural steel plates are described. Both empirical and theoretical methods of predicting charge size have been

developed for explosive disks. Theory is compared with test results. Experiments are discussed which investigate the residual energy remaining in a sheared plug when the breaching threshold is exceeded.

81-645

Equations for Determining Fragment Penetration and Perforation Against Metals

I.M. Gyllenspetz

National Defense Res. Inst. (FOA), Stockholm, Sweden, Shock Vib. Bull., U.S. Naval Res. Lab., Proc., No. 50, Pt. 4, pp 213-222 (Sept 1980) 10 figs, 3 tables, 20 refs

Key Words: Ammunition, Penetration, Projectile penetration, Metals

To use computer models successfully to calculate munitions effects in targets, one must be able to calculate fragment impact. These equations must be functional for fragments of different materials, sizes and velocities, and for plates of various thicknesses and materials. Similitude modeling makes it possible to develop approximate equations covering a wide range of variations in the parameters. The equations presented here can be useful in simplified munitions effects calculations and for estimations when no test data are available.

81-646

Scaling of Initiation of Explosives by Fragment Impact

W.E. Baker, M.G. Whitney, and V.B. Parr

Southwest Res. Inst., San Antonio, TX, Shock Vib. Bull., U.S. Naval Res. Lab., Proc., No. 50, Pt. 4, pp 199-211 (Sept 1980) 6 figs, 6 tables, 12 refs

Key Words: Explosives, Storage, Penetration, Projectile penetration

A similitude analysis of the title problem, scaling of test results from the literature, and a careful survey of the scaled results are reported. Correlations are made of the scaled results from various investigators, and implications drawn regarding the physics of the initiation processes for fragment impacts on bare and cased explosives. Scaled prediction curves are given, with error bands.

VIBRATION EXCITATION

(Also see Nos. 567, 571, 602, 636)

81-647

Nonlinear Oscillations of Third Order Systems

N. Van Dao

Technical Univ., Hanoi, Vietnam, J. Tech. Phys., 21 (1), pp 125-134 (1980) 4 figs, 11 refs

Key Words: Nonlinear vibration

Oscillation of third order non-autonomous systems is studied. The approximate solution of the motion equation is found by means of the asymptotic method. Forced oscillation in the third order self-excited system is studied. An experiment on the analog computer is conducted to verify theoretical results.

81-648

Kinematic and Kinetic Studies of a Connecting Rod Gear Train with a Large Angle of Oscillation (Kinematische und kinetische Untersuchungen eines Raderkoppelgetriebes mit grossem Schwingwinkel)

R. Neumann

Technische Universitat Dresden, Germany, Maschinenbautechnik, 29 (9), pp 399-404 (1980) 18 figs, 3 refs

(In German)

Key Words: Connecting rods, Angular vibration

Five-membered connecting rod gear trains are well suited for generation of a large angle of oscillation. There are many gear trains (with different dimensions) which accomplish this function. As an example the results for driving torque, joint forces, course of velocity and acceleration dependent upon the smallest transmission angle of the basic gear train are studied for three different load cases. Diagrams show favorable results.

81-649

Controlling Vibration

Engr. Matl. Des., 24 (8), pp 36-40 (Sept 1980) 3 figs

Key Words: Vibration response

The fundamentals of vibration needed for a proper selection of components are described, including methods of vibration isolation.

81-630

Coordinated Parameter Variations of Oscillating Systems (Koordinierte Parametervariationen an schwingenden Systemen)

K. Salewski, U. Marzok, and M. Streich

Ernst Moritz Arndt-Universität Greifswald, Sektion Physik/Elektronik, Maschinenbautechnik, 29 (8), pp 364-366 (1980) 1 fig, 4 refs

(In German)

Key Words: Parametric vibration

Conditions, which change the vibrational behavior of a system by varying its parameters without changing the mode shapes of the system, are presented. From the resulting equations the needed variation of parameters is calculated.

MECHANICAL PROPERTIES

DAMPING

(Also see Nos. 502, 542, 660)

81-651

Investigation into Oscillatory Mode of Motion and Efficiency Estimation for Special Torsional Oscillation Damper

A.-P. Kavolelis and B. Spruogis

Dynamics and Strength of Structures (Konstrukciju dinamika ir atsparumas), Collection of Papers in Mechanics, No. 21, Ministry of Higher Education of Lithuanian SSR and Vilnius Civil Engrg. Inst. Vilnius, Lithuanian SSR, c 1980, pp 74-82, 4 figs, 3 refs

(In Russian, summaries in Lithuanian and English)

Key Words: Vibration dampers, Torsional vibration

The basic structural element of the damper is a rotary flexible ring. The paper investigates the motion of the system using a set of sixth order nonlinear differential equations. On separation of the motion into uniform rotary and oscillatory, and after expansion of the equation coefficients into Taylor's power series and exclusion of static members, a system of equations for insignificant oscillations is derived. The system contains inertia, flexible and gyroscopic terms. The effect of various parameters on the efficiency of the damper is evaluated using the equivalent moment of inertia and its limit values. Some simplified dependencies are also presented.

81-652

Torsional Oscillation Damper on the Basis of Rotary Flexible Ring

A.-P. Kavolelis and B. Spruogis

Dynamics and Strength of Structures (Konstrukciju dinamika ir atsparumas), Collection of Papers in Mechanics, No. 21, Ministry of Higher Education of Lithuanian SSR and Vilnius Civil Engrg. Inst. Vilnius, Lithuanian SSR, c 1980, pp 63-73, 3 figs, 3 refs

(In Russian, summaries in Lithuanian and English)

Key Words. Vibration dampers, Torsional vibration, Rings

The paper reviews an original torsional oscillation damper retaining its efficiency in a wide disturbing frequency band. Some potential design alternatives are considered. Analytical investigations are based on the kinetic and potential energy expressions of the system with three generalized coordinates. Potential energy is primarily expressed in terms of the induction coefficients and then by stiffness factors. The equations for the calculation of the motion of the system are derived and stability conditions for the dynamic balance of the system are formulated.

81-653

Vibration Exciting Mechanisms Induced by Flow in Turbomachine Stages

W.F. Thompson

Turbo Res. Inc., Lionville, PA, NASA Lewis Res. Ctr. Rotordyn. Instability Probl. in High-Performance Turbomachinery, pp 285-302 (1980)

N80-29722

Key Words: Turbomachinery, Fluid-induced excitation, Damping coefficients, Computer programs

The quasisteady computer analysis of the perturbated centrifugal impeller passage flow is reviewed. A total of 115 stage calculations were used to define the fluid damping coefficient, delta sub fluid.

81-654

The Damping Capacity of a Flat Surface to Roller Contact

T. Koizumi and Y. Saito

Dept. of Mech. Engrg. for Production, Tokyo Inst. of

Tech., Meguro-ku, Tokyo, Japan, Wear, 63 (2), pp 347-357 (June 1980) 10 figs, 3 tables, 8 refs

Key Words: Rolling friction, Damping coefficients

The behavior of the damping capacity of a flat surface to roller contact with various beam hardnesses and thicknesses is investigated. It is established that the hardness and thickness of the beam have a marked effect on the characteristics of its damped vibrations.

81-655

Hysteretic and Viscous Material Damping

F. Molenkamp and I.M. Smith

Delft Soil Mechanics Lab., The Netherlands, Intl. J. Numer. Anal. Methods Geomech., 4 (4), pp 293-311 (Oct/Dec 1980) 14 figs, 11 refs

Key Words: Material damping, Viscous damping, Hysteretic damping, Interaction: soil-structures

Hysteretic and viscous material damping are compared in the context of soils. Popular assumptions about damping are shown to lead to different results for the rocking mode of surface foundations at low frequency.

