RESONANCE FREQUENCIES OF A TUBULAR SHELL SURROUNDED INTERNALLY AND EXTERNALLY BY FLUID ANNULI OF VARIABLE THICKNESS

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SUMMARY

The difficulties due to excessive vibration, which were experienced in recent years with the thermal shields of several PWR reactors, motivated theoretical and experimental investigations of the vibrating behaviour of reactor internals, emphasis being laid on the resonance frequencies of beams, rods, cylindrical shells, etc. in confined spaces.

In the open literature detailed experimental data for the geometries involved are very limited. In particular results of parametric test series providing support and guidance for mathematical modelling are almost completely lacking.

The present paper is essentially an experimental contribution to the problem of the resonance frequencies of a vibrating tubular shell externally and internally surrounded by water filled annuli the thickness of which varies from one test to the other:

The basic set-up simulates to some extend the situation of the thermal shield in a PWR reactor and consists of a horizontal plate to which are attached:

- a vertical tubular shell the main dimensions of which are: height: 420 mm; inner diameter: 44 mm; outer diameter: 52 mm,
- an inner plug with the following dimensions: height: 395 mm; diameter: 22, 31, 38, 40, 41, 42 or 43 mm,
- an outer sleeve with the following dimensions: height: 395 mm; inner diameter: 53, 54, 55, 56 or 58 mm.

The first resonance frequency of the shell was measured with either the inner annulus or the outer annulus or both annuli filled with water and compared with the resonance frequency of the shell in air which is about 237 Hz.

It appeared in particular that the resonance frequency decreases with the thickness of the inner annulus down to 183 Hz whereas it decreases down to 60 Hz with the thickness of the outer annulus. The explanation of the apparent discrepancy in these results lies at least partially in the limited stiffness of the inner plug. This illustrates that simplified reasoning with rigid boundaries is subject to pitfalls.

The lowest resonance frequency observed with water in the inner and in the outer annulus is about 45 Hz.

A comparison is finally made with available results of other authors.