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On Vibration of a Circular Elastic Bar which is Partly Immersed in Liquid

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Equations are derived for the calculation of natural frequencies of vibratory motion of a circular elastic bar which is partly immersed in liquid contained in a cylindrical tank.

Analytical study is made on both of simply supported and clamped bars whose transverse vibratory motions are assumed to be of infinitesimally small amplitude. The side-wall and the bottom of the tank, in which elastic bar is set up vertically, are assumed to be completely rigid. The liquid contained in the tank is also assumed to be incompressible and inviscid.

The derivation follows a Rayleigh-Lagrange procedure, in which expressions for kinetic and potential energies are developed in terms of the displacements of elastic bar, whose shape is assumed. Lagrange's equations are applied to give a set of linear simultaneous equations of motion, upon substitution of simple harmonic motion, and to yield a frequency determinant.

Also presented are experimentally determined natural frequencies of an elastic bar which is simply supported.

Comparison between the theoretical and experimental frequencies indicates that the equation derived herein is adequate for prediction of the experimental frequencies of the elastic bar tested. Both calculated and experimental results show that the frequency of the simply supported bar decreases monotonously to 94 %, when the ratio of depth to bar length increases from 0 to 1. Calculation shows that the clamped bar decreases its frequency more sharply than simply supported one.

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