81-656

Use of Elastomeric Elements in Control of Rotor Instability

A.J. Smalley

Mechanical Technology Inc., Latham, NY, NASA Lewis Res. Ctr. Rotordyn. Instability Probl. in High-Performance Turbomachinery, pp 453-465 (1980) N80-29732

Key Words: Rotors (machine elements), Dynamic stability, Elastomeric dampers, Stiffness coefficients, Damping coefficients

The dynamic characteristics of elastomeric supports are discussed. Stiffness and damping characteristics for elastomers of various geometries including O-rings, buttons loaded in compression, and rectangular elements loaded in shear are presented. The effects of frequency, temperature, and amplitude are illustrated, as well as the effects of material and geometry. Empirical design methods are illustrated, and several examples are presented where elastomers have successfully controlled both synchronous and nonsynchronous vibrations.

81-657

Comparison of Analytical and Experimental Results for a Semi-Active Vibration Isolator

L.J. Krasnicki

Lord Kinematics, Erie, PA, Shock Vib. Bull., U.S. Naval Res. Lab., Proc., No. 50, Pt. 4, pp 69-76 (Sept 1980) 15 figs, 3 refs

Key Words: Active damping, Vibration isolation

A single degree of freedom system employing an active damper, used as a semi-active vibration isolation device, is successfully reduced to practice. A laboratory prototype is fabricated and tested, and the rest results of the active damper performance, subject to both sinusoidal and random vibrational input, are discussed and compared to recent analytical simulations.

81-658

An Application of Tuned Mass Dampers to the Suppression of Severe Vibration in the Roof of an Aircraft Engine Test Cell

J.L. Goldberg, N.H. Clark, and B.H. Meldrum

CSIRO Division of Applied Physics, Sydney, Australia 2070, Shock Vib. Bull., U.S. Naval Res. Lab., Proc., No. 50, Pt. 4, pp 59-68 (Sept 1980) 14 figs, 6 refs

Key Words: Tuned dampers, Buildings, Test facilities, Concretes, Vibration absorbers

Tuned mass dampers are applied to suppress severe vibration in the concrete roof panels of a building used for testing constant speed turbopropeller aircraft engines. A basis for design of the dampers is described. The size and number of absorber masses and the characteristics of the spring required to effectively supress the particular mode of the panel are determined from calculations of the modal energy using experimentally measured data. The procedure is illustrated by examining the response of the slab situated above the propeller and subjected to the strongest excitation.

FATIGUE

(Also see Nos. 599, 600, 680)

81-659

Fatigue Life Prediction for Multilevel Step-Stress Applications

R.G. Lambert

General Electric Co., Aircraft Equipment Div., Utica, NY 13503, Shock Vib. Bull., U.S. Naval Res. Lab., Proc., No. 50, Pt. 3, pp 189-200 (Sept 1980) 7 figs, 9 tables, 5 refs

Key Words: Fatigue life, Fatigue materials, Prediction techniques

A cumulative fatigue damage procedure is developed which uses linear elastic fracture mechanics theory as its basis in order to predict the fatigue life of structures subjected to multilevels of sequentially applied stress. The applied stress can be sinusoidal or random. The material's fatigue curve is treated as a scatterband of failure points.

81-660

Material Damping as a Means of Quantifying Fatigue Damage in Composites

P.J. Torvik and C. Bourne
Dept. of Aeronautics and Astronautics, Air Force Inst. of Tech., Wright-Patterson Air Force Base, OH, Shock Vib. Bull., U.S. Naval Res. Lab., Proc., No. 50, Pt. 4, pp 1-11 (Sept 1980) 10 figs, 4 tables, 7 refs

Key Words: Fatigue life, Composite materials, Nondestructive tests, Material damping

The possibility of using damping measurements as a nondestructive means of quantifying damage accumulation during the fatigue life of composites is considered. Damping measurements are made during the course of fatigue studies on a graphite epoxy composite using both the logarithmic decrement and the bandwidth techniques.

81-661

Wear Out Failure Patterns and Their Interpretation

A.D.S. Carter
Royal Military College of Science, Shrivenham, Wiltshire, J. Mech. Engr. Sci., 22 (3), pp 143-151 (June 1980) 10 figs, 9 refs

Key Words: Fatigue life, Failure analysis

It is shown theoretically that fatigue of a component will result in a failure pattern which consists of an initial period of intrinsic reliability, or near zero failures, followed by a rapid increase in failure rate when loss of fatigue strength becomes operative, to be followed in turn by a period during which the failure rate decreases with time or maybe remains constant. By contrast other wear-out modes involving a continuous loss of strength give rise to a steadily increasing failure rate after the period of intrinsic reliability has expired. Practical examples of each type are quoted to substantiate the theoretical deductions. The interpretation of wear out characteristics by Weibull distributions is discussed.

ELASTICITY AND PLASTICITY

81-662

Dynamic Crack Propagation in a Viscoelastic Strip

C.H. Popelar and C. Atkinson
Dept. of Engrg. Mechanics, The Ohio State Univ., Columbus, OH 43210, J. Mech. Phys. Solids, 28 (2), pp 79-93 (Apr 1980) 5 figs, 14 refs

Key Words: Crack propagation, Viscoelastic media

The dynamic propagation of a semi-infinite crack in a finite linear viscoelastic strip subjected to Mode I loading is investigated. Through the use of integral transforms the problem is reduced to solving a Wiener-Hopf equation. The asymptotic properties of the transforms are exploited to establish the stress intensity factor. Plane-stress and plane-strain stress intensity factors as a function of crack speed for both fully-clamped and shear-free lateral boundaries are presented for the standard linear viscoelastic solid. Comparisons are made with previously obtained asymptotic stress intensity factors and with stress intensity factors for the equivalent elastic strips.

81-663

Finite-Strain Large-Deflection Elastic-Viscoplastic Finite-Element Transient Response Analysis of Structures

J.J.A. Rodal and E.A. Witmer
Massachusetts Inst. of Tech., Cambridge, MA, Rept. No. NASA-CR-159874, ASRL-TR-154-15, 567 pp (July 1979)
N80-29762

Key Words: Viscoelastoplastic properties, Transient response, Finite element technique

A method of analysis for thin structures that incorporates finite strain, elastic-plastic, strain hardening, time dependent material behavior implemented with respect to a fixed configuration and is consistently valid for finite strains and finite rotations is developed. The theory is formulated systematically in a body fixed system of convected coordinates with materially embedded vectors that deform in common with continuum. Tensors are considered as linear vector functions and use is made of the dyadic representation. The kinematics of a deformable continuum is treated in detail, carefully defining precisely all quantities necessary for the analysis.

81-664
On the Dynamic Buckling of a Simple Elastic-Plastic Model

N. Jones and H.L.M. dos Reis
Dept. of Ocean Engrg., Massachusetts Inst. of Tech., Cambridge, MA 02139, Intl. J. Solids Struc., 16 (11), pp 969-990 (1980) 19 figs, 26 refs

Key Words: Dynamic buckling, Elastic-plastic properties

In order to provide some insight into the phenomenon of dynamic plastic buckling, the response of an imperfection-sensitive idealized model with elastic-plastic springs to simulate material plasticity is examined using theoretical and numerical methods.

EXPERIMENTATION

MEASUREMENT AND ANALYSIS
(Also see Nos. 642, 718)

81-665
Angular Acceleration Measurement Errors Induced by Linear Accelerometer Cross-Axis Coupling

A.S. Hu
Physical Science Lab., New Mexico State Univ., Las Cruces, NM 88003, Shock Vib. Bull., U.S. Naval Res. Lab., Proc., No. 50, Pt. 2, pp 11-16 (Sept 1980) 3 figs, 3 refs

Key Words: Accelerometers, Impact response (mechanical), Error analysis

In biomechanical experiments, the head angular impact responses of the test subject are usually calculated from the data of linear accelerometers because of their small size and light weight. As many as nine linear accelerometers are sometimes used for a complete three dimensional head kinematic measurement. One major error source of this type of measurement is the cross-axis coupling of the accelerometers. This paper derives the mathematical model of the instrument, defines the cross-axis sensitivity, computes the angular measurement errors caused by the linear accelerometers, and discusses the physical meaning of each error term under various impact motions. The study reveals some insight into the limitations of the measurement technique.

