Faculty Engineering Technology Program
Mechanical Engineering

UNIVERSITY OF TWENTE.

COLLOQUIUM

Group: **Engineering Fluid Dynamics**

As part of his MSc thesis assignment

S. van der Linden

will give a presentation, entitled:

Investigation of linear sloshing behavior due to translational motion in an LNG container

Date: 08-09-2016
Time: 10:00
Room: Horst Building, room HT-1300

Summary:

Liquified natural gas, or LNG, is an important fuel source. It is mostly used for electricity generation, heating and as a vehicle fuel and is especially popular in Japan. As the name suggests, LNG is liquified before use as this greatly reduces its volume and makes it easier to transport. This transport is facilitated through different means, but large scale transport is typically restricted to large naval vessels known as LNG carriers. One of the problems these carriers face is evaporation of the liquified gas due to excessive sloshing behaviour as a result of the motion of the vessel through water. An adequate solution for this sloshing has yet to be found. As such, the research described in this thesis focused on a method to describe this sloshing behaviour through analytic means.

To create a model which generates analytic sloshing solutions, several simplifications were made. Geometries were restricted to a 2-D and 3-D rectangular box and a 3-D standing cylinder. The motion forced upon the geometries was restricted to sinusoidal movement of a purely translational nature. The translational behaviour was restricted to one directional motion for the 2-D rectangular box and the standing cylinder, whereas the forced motion was imposed on two directions for the 3-D rectangular box. Inviscid, non-heat conducting and incompressibility assumptions were used for all geometries after which a potential flow model was chosen to model the flow. A perturbation potential was included in the analysis after which linearisation was performed. A solution method was then created based on the principles of separation of variables and Fourier series.

A solution was successfully produced for all geometries. The solutions found in literature match those produced in this thesis. By grace of the Fourier series approach, all solutions consist of at least one infinite series of orthogonal wave modes. Time behaviour of each wave is made up of either two or one frequencies. These frequencies are the eigenfrequencies unique to each wave and the frequency of the applied motion. If the eigenfrequency is equal to the frequency of the applied motion, the wave mode exhibits unstable time behavior.

The wave modes for the rectangular tank consist of sine wave modes and for the 3-D case, the solution is composed of two 2-dimensional series one of which is identical to the 2-D rectangular tank solution. The wave modes for the cylindrical tank are Bessel functions of the first kind and of the first order. All solutions contained the same exponential behaviour in the depth direction of the tank. Time behaviour differed due to differences in wave numbers induced by the difference in geometry.

Assessment committee:
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d.d. 08 08 2016