NASA TECH BRIEF

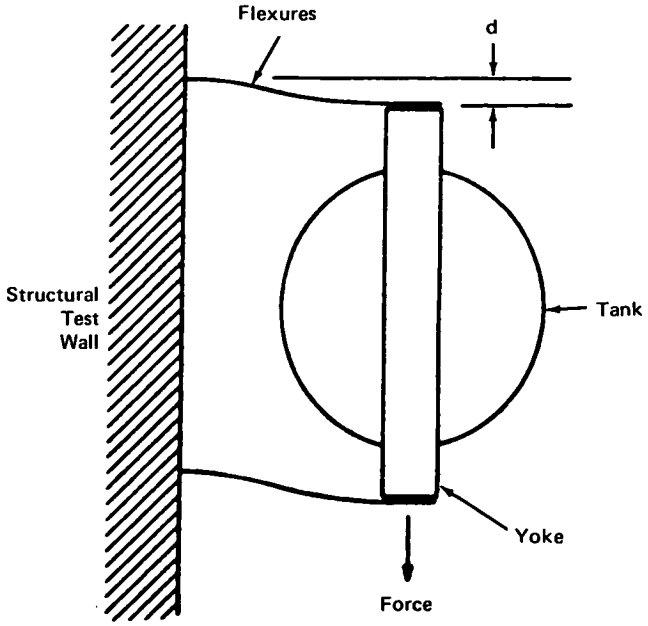
NASA Pasadena Office

Fluid Dynamics Test Method

An assessment of the dynamic loads experienced by a vehicle with a liquid propellant during acceleration requires a knowledge of the inertia loads attributable to the liquid mass stored in propellant tanks. If the dynamic environment can be estimated, what is then necessary is a determination of the liquid effective mass as a function of the ullage volume, the frequency, and the vibratory acceleration levels.

The frequency range of significance, with respect to dynamic loads, is typically well above that of the first few slosh modes. Accordingly, a resonance test method and an apparatus have been developed for determining fluid effective mass and damping in the frequency range where the effective mass may be considered as the total mass less the sum of the slosh masses. The apparatus (see figure) is designed so that a test tank and its mounting yoke are supported from a structural test wall by a series of flexures, which may be varied in number or in stiffness to provide discrete changes in frequency. Excitation is then provided in one or more test planes by electrodynamic shakers.

For each different configuration of the apparatus, resonance tests are conducted with various tank ullage volumes and at prescribed acceleration levels. At the conclusion of these tests, the tank is removed from its mounting yoke and is replaced with an inert weight, equal to that of the empty tank, and a series of incremental weights, giving resonant frequencies spanning the range measured for the test tank at the same excitation level. By interpolation, the effective mass of the fluid can be obtained. The difference in the forces required for the excitation of the tank, and of the inert mass, is attributable to fluid damping. Hence, the damping coefficient can be computed.



Fluid Dynamics Test Apparatus

(continued overleaf)

Note:

Requests for further information may be directed to:

Technology Utilization Officer
NASA Pasadena Office
4800 Oak Grove Drive
Pasadena, California 91103
Reference: TSP74-10211

Patent status:

NASA has decided not to apply for a patent.

Source: William H. Gayman of
Caltech/JPL
under contract to
NASA Pasadena Office
(NPO-11895)