81-666
Measurement and Analysis of Torsional Vibration

R.L. Eshleman
Vibration Institute, Clarendon Hills, IL, Proc. Machinery Vibrations IV seminar, Nov 11-13, 1980, Cherry Hill, NJ, 16 pp, 9 figs, 2 tables, 7 refs
Sponsored by Vibration Institute, Clarendon Hills, IL

Key Words: Torsional vibration, Measuring instruments, Measurement techniques

After an introduction to torsional vibration and its causes, several torque measuring and analysis instruments and techniques are described. Case histories of an engine flywheel gear failure, a motor-driven compressor and a synchronous motor-gearbox are discussed.

81-667
A Method for Experimentally Determining Rotational Mobilities of Structures

S.S. Sattinger
Westinghouse-Bettis Atomic Power Lab., Pittsburgh, PA, Shock Vib. Bull., U.S. Naval Res. Lab., Proc., No. 50, Pt. 2, pp 17-28 (Sept 1980) 17 figs, 9 refs

Key Words: Measurement techniques, Rotational response, Angular vibration, Translational response, Structural members, Beams

The difficult task of experimentally measuring rotational mobilities has been approached with the use of special fixturing attached to the components. It is shown here that rotational mobilities of structures are equivalent to spatial derivatives of their translational mobilities. The method of finite differences is adapted to the approximation of these derivatives. By this method the rotational mobilities are derived from sets of conventionally measured translational mobilities, eliminating the need for special fixturing. This approach to determining rotational mobilities is demonstrated in a set of experiments on a free-free beam.

81-668

A Precision Inertial Angular Vibration Measuring System

H.D. Morris, R.B. Peters, and P.H. Merritt

Systron-Donner Corp., Concord, CA, Shock Vib. Bull., U.S. Naval Res. Lab., Proc., No. 50, Pt. 2, pp 1-10 (Sept 1980) 9 figs, 2 tables, 9 refs

Key Words: Measuring instruments, Measurement techniques, Displacement measurement, Angular vibration, Aircraft

An instrumentation system is described which permits high precision broadband angular vibration measurements or real time image motion compensation in typical aircraft environments. The system consists of a proprietary dynamic inertial angular displacement sensor calibrated by a special purpose table which is capable of producing and measuring sinusoidal motions up to one milliradian peak amplitude from 1 Hz to over 500 Hz.

81-669

The Use and Interpretation of Vibration Measurements

P.G. Morton and J.H. Johnson

Stafford Mech. Lab., GEC Power Engrg. Ltd., Stafford ST17 4LN, UK, Tribology Intl., 13 (5), pp 225-230 (Oct 1980) 9 figs, 8 refs

Key Words: Vibration measurement, Measurement techniques, Shafts (machine elements), Rotating structures

Vibrations in any structure are the manifestation of energy exchanges, both internal and between the structure and its environment. Most rotor dynamic vibration phenomena can be compared directly with the behavior of other, physically different, dynamical systems. The interpretation of vibration measurements is the inverse process; i.e., that of identifying such equations from their solutions and relating those equations to physical processes. Over the years a library of mechanisms contributing to the vibration behavior of rotating systems has been built up.

81-670

Using a "Soundtube" to Measure Noise of Structural Sources in High Background Noise Environments

J.T. Rainey and F. Kushner

Carrier Corp., Res. Div., Syracuse, NY, Proc. 9th Turbomachinery Symp., Gas Turbine Labs., Dec 9-11, 1980, pp 69-73, 6 figs, 4 refs

Sponsored by Mech. Engrg. Dept., Texas A&M Univ.

Key Words: Measuring instruments, Noise measurement

A device referred to as a soundtube, designed to accurately measure only the normal component of the surface velocity of a vibrating structural noise source is described. Both laboratory and field data are presented. There are significant advantages of the soundtube over an accelerometer for surface velocity measurements.

81-671

Basic Problems Caused by Depth and Size Constraints in Low-Frequency Underwater Transducers

R.S. Woollett

New London Lab., Naval Underwater Systems Ctr., New London, CT 06320, J. Acoust. Soc. Amer., 68 (4), pp 1031-1037 (Oct 1980) 10 figs, 13 refs

Key Words: Transducers, Acoustic measuring instruments, Underwater sound

Scaling of a conventional transducer design to very low frequencies usually leads to greater power than needed and greater size than is considered tolerable. Normally, therefore, scaling guidelines are abandoned, and very low-frequency transducers are miniaturized; that is, made with dimensions much smaller than the sound wavelength. The resulting low radiation resistance leads to high mechanical Q, poor power-to-weight ratio, and poorly behaved driving-point impedance. By employing electrical equalizers and acoustoelectrical feedback, the designer can achieve broad bandwidth in spite of the high Q, but an oversized driving amplifier is required. Transducers that operate at full ocean depths are usually liquid-filled. The stiffness of the interior liquid increased the transducer size and tends to raise its Q and lower its coupling factor.

81-672

Present Status in Flextensional Transducer Technology

G. Brigham and B. Glass

Sanders Associates, Inc., Nashua, NH 03061, J. Acoust. Soc. Amer., 68 (4), pp 1046-1052 (Oct 1980) 8 figs, 6 refs

Key Words: Transducers, Acoustic measuring instruments

Use of flextensional transducers has been limited historically by an inability to design them accurately and by their apperent unsuitability for phased or conformal arrays. Reliable design requires development of cost-effective, relatively accurate, and preferably algebraic mathematical models. Recent work on flextensional transducers produced unrestrained equations of the required accuracy for peak radiated power, resonant halfpower bandwidth, resonant frequency, and the optimum power-bandwidth product design that represents the smallest, lightest, Class IV transducer for any acoustic requirements. This paper briefly summarizes the analytical background of the model; recent experimental work, application to several sonars, including both expendable and ship systems; and the ultimate capabilities of Class IV devices.

81-673

The Air Gun Impulsive Underwater Transducer

J.E. Barger and W.R. Hamblen

Bolt Beranek and Newman, Inc., 50 Moulton St., Cambridge, MA 02138, J. Acoust. Soc. Amer., 68 (4), pp 1038 1045 (Oct 1980) 7 figs, 7 refs

Key Words: Transducers, Acoustic measuring instruments, Underwater sound

Experience with the use of high-pressure guns at many depths to generate impulsive underwater sound in the fundamental frequency range from 10 to 200 Hz is reported. A simple analysis shows that the fundamental frequency of waveforms increases faster with increasing depth than predicted by the Rayleigh-Willis equation. In addition, the acoustical efficiency of air gun sources is found to decrease with increasing depth, falling sharply as the ambient pressure becomes a significant fraction of the initial gun pressure. Experimental waveform and energy source level data verify these analytical results. Finally, data obtained from arrays of air guns are presented.

81-674

Concepts and Use of the Real Time Analyzer

J.L. Frarey

Shaker Res. Corp., Ballston Lake, NY, Proc. Machinery Vibration Monitoring and Analysis seminar, Apr 8-10, 1980, New Orleans, LA, pp 127-137, 13 figs

Sponsored by Vibration Institute, Clarendon Hills, IL

Key Words: Real time spectrum analyzers, Fast Fourier transform, Vibration measurement, Measuring instruments, Spectrum analyzers

Concepts such as aliasing, negative frequencies, windowing and real time rate are discussed. The real time rate will be compared between older time comparison analyzers and the newer FFT unit. Problems associated with a transient capture button on the front of an analyzer whose basic process assumes stationary or non-changing data is addressed.

