Bottom Slamming on Point Absorber Systems

Introduction

An experimental test programme has been executed to investigate bottom slamming phenomena on heaving point absorbers. Point absorbers are small oscillating Wave Energy Converters. During operation, the point absorbers move up and down in the waves. By damping their motion electricity is produced. It might happen that a buoy becomes detached from the water surface and is exposed to important impact pressures when re-entering the water. These slamming phenomena occur particularly in case the buoys are phase controlled and when they have a small draft.

For design purposes, it is important to know which pressures the bodies experience during impact. An experimental test setup has been built at Ghent University to assess the impact of slamming on point absorbers by drop tests.

Test setup and test results

In a first step a lab test setup has been developed which is shown in Fig. 1. The test objects are rigid bodies with different shapes (hemisphere shape, cone shapes with deadrise angles of 20° and 45°). The bodies are dropped from different heights in the basin. A stiff aluminium guiding system assures the verticality of the falling objects. With this test setup the verticality of the impacting objects is assured and the tests are very well reproducible. The maximum drop height is about 2 m. A plexiglass window with thickness 10 mm was installed in the basin, allowing to film the slamming phenomenon.

Figure 1 Test setup with guiding system

High frequency piezoelectric pressure sensors were used, more specifically ICP pressure sensors with built-in microelectronic amplifier and high frequency pressure sensors have external amplifiers. The sensors have a large natural frequency and a small cell membrane.

The deceleration during impact was measured by a shock accelerometer. A high speed camera is used to measure the impact velocity during penetration and to produce images of the different stages of water uprise. The camera delivered images at 5000 up to 18000 frames per second (fps), dependent on the desired pixel resolution. A very high frame rate is necessary, since slamming phenomena occur in a very short time interval (order of magnitude milliseconds). Because of the high frame rate, the camera shutter time is extremely short. In order to overcome low illumination and to avoid interference with the grid frequency, special flicker free lights have been used. Some examples of the high speed camera images are shown in Fig. 2.

(a) (b) (c)

Figure 2 - Snapshot of impacting objects at a penetration depth of 0.02 m for different drop heights. (a) Cone 20°, (b) Cone 45 °, (c) Hemisphere.

In a second step, large scale outdoor drop tests have been performed at the Watersportbaan in Ghent, Belgium in cooperation with the Department of Materials Science and Engineering at Ghent University. Two large test bodies made of composite material are dropped from 1 m to 5 m in a canal. The bodies have a diameter of about 1.75 m and consist of two conical parts with a cylindrical middle part. The floaters are designed by the Department of Materials Science and Engineering and manufactured by the company SPIROMATIC with the filament winding technique. A crane lifted the bodies at the desired drop height between 1 and 5 m. The pressure time history and deceleration of the body is measured, as well as the deformation of the structure during impact using strain gauges. The tests took place within the framework of SEEWEC, a project funded by the European Commission within the 6th framework programme. SEEWEC stands for Sustainable Economically Efficient Wave Energy Converter and focuses on the development of the FO^3 point absorber system.

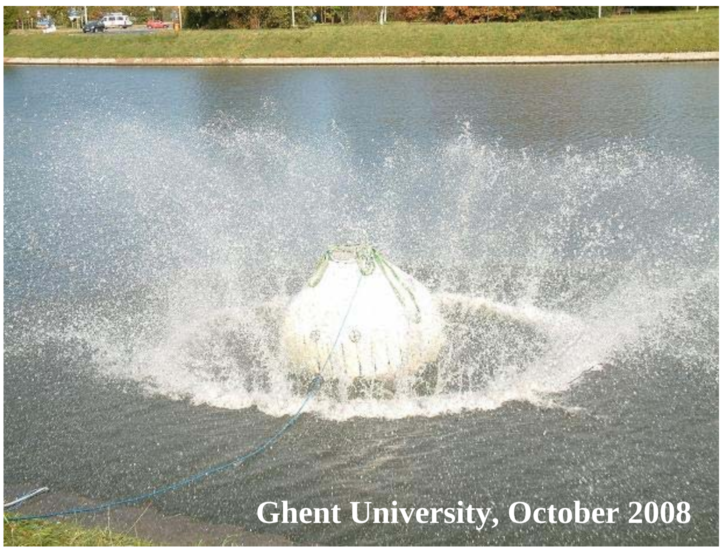

Figure 3 – Bottom slamming on large scale composite floaters at the Watersportbaan, Ghent.

Contact

ir. Griet De Backer- email: griet.debacker@ugent.be