INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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SHORT ABSTRACT

In this thesis, free surface flows are investigated under various considerations. We investigate sloshing problems for different configurations and try to solve them such that the unfavourable effect of sloshing on stability of the system reduces. We discuss sloshing in some special types of containers like a cylinder with a semi cover (baffle), a coaxial cylindrical wall, and a cylinder with a spherical bottom. We examine the effect of various parameters such as radius, bottom, liquid depth, baffle width etc. on sloshing. Further, we also consider sloshing in a two-layer fluid and examine the effect of the baffle on sloshing frequencies. We evaluate sloshing frequency of the liquid subject to different conditions: (i) changing the geometry of the container (ii) introducing slosh suppression device such as a rigid baffle.

A semi-analytical approach based on linear water wave theory is employed to model some specific sloshing problems in terms of potentials. The work carried out in this thesis focuses mainly on determining sloshing modes and sloshing frequencies in circular cylindrical containers with different configurations. Sloshing frequencies are computed for both single-layer and two-layer fluids. In the two-layer fluid problems, the effect of the surface tension at free surface and surface of separation is neglected and fluids are considered to be immiscible. Furthermore, the solutions are obtained under the assumption of linear and time harmonic motion of the liquid. The thickness of rigid baffle is considered negligible compared to its radius. For single-layer fluid, we observe the effect of surface tension on sloshing frequencies when a rigid baffle is placed on the free surface in a vertical coaxial annular circular cylinder or a vertical circular cylinder. We also study the effect of an uneven bottom of a cylindrical container on sloshing frequencies. We restrict ourselves to studying the free oscillations of the free surface.

When a baffle is placed inside the fluid domain for single-layer and two-layer fluid problems, the complex fluid domain is divided into sub-domains to get the solutions. Boundary value problem is set up for each sub-domain and the corresponding potentials are found by using separation of variables method. Matching conditions are used at the free surface and interfaces of two consecutive sub-domains to maintain the continuity of pressure and velocity. The eigenfrequency equation is obtained with the help of matching conditions by using Fourier and Bessel series expansions. The sloshing frequencies are obtained by solving the homogenous linear system presented by matching conditions.

Most part of the thesis is devoted to the investigations of the effect of a rigid annular baffle on sloshing frequencies placed on the free surface and inside the liquid domain for different configurations as stated. The benefit of a partly covered free surface is that it increases the natural frequencies and decreases the sloshing mass participating in the dynamic motion of the system. It is shown that the baffle is effective on controlling sloshing frequencies when it is placed near and on the free surface. It is observed that when the baffle is nearer the free surface, it is more effective in controlling the sloshing as compared to the case corresponding to the increase of liquid level in the container. The influence of the baffle placed inside liquid domain is less. In the present study, it is observed that sloshing behaviour of partially filled liquid containers depends on the geometry and size of the container and also on those of the cover.