81-675

Evaluation of Machinery Condition by Spectral Analysis

J.I. Taylor

Gardinier, Inc., P.O. Box 3269, Tampa, FL 33601, Proc. Machinery Vibration Monitoring and Analysis seminar, Apr 8-10, New Orleans, LA, pp 1-15, 20 figs, 5 refs

Sponsored by Vibration Institute, Clarendon Hills, IL

Key Words: Rotating structures, Monitoring techniques, Spectral analysis, Time domain method

Procedures for identifying general machine condition such as unbalance, looseness, bent shaft, misalignment, cavitation, rubbing and other conditions that cause vibration problems are described. These problems/conditions can be identified by spectral analysis, however, analysis of the time domain signal is helpful in determining how the machine is behaving. Careful analysis of the spectrum frequency, shape, amplitude, and sum and difference frequencies can reveal the above problems. The importance of taking data in the load zone is stressed. An actual case history of each problem is presented.

81-676

Signature Analysis of Rotating Machinery in the Chemical Industry

J.B. Erskine, M.A. Phipps, and N. Hensman

Agricultural Div., Imperial Chemical Industries, Ltd., Cleveland, UK, Proc. Machinery Vibration Monitoring and Analysis seminar, Apr 8-10, 1980, New Orleans, LA, pp 35-41, 3 figs, 1 table, 3 refs

Sponsored by Vibration Institute, Clarendon Hills, IL

Key Words: Rotating structures, Monitoring techniques, Spectrum analyzers, Computer-aided techniques, Signature analysis

The evolution of a specific system which employs a commercially available spectrum analyzer and digital computer together with in-house software is described. Some of the problems encountered en route and progress in developing the use of the system are outlined.

81-677
Dynamic Analysis of Machines and Structures
A.C. Keller
Spectral Dynamics, Scientific-Atlanta, Proc., Machinery Vibration Monitoring and Analysis Seminar, Apr 8-10, 1980, New Orleans, LA, pp 139-149, 30 figs
Sponsored by Vibration Institute, Clarendon Hills, IL

Key Words: Diagnostic techniques, Rotating structures, Frequency response

The measurement, interpretation and use of frequency response measurements in diagnosing rotating machinery and structural problems is described.

81-678
Modal Analysis - Design Aid for Use of New Materials
D.J. Durham
Zonic Technical Labs., Inc., Cincinnati, OH, Industrial Res. and Dev., 22 (11), pp 141-143 (Nov 1980) 2 figs

Key Words: Modal analysis, Machining

A minicomputer-based modal analysis system and a controlled-force hydraulic exciter system is described and its application in the design of components to minimize vibration during machining is presented. The system consists of a data memory that can contain from 2 to 16 input channels, anti-aliasing filters, a multichannel high speed FFT processor, a minicomputer, a display terminal, and a hard copy unit. The exciter system comprises an exciter head, a master controller, and a hydraulic power supply.

81-679
Limitations on Random Input Forces in Randomdec Computation for Modal Identification
S.R. Ibrahim
Dept. of Mech. Engrg. and Mechanics, Old Dominion Univ., Norfolk, VA, Shock Vib. Bull., U.S. Naval Res. Lab., Proc., No. 50, Pt. 3, pp 99-112 (Sept 1980) 10 figs, 3 tables, 18 refs

Key Words: Random decrement technique, Modal analysis, Parameter identification technique, Time domain method

The condition of having white noise random input to test structures has been proven unnecessary for the purpose of using random decrement technique for modal identification of vibrating structures. It is shown that nonwhite, stationary narrow band random inputs will yield modal parameters as accurate as those obtained if the inputs were narrow band white noise. Seven simulated experiments are included in support of the material presented.

DYNAMIC TESTS

(Also see No. 559)

81-680
Sonic Fatigue Testing of the NASA L-1011 Composite Aileron
J. Soovere
Lockheed-California Co., Burbank, CA, Shock Vib. Bull., U.S. Naval Res. Lab., Proc., No. 50, Pt. 4, pp 13-23 (Sept 1980) 26 figs, 12 refs

Key Words: Fatigue tests, Aircraft noise, Aircraft wings, Composite materials

The sonic fatigue test program to very the design of the composite inboard aileron for the L-1011 airplane jet noise environment is described. The composite aileron is fabricated from composite minisandwich covers which are attached to graphite/epoxy front spar and ribs, and to an aluminum rear spar with fasteners. Coupon testing, with large electromagnetic shakers, is used to develop random S/N (stress vs. number of cycles) data for specific components in the design. Coupon failure modes are presented and discussed.

81-681
A Method to Determine Realistic Random Vibration Test Levels Taking Into Account Mechanical Impedance Data Part 1: Basic Ideas and Theory
O. Sylwan
IFM Akustikbyran AB, Stockholm, Sweden, Shock Vib. Bull., U.S. Naval Res. Lab., Proc., No. 50, Pt. 2, pp 129-135 (Sept 1980) 2 figs, 1 ref

Key Words: Vibration tests, Testing techniques, Random vibration, Mechanical impedance, Airborn equipment response, Acceleration, Spectral energy distribution techniques

A new method to determine more realistic random vibration test levels based on measured acceleration spectral densities has been developed. It takes into account the differences between the mechanical impedances of the system equipment - supporting structure in service and under test conditions. Basic ideas and theory behind the method are presented.

81-682

A Method to Determine Realistic Random Vibration Test Levels Taking Into Account Mechanical Impedance Data Part II: Verification Tests

T. Hell

SAAB-SCANIA AB, Linkoping, Sweden, Shock Vib. Bull., U.S. Naval Res. Lab., Proc., No. 50, Pt. 2, pp 137-154 (Sept 1980) 20 figs, 4 tables

Key Words: Vibration tests, Testing techniques, Random vibration, Mechanical impedance, Acceleration, Spectral energy distribution techniques, Airborne equipment response

A new method to determine more realistic random vibration test levels based on measured acceleration spectral densities has been tested. The different phases of the test program which are presented are tests, measurements, signal analysis, and test results.

81-683

Bias Errors in a Random Vibration Extremal Control Strategy

D.O. Smallwood and D.L. Gregory

Sandia Labs., Albuquerque, NM, Shock Vib. Bull., U.S. Naval Res. Lab., Proc., No. 50, Pt. 2, pp 199-205 (Sept 1980) 1 fig, 1 ref

Key Words: Random vibration, Vibration tests, Error analysis

The theoretical basis for an extremal control strategy in random vibration testing is discussed. Except for special cases, this strategy results in bias errors. Formulas for estimating the bias are given, and methods for minimizing the error are suggested.

81-684

Consideration of an Optimal Procedure for Testing the Operability of Equipment under Seismic Disturbances

C.W. de Silva, F. Loceff, and K.M. Vashi

Carnegie-Mellon Univ., Pittsburgh, PA 15213, Shock Vib. Bull., U.S. Naval Res. Lab., Proc., No. 50, Pt. 4, pp 149-158 (Sept 1980) 3 figs, 7 refs

Key Words: Testing techniques, Equipment response, Seismic excitation

An optimal single-shaker test procedure is developed for the seismic qualification of Class 1E multicomponent electrical equipment. The method comprises a single test that uses a uniaxial excitation having certain minimum intensity applied at the equipment support location in a predetermined optimal direction. Analytical expressions for the optimal test parameters are obtained by maximizing the risk of component failure during testing.

81-685

Dynamic Testing - How Far We've Come - How Much Further to Go

A.J. Curtis

Hughes Aircraft Co., Culver City, CA, Shock Vib. Bull., U.S. Naval Res. Lab., Proc., No. 50, Pt. 1, pp 39-44 (Sept 1980) 2 figs, 3 tables

Key Words: Dynamic tests, Vibration tests

The evolution of dynamic and, in particular, laboratory vibration testing is reviewed, followed by introduction of test purpose and test condition matrices which may help in understanding why certain tests are or should be performed in certain ways. This leads to a discussion, both philosophic and hardware-directed, of a few of the needed developments in the field. One of these developments, namely the very topical area of vibration screens, is discussed in some detail.

