

The protection efficiency of dolphins tested in a geotechnical centrifuge

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ABSTRACT

The stability of dolphins under ship impact was investigated in a geotechnical centrifuge. 31 tests were performed at 200g. Static and dynamic tests were run. In various tests the influence of the soil density in the dolphin was tested as well as the diameter of the dolphin and the location of impact. The results show that in dynamic tests there was suction underneath the dolphin increasing its stability. The paper describes the test set-up, the model preparation, the scaling rules and the results of the tests.

KEY WORDS: centrifuge, ship impact, dolphin, scaling

INTRODUCTION

Bridge pillars that are built in open water have to be protected against ship impact. One of the protection measures is building dolphins around the pillars. These dolphins are cylindrical structures with a diameter of several meters, up to approximately 30 m. The cylinder is made by a sheetpile wall with a concrete slab on top; the interior is filled with sand or gravel. The energy of the moving ship is dissipated in the dolphin and this prevents damage to the pillar and the bridge on top of that. The dolphins themselves are sacrificial structures, if an impact occurs they have to be replaced. A typical cross-section of a dolphin is shown in Figure 1.

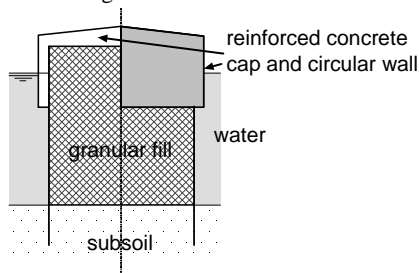


Figure 1. Schematic cross-section of a dolphin.

The design of dolphins was mainly based on experience. However, since bridges are crossing deeper water and ship size, tonnage and sailing speed increase, this is no longer sufficient. A present day state

of the art design for dolphins to protect against ships of 100.000 ton and more includes 3 dimensional finite element calculations. However, for the large deformations that can be expected during impact experimental verification and calibration of these calculations is necessary. This was done for the Incheon Bridge that is built in Korea at the moment by a series of 30 centrifuge tests in the GeoCentrifuge of GeoDelft. An overview of the planned bridge is shown in Figure 2.

This paper deals with the set up of the model tests and the test results. How Test plan and results had to be incorporated into the design of Incheon Bridge is the subject of a second paper to this conference (Kim et al. 2007).



Figure 2. Overview of Incheon Bridge, South Korea. The dolphins are shown around the bridge pillars.

TEST SET-UP

General

Test set-up was designed taking into account that a relatively large number of 31 tests had to be performed. Replacing the soil model and the dolphin after a test must be relatively easy. Furthermore the soil model with dolphin and instrumentation was separated from the ship model. The latter performing the actual impact. This separation allows using two different setups to prepare the soil model and the dolphin,