AEC-NASA TECH BRIEF

Identification and Evaluation of Linear Damping Models in Beam Vibrations

An effort to identify and evaluate effective linear damping models in beam vibrations has been reported (*1*); the three mechanisms considered were viscous, stress, and load damping. The purpose was to model mathematically the dynamic response of a beam-type element in which significant dissipation of energy could be attributed to contact of the component with adjacent similar components.

An example of such a case is a nuclear-reactor core consisting of many structural elements, usually in the form of slender plates or rods containing the fuel. These fuel elements are often arranged in small subassemblies, which in turn are mounted on a support grid to form a relatively tightly spaced bundle. High-velocity coolant flows axially through this arrangement and can induce vibratory motion of the subassemblies. Study of the vibration response requires among other things a mathematical representation of the damping, or dissipation of energy.

The usual method of modelling damping was employed; that is, assumption of damping mechanisms and empirical evaluation of the coefficients. The problem was in identification of the dominant damping mechanism or mechanisms—viscous, stress, and load—for inclusion in the mathematical model, and in evaluation of the associated damping coefficients.

A theoretical analysis was based on the usual assumptions in (Euler) beam theory, and on the further assumption that the damping is so little that the natural frequencies and mode shapes are unaffected. The analysis led to a sensitive method, compatible as to results with tests with a vibration exciter, for identifying the effective damping mechanisms. The technique involves comparison of the experimentally determined ratio of first- to second-mode magnification factors, related to a common point on the beam, with the constant values of this ratio corresponding to "pure forms" of the proposed damping.

Study of the interaction and damping, with a full-size mockup of a core, was prohibited by the high cost of fabrication of prototype fuel elements. Therefore the method was illustrated by application, to the modelling, of the response of a cluster of cantilevered beams clamped together at the base. This model was employed in the preliminary analysis of the interaction effects of vibrating rods in the nuclear-reactor core. Damping models were identified, and curves of damping coefficients as a function of cluster size are presented. The results show that

1) The cluster size (and hence the interaction phenomena) has little if any effect on the natural frequencies of an individual element within the cluster.

2) The magnification factor, related to the free end of the rod, decreases continuously with cluster size, but appears to be approaching a limiting value.

3) In the attempt to determine the scale of experiment required to give results typical of a full-size core, the only invariant observed was the ratio of first- to second-mode magnification factors. The mag-

(continued overleaf)

nitude of this ratio indicates that viscous and stress damping may be the dominant damping mechanisms for the particular case studied.

Reference:

1. M. W. Wambsganss, Jr., B. L. Boers, and G. S. Rosenberg, *ANL-7292* (Argonne National Laboratory, Argonne, Ill., April 1967); available from CFSTI, Springfield, Va. 22151, at $3.00 (microfiche, $0.65).

Notes:

1. This information may interest persons in the construction or aircraft industry.
2. Inquiries may be directed to:

   Office of Industrial Cooperation
   Argonne National Laboratory
   9700 South Cass Avenue
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   Reference: B69-10196

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Patent status:

Inquiries concerning rights for commercial use of this innovation may be made to:

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