81-686

Conservatism in Shock Analysis and Testing

T.L. Paez

The University of New Mexico, Albuquerque, NM, Shock Vib. Bull., U.S. Naval Res. Lab., Proc. No. 50, Pt. 4, pp 117-136 (Sept 1980) 6 figs, 3 tables, 14 refs

Key Words: Shock tests, Testing techniques

When a structure is to be subjected to mechanical shocks in the field, it is desirable to test that structure using a shock test which is conservative (excites a more severe response in a structure than the inputs it is meant to represent) with respect to the field shock inputs. For a particular shock test there exists a probability of conservatism. It is shown how the probability of conservatism of a shock test can be approximately calculated when some shocks measured from the random field source are available.

81-687

An Overview of Shock Analysis and Testing in the Federal Republic of Germany

K.E. Meier-Dornberg

Institut f. Mechanik, Technische Hochschule Darmstadt, Shock Vib. Bull., U.S. Naval Res. Lab., Proc., No. 50, Pt. 4, pp 105-115 (Sept 1980) 8 figs, 4 refs

Key Words: Shock tests, Testing techniques

The presentation is confined to some ideas of data reduction. The main object is a relevant approximation and classification of input shock pattern by sets of only few significant parameters.

81-688

Measurement of Dynamic Structural Characteristics of Massive Buildings by High-Level Multipulse Techniques

D.G. Yates and F.B. Safford

Agbabian Associates, El Segundo, CA, Shock Vib. Bull., U.S. Naval Res. Lab., Proc., No. 50, Pt. 4, pp 137-147 (Sept 1980) 15 figs, 9 refs

Key Words: Testing techniques, Off-shore structures, Nuclear power plants, Seismic response

Experimental determination of the responses of large structures has become a necessary tool for structural design verification and analysis. The structural integrity of off-shore oil platforms and the seismic risks in nuclear power plants and other large structures require much greater safety assurance. Multipulsed high-level structural testing is an innovative approach to high-level transient testing. A portable impulse device of recent development produces large force time histories that can be controlled to satisfy multimode system response.

81-689

A 50 km/h Vehicle-to-Vehicle Crash with Test Dummies (Ein 50-km/h-Front-Heck-Aufprall mit Testpersonen)

M. Danner and R. Wagner

Strindbergstrasse 8, 8000 Munchen 60, Automobiltech. Z., 82 (10), pp 501-504 (Oct 1980) 8 figs, 3 refs

(In German)

Key Words: Collision research (automotive), Human response, Anthropomorphic dummies

Crash tests and sled tests with human test persons and Hybrid II dummies are described. To obtain a realistic accident simulation the tests were run with standard Audi 80 vehicles fitted with the standard seat belt systems.

81-690

The Vibration Test Unit - A Unique Rail Vehicle Vibration Test Facility

R.O. Coupland and A.J. Nintzel

Wyle Labs., Colorado Springs, CO, Shock Vib. Bull., U.S. Naval Res. Lab., Proc., No. 50, Pt. 2, pp 217-227 (Sept 1980) 14 figs

Key Words: Vibration tests, Test facilities, Interaction: rail-wheel, Railroad cars

A vibration test unit, a twelve shaker vibration system designed to vibrate a railcar to simulate the action of track/train dynamics, is described. Included is a description of the system and a summary of its performance capabilities.

81-691

The Application of Computers to Dynamic Rail Vehicle Testing

B. Clark

Wyle Labs., Colorado Springs, CO, Shock Vib. Bull., U.S. Naval Res. Lab., Proc., No. 50, Pt. 2, pp 229-233 (Sept 1980) 2 tables

Key Words: Vibration tests, Test facilities, Interaction: rail-wheel, Railroad cars, Automated testing, Computer-aided techniques

A two-computer system is used to provide semiautomated test control and monitoring for a rail vehicle test facility. The system provides control at 12 independent force transfer points, and a data acquisition capability of 100,000 samples per second. The computer equipment and the control and data acquisition computer software are described.

81-692
Shock in Solids: Army Materials Research and Applications
R. Shea and J.F. Mescall
U.S. Army Materials and Mechanics Res. Ctr., Watertown, MA, Shock Vib. Bull., U.S. Naval Res. Lab., Proc., No. 50, Pt. 1, pp 27-38 (Sept 1980) 12 figs, 1 table, 3 refs

Key Words: Shock wave propagation, Test facilities

The mission of U.S. Army Materials and the Mechanics Research Center and its current research program of shock in solids is described.

81-693
Crash Test Facility at the Federal Highway Research Institute (Die Aufprall-Versuchsanlage der Bundesanstalt fur Strassenwesen)
W. Sievert
Bundesanstalt f. Strassenwesen, Fachgruppe Kraftfahrzeugtechnik, Bruhler Strasse 1, D-5000 Koln 51, Automobiltech. Z., 82 (10), pp 507-511 (Oct 1980) 7 figs, 3 tables, 11 refs
(In German)

Key Words: Test facilities, Collision research (automotive)

At the Federal Highway Research Institute a crash-test facility was developed enabling accident simulation. By means of this facility, research in the area of passive motor vehicle safety, and international cooperation in this field can be supported, and the Institute's role as technical advisor to other governmental agencies can be improved.

81-694
Automatic Data Channel Calibration and Noise Identification
E.E. Nesbit
Lawrence Livermore Lab., Livermore, CA, Shock Vib. Bull., U.S. Naval Res. Lab., Proc., No. 50, Pt. 2, pp 57-72 (Sept 1980) 5 figs, 1 table, 2 refs

Key Words: Test facilities, Dynamic tests, Automated testing, Parameter identification technique, Noise source identification

As part of an overall upgrade of dynamic testing facilities, an automatic data channel calibration system has been implemented that uses microcomputer-based hardware and a parameter identification algorithm derived from optimal control theory. Analyses are performed using sine and square wave calibration signals (at user-specified frequencies) to determine channel gain and offset, and known constant calibration signals to determine 60, 120, and 180 Hertz channel noise.

DIAGNOSTICS

(Also see Nos. 674, 677, 716)

81-695
A Review of Machinery Condition Monitoring
J.S. Mitchell
Turbomachinery Consultant, San Juan Capistrano, CA, Proc. Machinery Vibration Monitoring and Analysis seminar, Apr 8-10, 1980, New Orleans, LA, pp 151-156, 4 figs
Sponsored by Vibration Institute, Clarendon Hills, IL

Key Words: Monitoring techniques, Rotating structures

A guide for establishing a condition monitoring program for operating machinery is presented. Three types of programs are described in some detail: a periodic measurement of vibration amplitudes, a continuous monitoring system, and a predictive spectrum analysis.

81-696
Improving Vibration Techniques for Detecting Workmanship Defects in Electronic Equipment
J.W. Burt and M.A. Condouris
Technical Support Activity, U.S. Army Electronics Command, Fort Monmouth, NJ 07703, Shock Vib. Bull., U.S. Naval Res. Lab., Proc., No. 50, Pt. 2, pp 173-189 (Sept 1980) 9 figs, 5 tables

Key Words: Diagnostic techniques, Failure detection, Vibratory techniques, Electronic instrumentation

The results of a study made to evaluate the effectiveness of sine and random vibration for detecting workmanship defects in electronic equipment are described. The vibration test program was based upon the use of a fastener-cantilever beam device which effectively simulated workmanship defects that had first mode resonant frequencies between 27 and 880 Hz.

81-697

Polar Plotting Applications for Rotating Machinery

D.E. Bently

Proc. Machinery Vibrations IV seminar, Nov 11-13, 1980, Cherry Hill, NJ, 6 pp, 17 figs, 13 refs

Sponsored by Vibration Institute, Clarendon Hills, IL

Key Words: Rotating structures, Rotors (machine elements), Graphic methods, Diagnostic techniques, Balancing techniques

Polar plots are being used with increasing frequency to document and assist in the interpretation of rotating machine performance. The advantages of polar plots include the ability to distinguish between split and close-together self-balance resonances, and the ability to distinguish between structural, aerodynamic, or self-balancing resonances. Other advantages include the ability to read shaft bow mode shapes for rotor diagnostics and balancing purposes, and the ability to show historical shaft bow mode amplitude and phase according to correlative pertinent parameters.

