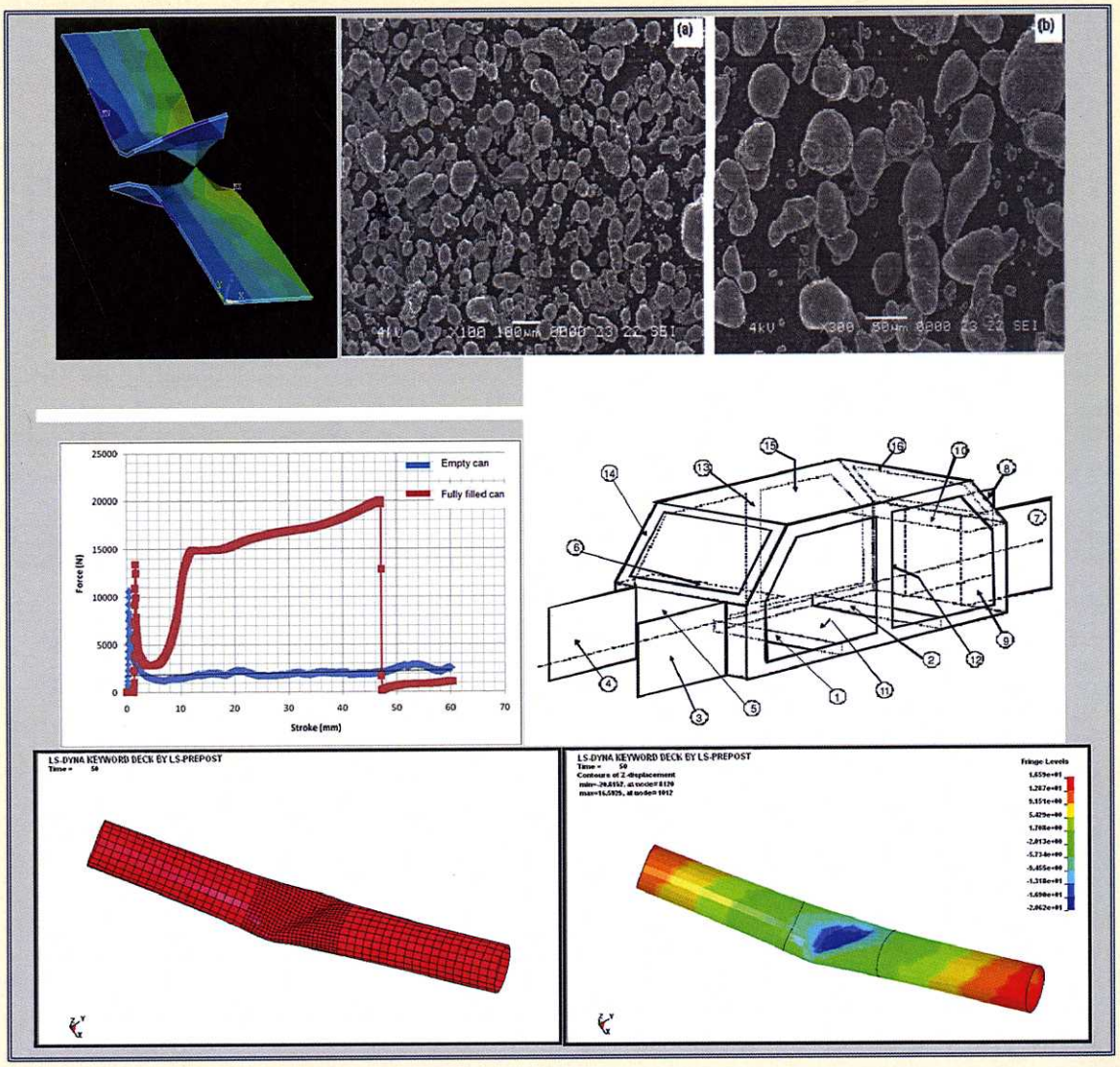
ADVANCED TOPICS IN MECHANICAL BEHAVIOR OF MATERIALS



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EXPERIMENTAL STUDY OF LIQUID SLOSH DYNAMICS IN A HALF FILLED CYLINDRICAL TANK

Qasim H. Shah, Hasan M.Abid, Adib B. Rosli

1. INTRODUCTION

Liquid in an arbitrary shaped container under external excitations, results in surface and bulk turbulence. The nature of such turbulence is quite complex due to several effects such as sloshing, pressure gradient etc. Amongst these, sloshing makes the liquid container more vulnerable to structural damages. Depending on the type of disturbance and container shape, the free liquid surface may experience different types of motion including simple planar, non-planar, rotational, irregular beating, symmetric, asymmetric, quasi-periodic and chaotic. However, the amplitude of slosh depends on the amplitude and frequency of the tank motion, liquid-fill depth, liquid properties and tank geometry. The resonance in the case of horizontal excitation occurs when the external forcing frequency is close to the natural frequency of the liquid. Hence liquid sloshing is a practical problem with regard to the safety of transportation systems, such as oil tankers on highways, liquid tank cars on railroads, oceangoing vessels with liquid cargo, propellant tank used in satellites and other spacecraft vehicles, and several others.

2. EXPERIMENTAL SETUP

Liquid slosh inside a partially filled cylindrical tank is experimentally investigated in a test tank in the laboratory. The measurements were performed to evaluate fundamental slosh frequencies, and dynamic slosh forces and moments under the influence of harmonic lateral and longitudinal acceleration fields. The measured data are analyzed to build an understanding of the conditions of magnitudes of slosh forces and moments developed and the role of primary influencing factors. The experimental study aims at capturing the fluid motion before and after impact through visualization. Several design concepts were