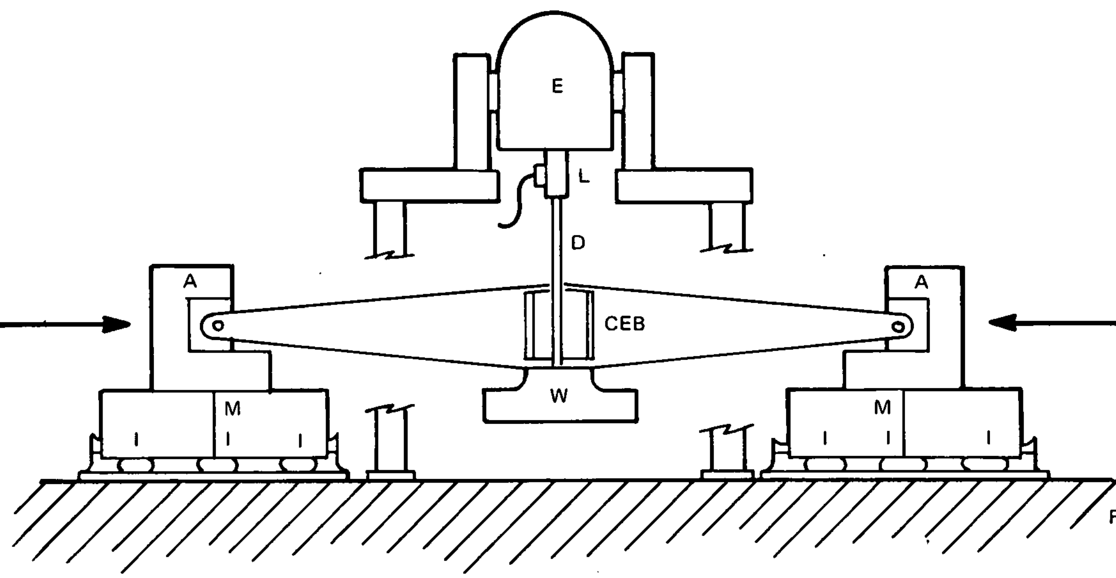
NASA TECH BRIEF
Marshall Space Flight Center

Multiple Reaction Mass And Isolation System



LEGEND

CEB: Center Engine Beam
F: Concrete Floor
E: Vibration Exciter
M: Reaction Masses
I: Vibration Isolators
W: Weight to Simulate Center Engine
A: Adapter Fitting Assembly
L: Load Cell
D: Driver Rod for Vibration of Beam
H: Horizontal Loading Device

Figure 1. Set-up For Vibration Test of Center Engine Beam

A multiple reaction mass isolation system is used to support large, massive, complex structures which are being tested for their damping and stiffness properties. This system allows measurement of damping and stiffness with the desired uncoupling of the measurement fixture and permits testing of large structures without the need for a costly foundation or base. The multiple independent reaction mass system can be designed so that the isolators permit horizontal displacement of individual masses relative to each other, permitting horizontal loading to be conveniently superimposed on vibratory loads.

Figure 1 shows four separate isolated bases utilized with one located at each of the four extremities of the beam. Each base is made of solid blocks of steel weighing 8.2 metric tons (9 tons), and each is supported by a set of four vibration isolators made of a layer of rubber in compression, shown in Figure 2. The rubber is 18 cm (7 inches) wide, 25 cm (10 inches) long, and 5 cm (2 inches) high and was bonded to two thin steel plates in the form of a sandwich. In order to achieve an isolator seismic frequency of about 8.5 Hz, it is necessary to adjust the vertical spring rate of each isolator to about

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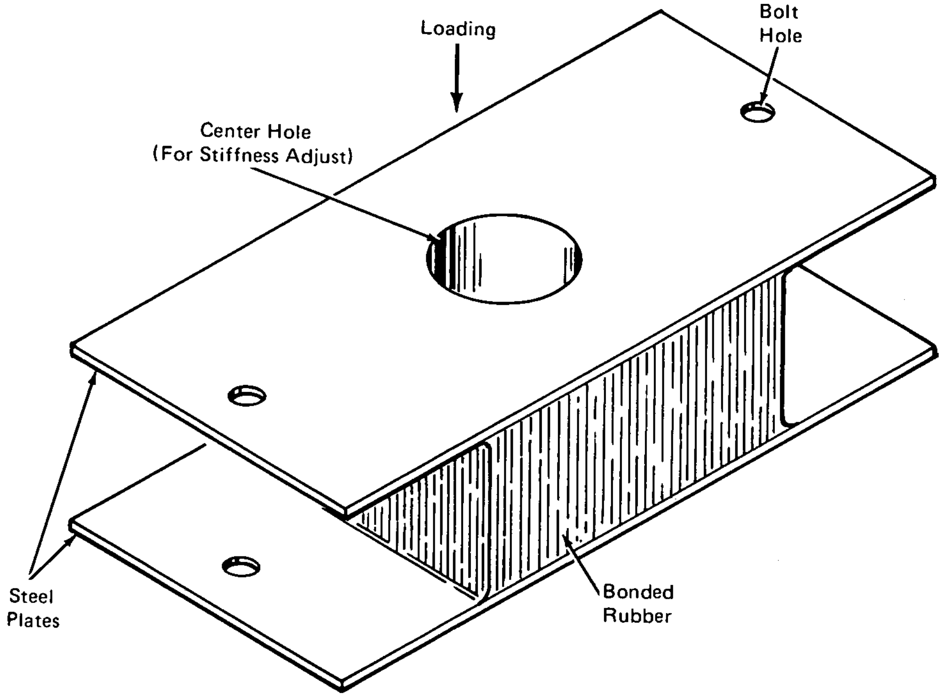

Figure 2. Vibration Isolator for Multiple Mass Reaction System

5.74×10^6 N/m (33,000 lbs/inch). This is accomplished by drilling a central vertical hole in each isolator of about 10 cm (4 inches) in diameter.

The horizontal spring constant of such an isolator is about 10 percent of its vertical value, because shear deformation of the rubber layer requires much smaller loading. The resistance to horizontal motion of the isolated bases is relatively negligible compared to other forces. Specifically, the horizontal spring rate of a set of four rubber isolators under each base is about 2.44×10^6 N/m (14,000 lbs/inch) compared to the horizontal rate of about 348×10^6 N/m (2,000,000 lbs/inch) for the arms of the beam. This condition makes it very simple to apply and adjust the horizontal (radial) compressive forces to this beam, because plain round steel tension rods instrumented with strain gages are used to pull together each pair of opposite bases. The force error due to the resistance of the isolators is less than 1 percent.

Notes:

1. The information concerning this innovation may be useful wherever large structures must be subjected to dynamic environments (bridge building, ship construction, etc.).
2. Requests for futher information may be directed to:

   Technology Utilization Officer
   Marshall Space Flight Center
   Code A&TS-TU
   Huntsville, Alabama 35812
   Reference: B72-10441

Patent status:

No patent action is contemplated by NASA.

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