81-698

Rotating Machinery Vibration Analysis Using Polar Diagrams

J.D. Halloran

Turbocompressor Div., Joy Machinery Co., Proc. Machinery Vibration Monitoring and Analysis seminar, Apr 8-10, 1980, New Orleans, LA, pp 55-71, 16 figs, 6 refs

Sponsored by Vibration Institute, Clarendon Hills, IL

Key Words: Rotating structures, Diagnostic techniques, Graphic methods, Vibration monitoring

Polar diagram data displays for vibration analysis are discussed from fundamental concepts to interpretation of a complex multiple peak response data set. Characteristics of the polar plot for symmetric and asymmetric systems, for forward and backward responses and for developing internal loops are seperately presented. The aim of the discussion is to foster the use and understanding of polar diagrams as a powerful and additional tool for vibration analysis.

81-699

Induction Motor Bearing Support Resonance - A Case History

D.E. Hasselfeld

Standard Oil Co. of California, San Francisco, CA, Proc. Machinery Vibration Monitoring and Analysis seminar, Apr 8-10, 1980, New Orleans, LA, pp 93-97, 4 figs, 3 refs

Sponsored by Vibration Institute, Clarendon Hills, IL

Key Words: Diagnostic techniques, Bearings, Induction motors

A problem with high axial vibration encountered on a large four-pole induction motor is described. The primary cause of the vibration was bearing supports which were in resonance with the third harmonic of running speed. A number of suspect mechanical conditions are discussed.

BALANCING

(Also see No. 697)

81-700

An Experimental Introduction to the Development of a Unified Approach to Flexible Rotor Balancing

A.G. Parkinson, M.S. Darlow, A.J. Smalley, and R.H. Badgley

The Open Univ., Milton Keynes, UK, Proc. Machinery Vibrations IV seminar, Nov 11-13, 1980, Cherry Hill, NJ, 34 pp, 7 figs, 19 tables, 13 refs

Sponsored by Vibration Institute, Clrendon Hills, IL

Key Words: Rotors (machine elements), Flexible rotors, Balancing techniques, Influence coefficient method

Several successful methods for balancing flexible rotating shafts have been developed in recent years. The methods can be divided into groups which are based on modal characteristics and groups which employ influence coefficients. The relative merits of these two approaches have been the subject of much discussion and argument – most of it inconclusive and rather fruitless. This paper represents the initial experimental stage of a joint project by which it is hoped to resolve the apparent differences and develop a unified approach to such balancing. Balancing trials are reported in much more detail than is usual in the published literature in the belief that this information will give a useful insight into balancing practice.

81-701

Flexible Rotor Balancing: A Review of Principles and Practices

R.S. Sharp

Dept. of Mech. Engrg., Univ. of Leeds, Leeds LS2 9JT, UK, Tribology Intl., 13 (5), pp 211-216 (Oct 1980) 3 figs, 29 refs

Key Words: Balancing techniques, Rotors (machine elements), Flexible rotors

The balancing of flexible rotors on bearing supports is considered from fundamental and practical standpoints. The effect of unbalance, the relevant parts of modal analysis and modal balancing, influence coefficients and influence coefficient balancing methods, the selection of balancing planes, measurements and procedures, results obtainable, outstanding difficulties, and likely developments are considered.

81-702
High Speed Balance Procedure
R. Ehrich
Borsig GmbH, Berlin, West Germany, Proc. 9th Turbomachinery Symp., Gas Turbine Labs., Dec 9-11, 1980, pp 25-31, 14 figs, 10 refs
Sponsored by Mech. Engrg. Dept., Texas A&M Univ.

Key Words: Balancing techniques, Turbomachinery, Rotors (machine elements)

Elastic balancing procedures and experimental results for turbomachine rotors are described. The commonly known criteria of static and dynamic balancing no longer apply in this case.

81-703
Dynamic Balancing
R.L. Fox
IRD Mechanalysis, Inc., Houston, TX, Proc. 9th Turbomachinery Symp., Gas Turbine Labs., Dec 9-11, 1980, pp 151-183, 55 figs, 1 table
Sponsored by Mech. Engrg. Dept., Texas A&M Univ.

Key Words: Balancing techniques, Dynamic balancing

Unbalance has been found to be one of the most common causes of machinery vibration, present to some degree on nearly all rotating machines. This paper is presented to provide essential information needed to solve the majority of balancing problems.

MONITORING

(Also see Nos. 675, 676, 698)

81-704
Vibration Analysis Applied to Aircraft Carrier Machinery Fault Diagnosis
M. Libby and B. Lundgaard
PERA (CV), Puget Sound Naval Shipyard, WA, Proc. Machinery Vibration Monitoring and Analysis seminar, Apr 8-10, 1980, New Orleans, LA, pp 85-91, 5 figs
Sponsored by Vibration Institute, Clarendon Hills, IL

Key Words: Monitoring techniques, Ships, Warships, Aircraft carriers, Data processing, Vibration signatures

A Navy program of machinery condition analysis is being used as a maintenance planning tool for scheduling aircraft carrier machinery overhaul and repairs. The program is replacing the traditional open and inspect of periodic overhaul with a program of objective analysis for determining repair requirements and priorities. The development, scope and application of the vibration analysis program is reviewed. Specific attention is directed to the data processing system and narrowband vibration criteria for evaluating quality of repair work.

81-705
Failure Indication and Corrective Action for Turboshaft Engines
A.D. Pisano
Advanced Control Engineer, General Electric Co., Aircraft Engine Group, Lynn, MA, J. Amer. Helicopter Soc., 25 (4), pp 36-42 (Oct 1980) 10 figs 2 tables, 4 refs

Key Words: Helicopter engines, Diagnostic techniques, Monitoring techniques

In order to prevent loss of power modulation capability in the event of a failed engine control sensor, an automatic in-flight failure indication and corrective action strategy is developed for advanced turboshaft helicopter applications. It provides for both the detection of a failed sensor and the generation of the best estimate of the failed signal which can then be used to provide continuity of stable engine control.

81-706

A Structural Database for Offshore Platforms

B. Hatlestad and K. Mellingen

A.S. Bergens Mekaniske Verksteder, Bergen, Norway, Computers Struc., 12 (4), pp 625-632 (Oct 1980) 4 figs, 4 refs

Key Words: Off-shore structures, Monitoring techniques, Finite element technique, Computer-aided techniques

A systematic use of the finite element method along with sub-structure techniques to provide the structural engineers responsible for design or maintenance of platforms with stress coefficients for fast and easy analytical monitoring of stresses as loads and structural details are changed is described. The database is established and accessed through a special computer program. The paper focuses on the practical use of a database for a typical Condeep platform in the North Sea.

81-707

Failure Analysis and Repair Techniques for Turbomachinery Gears

T.C. Glew

Prager, Inc., Gear and Machine Products, New Orleans, LA, Proc. 9th Turbomachinery Symp., Gas Turbine Labs., Dec 9-11, 1980, pp 11-23, 9 figs, 1 table, 4 refs

Sponsored by Mech. Engrg. Dept., Texas A&M Univ.

Key Words: Turbomachinery, Gears, Failure analysis, Monitoring techniques

The use of gears in turbomachinery applications is covered. Contents of the American Gear Manufacturers Association and American Petroleum Institute standards are reviewed. When gears fail or are damaged, various proven repair techniques are available. These methods can save much downtime and through the reuse of salvageable parts, substantial cost savings can be realized.

81-708

The Graphical Shaft Alignment Calculator

J.D. Piotrowski

Proc. Machinery Vibration Monitoring and Analysis seminar, Apr 8-10, 1980, New Orleans, LA, pp 117-125, 28 figs, 3 refs

Sponsored by Vibration Institute, Clarendon Hills, IL

Key Words: Alignment, Shafts (machine elements), Graphic methods

A graphical shaft alignment calculator is described which plots reverse indicator readings from two rotating units, enabling the determination of shim changes and/or lateral moves, and a quick and accurate alignment between the two units.

