# ABSTRACT

Sloshing is a fascinating physical phenomenon characterized by the oscillation of the unrestrained free surface of liquid in a partially filled container due to external excitation. The phenomenon is of great engineering importance associated with several engineering applications. The general problem involves the viscosity and compressibility of the liquid, complicated temporal and spatial motion of the liquid free surface, the elasticity of the container walls and the inertias of both. The surface tension at the free surface may become important in situations where the gravity force is small. Often, a liquid tank contains submerged components that contribute greatly to the overall dynamical behavior of the system. In addition, the dynamic boundary condition at the fluid free surface is nonlinear and the position of the free surface varies with time in a manner not known a priori. The need for economization of space and cost add another dimension to the problem.

The solution of the completely general problem is not essential in many practical applications and many simplifying assumptions can be made. The effects of fluid viscosity and compressibility are usually very small and their contribution to slosh dynamics can most often be neglected. Further, the resulting fluid motion in the sloshing of contained liquid is usually small and the convective momentum transport can be neglected. If the free surface displacements are assumed small, the related boundary conditions become linear. These assumptions are found to work quite satisfactorily in both uncoupled and coupled slosh dynamic problems.

In the present study, the slosh dynamic problems are modeled using the above assumptions. To simplify the problem further the container is assumed rigid. The problem is discretized in the fluid domain using Galerkin finite element with isoparametric quadrilateral and triangular elements. The finite element semi-discretized equations are integrated in time using iterative time-stepping techniques. The complete numerical algorithm is coded in C++ and is used to solve large number of sloshing problems. The present thesis is focused to containers with internal components as slosh suppression devices. Attempts are made to evaluate the efficacy of horizontal baffles, bottom-mounted and surface-piercing vertical baffles, perforated baffles and screens as dynamic control devices in rectangular and cylindrical tanks. Performances of the various control devices are analyzed and their dependence on various parameters is enumerated. Slosh dynamics of contained liquid in triangular and trapezoidal tanks and in their capped variants are also investigated. Investigations are further carried out for liquid sloshing in cylindrical, conical, truncated conical and capped conical tanks. Efficacy of ring baffles and coaxial cylindrical baffles in a cylindrical tank is also investigated wherein coaxial baffles are found to be more effective anti-slosh device. Numerical results are presented that assess the applicability of the developed code. The studies show that the surface-piercing vertical baffles are the most efficient dynamic control devices. While a vertical screen with a large bore is found most suitable for slosh suppression, a screen with multiple bores is more effective in reducing baffle loading and providing flow uniformity. The trapezoidal tanks are found most suitable from stability against sloshing point of view as the base shear and overturning moment in trapezoidal tanks are considerably smaller than in other tanks of same volume.

**Keywords:** free surface, sloshing, horizontal baffle, bottom-mounted baffle, surface-piercing baffle, perforate baffle, screen, ring baffle, coaxial cylindrical baffle, triangular and trapezoidal tanks, conical tanks, frustum, cap