A Computer Code to Design Liquid Containers for Vehicles

Hamideh B. Parizi[1], Mohammad P. Fard[2], Ali Dolatabadi[3]

1-3:Simulent Inc. 229 College St., Suite 108, Toronto, Ontario, M5T 1R4

Email: parizi@simulent.com

ABSTRACT

We are presenting the development of a modualr code for the simulation of the fluid sloshing that occurs in the liquid containers in vehicles. Sloshing occurs when a partially filled container of liquid goes through transient or steady external forces. Under such conditions, the free surface of the liquid may move and the liquid may impact on the walls of the container, exchanging forces. These forces may cause numerous harmful and undesirable consequences in the operation of the vehicle, such as vehicle turn over.

The fluid mechanic equations that describe the fluid sloshing in the container and the dynamic equations that describe the movement of the container are solved separately in two different codes. The codes are coupled weekly, such that the output of one code will be used as the input to the other code in the same time step. The outputs of the fluid code are the forces and torques that are applied to the body of the container due to sloshing, whereas the output of the dynamic code are the translational and rotational velocities and accelerations of the container.

The proposed software can be used to test the performance of the designed container under various operating condition and allow effective improvements to the container design. The proposed code is different than the presently available codes, in that it will provide a true simulation of the coupled fluid and structure interaction.

1. INTRODUCTION

Sloshing occurs when a partially filled container of liquid goes through transient or steady external forces. Sloshing in moving liquid containers (shown in Figure 1 causes safety and comfort issues such as:

- Undesirable forces on brake systems in liquid carrying tankers,
- Vehicle turn-over in severe cases.
- Producing noises referred to as "clinking noises" in automobile fuel tanks.
- Safety issues in propellant tanks in the spacecrafts under micro- gravity conditions.
- Safety problem in nuclear reactors under earthquake conditions.

The annual cost associated with the above problems can be substantial. At the present time, these issues are addressed purely based on physical experimentation and empirical data. This is a very costly process. Therefore, there is an urgent need for the development of a code that can simulate the sloshing process accurately and efficiently. The presently available codes do not consider the true interaction of the fluid with the container walls and the whole vehicle structure. Therefore, the results are not very accurate and cannot be totally relied on. The proposed code will resolve these issues. Therefore, it can be used to design the liquid containers in vehicles accurately and efficiently.

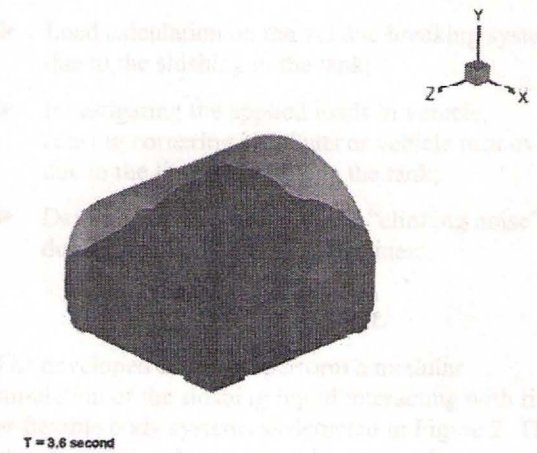

Figure 1. Illustration of sloshing inside a container