ANALYSIS AND DESIGN

ANALYTICAL METHODS

81-709

On the Efficient Time Integration of Systems of Second-Order Equations Arising in Structural Dynamics

W.H. Enright

Dept. of Computer Science, Univ. of Toronto, Toronto, Canada, Intl. J. Numer. Methods Engr., 16, pp 13-18 (Oct 1980) 3 tables, 14 refs

Key Words: Boundary value problems, Dynamic structural analysis

Fixed stepsize low-order methods are the most widely used technique for solving the second-order initial value problems that arise in structural dynamics. The special stability difficulty that arises with this class of problem is described and an outline showing how variable stepsize techniques can cope with this difficulty and result in efficient numerical methods is given.

81-710

Vibrations of Point Loaded Systems with Coupling between Different Wave Types - Part I (Schwingungen punktweise belasteter Systeme unter Berucksichtigung der Kopplung verschiedener Wellenarten - Teil I)

F. Pesko

Institut f. Technische Akustik der TU Berlin, Acustica, 45 (4), pp 209-217 (Aug 1980) 3 figs, 27 refs (In German)

Key Words: Eigenvalue problems, Point source excitation, Beams

The system of partial, non-homogeneous differential equations of the first order describing a mechanical system with 2 n variables can be derived by considering the continuity of the n kinematic variables and the equilibrium of the n dynamic variables for each volume element. Such systems are solved with well-known methods by reducing them to one 2nd order differential equation. This reduction is not possible if there exists a coupling between the different wave types, e.g. for a vibrating beam carrying eccentric masses. Applying the well-known theory of systems of linear differential equations of the first order with constant coefficients, solutions for equations with variable coefficients are derived by analytical means. In this paper the theory is used to calculate the eigenvalues of a point loaded beam of finite length.

MODELING TECHNIQUES

(See Nos. 505, 554)

PARAMETER IDENTIFICATION

(Also see Nos. 534, 679)

81-711

Some Aspects of Recursive Parameter Estimation

V. Solo
Mathematics Res. Ctr., Univ. of Wisconsin, Madison, WI 53706, Intl. J. Control, 32 (3), pp 395-410 (Sept 1980) 29 refs

Key Words: Parameter identification technique, Stochastic processes

A unified view of the nature of the recursive, stochastic approximation and model reference methods for estimating the parameters of a lumped model of a dynamic system is developed. It is shown how, by sequential minimization of an average prediction error, it is possible to construct recursive algorithms for almost any lumped parametric model. For a general class of recursions an informal analysis of convergence is given by considering the first order moment behavior of the recursion.

COMPUTER PROGRAMS

81-712

STINT/CD: A Stand-Alone Explicit Time Integration Package for Structural Dynamics Analysis

P.G. Underwood and K.C. Park
Palo Alto Res. Lab., Lockheed Missiles and Space Co., Inc., Palo Alto, CA, Rept. No. LMSC/D770637, 45 pp (June 1980)
AD-A087 423/0

Key Words: Computer programs, Dynamic structural analysis

This paper is a user's guide for the stand-alone explicit direct time integration package STINT/CD for structural dynamics analysis. STINT/CD uses an automatic variable time increment central difference method. The purpose, function, limitations, and usage of the package are described.

81-713

User's Manual for NEMESIS and PLMODE

R. Gonzalez and S.C. Payne
Appl. Res. Labs., Texas Univ. at Austin, TX, Rept. No. ARL-TM-80-6, 132 pp (May 1, 1980)
AD-A087 254/9

Key Words: Computer programs, Elastic waves, Wave propagation

The normal mode model, NEMESIS, was designed and implemented to aid in the investigation of low frequency, range invariant, acoustic propagation effects. NEMESIS computes the eigenvalues and normal modes of the depth separated acoustic wave equation. Group velocities and modal attenuation terms are also computed. Propagation loss and velocity potential for a source and receiver at a given range can be calculated from these quantities. A computer model, PLMODE, was designed to perform these computations, and the computer code for both NEMESIS and PLMODE was prepared for export to other research laboratories. This report is designed to accompany this software and to assist persons who wish to use it. The contents include descriptions of the modeled environment, the input data and their format, and the output produced by the models.

81-714

Steady, Oscillatory, and Unsteady Subsonic Aerodynamics, Production Version 1.1 (Sousssa-P 1.1) Volume 2: User/Programmer Manual

S.A. Smolka, R.D. Preuss, K. Tseng, and L. Morino
Aerospace Systems, Inc., Burlington, MA, Rept. No. NASA-CR-159131, 184 pp (June 1980)
N80-29253

Key Words: Computer programs, Aerodynamic loads, Aircraft

A user/programmer manual for the computer program SOUSSA-P 1.1 is presented. The program is designed to provide accurate and efficient evaluation of steady and unsteady loads on aircraft having arbitrary shapes and motions, including structural deformations.

81-715
Increased Rail Transit Vehicle Crashworthiness in Head-on Collisions. Volume IV. IITRAIN User's Manual
E.E. Hahn
IIT Res. Inst., Chicago, IL, Rept. No. UMTA-MA-0025-00-4, 233 pp (June 1980)
PB80-205735

Key Words: Computer programs, Crashworthiness, Collision research (railroad), Railroad trains, Simulation

A specific goal of safety is to reduce the number of injuries that may result from the collision of two trains. A computer code for the simulated crash of two railcar consists is described. The code is capable of simulating the mechanics of head-on impact of two consists on straight level track. The user can model the individual car components or cars in as complex or as simple a manner as is warranted by the simulation results desired.

GENERAL TOPICS

CONFERENCE PROCEEDINGS

81-716
Rotordynamic Instability Problems in High-Performance Turbomachinery
NASA Lewis Res. Ctr., Cleveland, OH, Conf. held at College Station, May 12-14, 1980, sponsored by Texas A&M Univ., Louisville Univ. and AROD, Rept. No. NASA-CP-2133, 463 pp (1980)
N80-29706

Key Words: Diagnostic techniques, Rotors (machine elements), Rotor bearing systems, Seals (stoppers), Fluid-induced excitation, Proceedings

Diagnostic and remedial methods concerning rotordynamic instability problems in high performance turbomachinery are discussed. Instabilities due to seal forces and work-fluid forces are identified along with those induced by rotor bearing systems. Several methods of rotordynamic control are described including active feedback method, the use of elastometric elements, and the use of hydrodynamic journal bearings and supports.

TUTORIALS AND REVIEWS

81-717
State-of-the-Art Literature Review of Water Hammer
J.C. Watkins and R.A. Berry
Idaho National Engrg. Lab., Idaho Falls, 116 pp (Apr 1979)
RE-A-79-044

Key Words: Water hammer, Computer programs, Reviews

A state-of-the-art review of literature pertinent to fluid transients (water hammer) was undertaken. A scenario of various fluid transients is presented, followed by a review of research and testing of various phenomena which affect the severity of the transient. Numerical simulation techniques of such transients as well as numerous computer codes which could be applied to such transients, are discussed.

CRITERIA, STANDARDS, AND SPECIFICATIONS

81-718
Machinery Vibration Measurement
ANSI Standard-ANSI S2.17-1980

Key Words: Standards and codes, Vibration measurement, Machinery vibration, Diagnostic techniques, Monitoring techniques

A new standard on techniques for machinery vibration measurement, ANSI S2.17-1980 (ASA 24-1980) contains descriptions of techniques for measuring all machinery vibrations except torsional. It is applicable to the manufacture and repair of machinery as well as to users of machinery interested in measuring vibrations. Measuring equipment, measuring procedures, and calibration related to the measurement of machinery vibration are described. All commonly accepted measuring quantities are included: displacement, velocity, and acceleration ANSI S2.17-1980 is applicable to machines having rigid or flexible foundations and to machines having rigid or flexible rotors.

81-719

Myths and Sacred Cows in the Environmental Sciences

H.J. Caruso, Tech. editor

J. Environmental Sci., 23 (6), pp 21-24 (Nov/Dec 1980) 12 refs

Key Words: Testing techniques, Standards and codes

The author argues against the sacrosanct status of standardization, which sometimes lacks scientific basis. As examples, he questions the wisdom of retaining the 71°C as the number for high temperature testing, the effectiveness of orthogonal axis testing in shock and vibration, the 2000 Hz upper limit for broadband vibration tests, and the requirement of a 15-g, 11ms shock test in a dynamic qualification test program. He hopes that a direct involvement of professional societies such as the IES, IEEE, AIA, and EIA in writing and reviewing key standards will improve the situation.

AUTHOR INDEX

CALENDAR

MARCH 1981

8-12 **26th International Gas Turbine Conference and Exhibit** [ASME] Houston, TX *(ASME Hq.)*

21-Apr 1 **Lubrication Symposium** [ASME] San Francisco, CA *(ASME Hq.)*

31-Apr 1 **Pressworking Machinery for the Eighties Conference** [IMechE] Birmingham, UK *(IMechE, 1 Birdcage Walk, Westminster, London SW1H 9JJ)*

APRIL 1981

6-8 **22nd Structures, Structural Dynamics, and Materials Conference** [AIAA, ASME, ASCE, AHS] Atlanta, Georgia *(AIAA, ASME, ASCE, AHS Hqs.)*

6-9 **NOISEXPO '81** [S/V, Sound and Vibration] Hyatt Regency O'Hare, Chicago, IL *(NOISEXPO '81, 27101 E. Oviatt Rd., Bay Village, OH 44140)*

27-30 **27th Intl. Instrumentation Symposium** [Aerospace Industries and Test Measurement Divisions of the Instrument Society of America] Hyatt Regency, Indianapolis, IN *(Jim Dorsey, c/o Measurements Group, P.O. Box 27777, Raleigh, NC 27611)*

MAY 1981

4-7 **Institute of Environmental Sciences' 27th Annual Technical Meeting** [IES] Los Angeles, CA *IES, 940 East Northwest Highway, Mt. Prospect, IL 60056)*

31-Jun 5 **Spring Meeting and Exhibition of the Society for Experimental Stress Analysis** [SESA] Hyatt Regency, Dearborn, MI *(SESA, P.O. Box 277, Saugatuck Station, Westport, CT 06880)*

JUNE 1981

1-4 **Design Engineering Conference and Show** [ASME] Chicago, IL *(ASME Hq.)*

8-10 **NOISE-CON 81** [Institute of Noise Control Engineering and the School of Engineering, North Carolina State University] Raleigh, North Carolina *(Dr. Larry Royster, Program Chairman, Center for Acoustical Studies, Dept. of Mechanical & Aerospace Engr., North Carolina State University, Raleigh, NC 27650)*

22-24 **Applied Mechanics Conference** [ASME] Boulder, CO ASME Hq.)

SEPTEMBER 1981

1-4 **Joint Meeting of the British Society for Strain Measurement and the Society for Experimental Stress Analysis** [B.S.S.M. and SESA] Edinburgh University, Scotland *(C. McCalvey, Administration Officer, B.S.S.M., 281 Heaton Road, Newcastle upon Tyne, NE6, 5QB, UK)*

7-11 **Applied Modelling and Simulation Conference and Exhibition** [I.A.S.T.E.D. and A.M.S.E.] Lyon, France *(A.M.S.E., 16, Avenue de Grande Blanche, 69160 Tassin-La-Demi-Lune, France)*

20-23 **Design Engineering Technical Conference** [ASME] Hartford, CT *(ASME Hq.)*

28-30 **Specialists Meeting on "Dynamic Environmental Qualification Techniques"** [AGARD Structures and Materials Panel] Noordwijkerhout, The Netherlands *(Dr. James J. Olsen, Structures and Dynamics Division, Air Force Wright Aeronautical Laboratories/FIB, Wright Patterson Air Force Base, OH 45433)*

30-Oct 2 **International Congress on Recent Developments in Acoustic Intensity Measurement** [CETIM] Senlis, France *(Dr. M. Bockhoff, Centre Technique des Industries Mecaniques, Boite Postale 67, F-60304, Senlis, France)*

OCTOBER 1981

4-7 **International Lubrication Conference** [ASME - ASLE] New Orleans, LA *(ASME Hq.)*

11-15 **Fall Meeting of the Society for Experimental Stress Analysis** [SESA] Keystone Resort, Keystone, CO *(SESA, P.O. Box 277, Saugatuck Station, Westport, CT 06880)*

19-22 **Intl. Optimum Structural Design Symp.** [U.S. Office of Naval Research and Univ. of Arizona] Tucson, AZ *(Dr. Erdal Atrek, Dept. of Civil Engr., Bldg. No. 72, Univ. of Arizona, Tucson AZ 85721)*

21-23 **34th Mechanical Failures Prevention Group Symp.** [National Bureau of Standards] Gaithersburg, MD *(J.E. Stern, Trident Engineering Associates, 1507 Amherst Rd., Hyattsville, MD 20783 - (301) 422-9506)*

27-29 **52nd Shock and Vibration Symposium** [Shock and Vibration Information Center, Washington, D.C] New Orleans, Louisiana *(Henry C. Pusey, Director, SVIC, Naval Research Lab., Code 5804, Washington, D.C. 20375)*

CALENDAR ACRONYM DEFINITIONS AND ADDRESSES OF SOCIETY HEADQUARTERS

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

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

AHS: American Helicopter Society
1325 18 St. N.W.
Washington, D.C. 20036

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

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

AREA: American Railway Engineering Association
59 E. Van Buren St.
Chicago, IL 60605

ARPA: Advanced Research Projects Agency

ASA: Acoustical Society of America
335 E. 45th St.
New York, NY 10017

ASCE: American Society of Civil Engineers
345 E. 45th St.
New York, NY 10017

ASME: American Society of Mechanical Engineers
345 E. 45th St.
New York, NY 10017

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

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

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

CCCAM: Chairman, c/o Dept. ME, Univ. Toronto,
Toronto 5, Ontario, Canada

ICF: International Congress on Fracture
Tohoku Univ.
Sendai, Japan

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

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

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
400 Stanwix St.
Pittsburgh, PA 15222

ONR: Office of Naval Research
Code 40084, Dept. Navy
Arlington, VA 22217

SAE: Society of Automotive Engineers
400 Commonwealth Drive
Warrendale, PA 15096

SEE: Society of Environmental Engineers
6 Conduit St.
London W1R 9TG, UK

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

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 Lab., Code 5804
Washington, D.C. 20375

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

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 funtional 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 example below.

> **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 the practical applications that have been explored [3-7] indicate that . . .**

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 June and December issues)**
- **volume, number or issue, 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, 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. Devel. (1962).**
4. **Lin, C.C., Reissner, E., and Tsien, H., "On Two-Dimensional Nonsteady Motion of a Slender Body in a Compressible Fluid," J. Math. Phys., 27 (3), pp 220-231 (1948).**
5. **Landahl, M., Unsteady Transonic Flow, Pergamon Press (1961).**
6. **Miles, J.W., "The Compressible Flow Past an Oscillating Airfoil in a Wind Tunnel," J. Aeronaut. Sci., 23 (7), pp 671-678 (1956).**
7. **Lane, F., "Supersonic Flow Past an Oscillating Cascade with Supersonic Leading Edge Locus," J. Aeronaut. Sci., 24 (1), pp 65-66 (1957).**

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 1500 to 2500 words in length. For additional information on topics and editorial policies, please contact:

Milda Z. Tamulionis
Research Editor
Vibration Institute
101 West 55th Street, Suite 206
Clarendon Hills, IL 60514