PHYSICAL MODEL TESTS
OF THE HYDRAULIC STABILITY OF ARMOUR UNITS

Introduction

Rubble mound breakwaters have been built all over the world to protect harbours, coast lines… Essential is the stability of these breakwaters under wave attack. Intensive research on the stability of the armour layer of rubble mound breakwaters has been carried out. In 1984 the HARO armour unit [1] has been developed.

In this study an investigation of the hydraulic stability of the HARO is carried out and a comparison with the hydraulic stability of the cube is made.

Methodology

The investigation consists of 2D model tests. The block weight is 58.1 g for the cubes and 41.1 g for the HARO units. Waves are generated up to H_s = 10 cm. The wave flume available at the Department of Civil Engineering (Ghent University) is used. Waves are generated by means of a computer-controlled electric motor, which is actuating a piston-type wave maker.

The damage to the armour layer due to the wave attack is studied. Different criteria for the damage have been considered: from 'beginning of movement' to 'large displacement' up to 'being pulled out of profile' of the armour units.

Fig. 1. *Construction of the model breakwater, armoured with concrete cubes, in the wave flume.*

First the model, which is based on a typical section of a rubble mound breakwater, has been built into the wave flume. Fig. 1 shows the last phase in the construction of the model breakwater.

Then an accurate method to detect the displacement of the armour units under wave attack has been elaborated. A new software program was developed: 'Armour Tracking Software [2]'. The program allows to identify certain objects on two photographs and then detects the relative displacement of the objects between the two photographs.

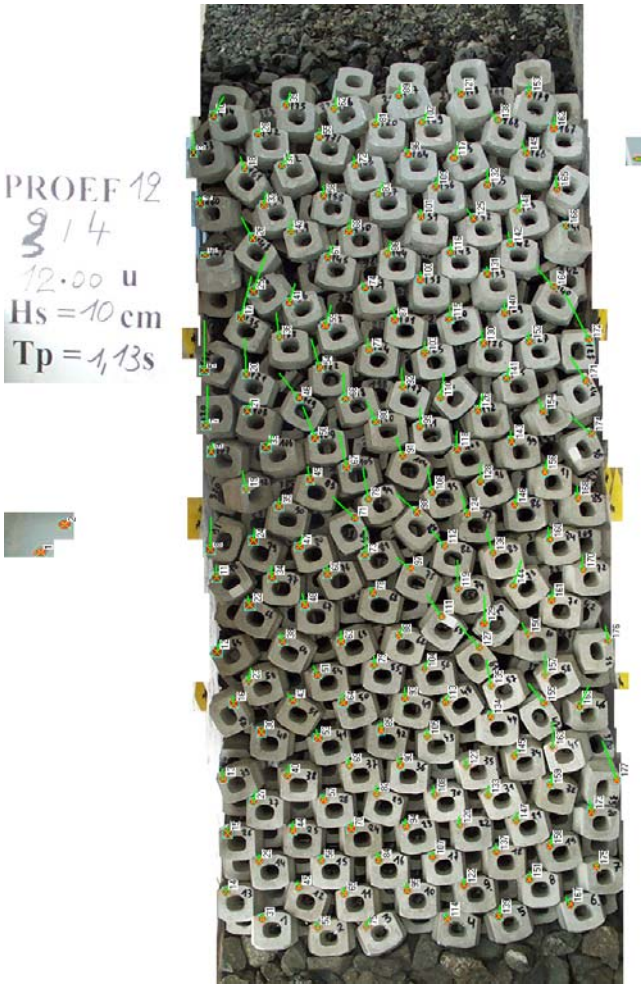

Fig. 2. *Armour layer of the breakwater: view from above after wave attack. The green lines represent the displacement of the individual HARO units.*

DEPARTMENT OF CIVIL ENGINEERING - GHENT UNIVERSITY
Technologiepark 904, B-9052 GHENT - BELGIUM ☎++32 (0)9 264 54 89 🖷++32 (0)9 264 58 37

Results

A test program is set up and carried out. Irregular waves (Pierson-Moscowitz spectrum) are generated. Every test (with specific H_s and T_p) consists of 2000 waves. Between every test a photograph of the armour layer is made. With the aid of the program 'Armour Tracking Software' the displacement of the armour units is detected in relation to a reference state. The (small) amount of armour units that is pulled out of profile is counted visually.

Fig. 2 shows a view from above of the armour units (here: HARO's) after a storm. The green lines are displacement vectors detected by the software program.

For each damage criterion a graph 'damage in terms of percentage' in relation to 'measured wave height' has been made. Fig. 3 shows an example. The damage is here related to a displacement of 30 mm in model.

From the tests it is concluded that the HARO has a good hydraulic stability, which is clearly higher than the cube. This also is shown in Fig. 3.

References

[1] J. De Rouck, Stabiliteit van stortsteengolfbrekers – Algemeen glijdingsevenwicht – Een nieuw deklaagelement, 1991. Ph.D. thesis KUL.

[2] S. Defever, T. Versluys – Armour Tracking Software, 2001

Acknowledgements:
The work presented here is the result of the M. Sc. thesis of Hadewych Verhaeghe.

Contact:
For more information, contact:
Hadewych.Verhaeghe@UGent.be, or visit the home page of the department at http://awww.UGent.be.

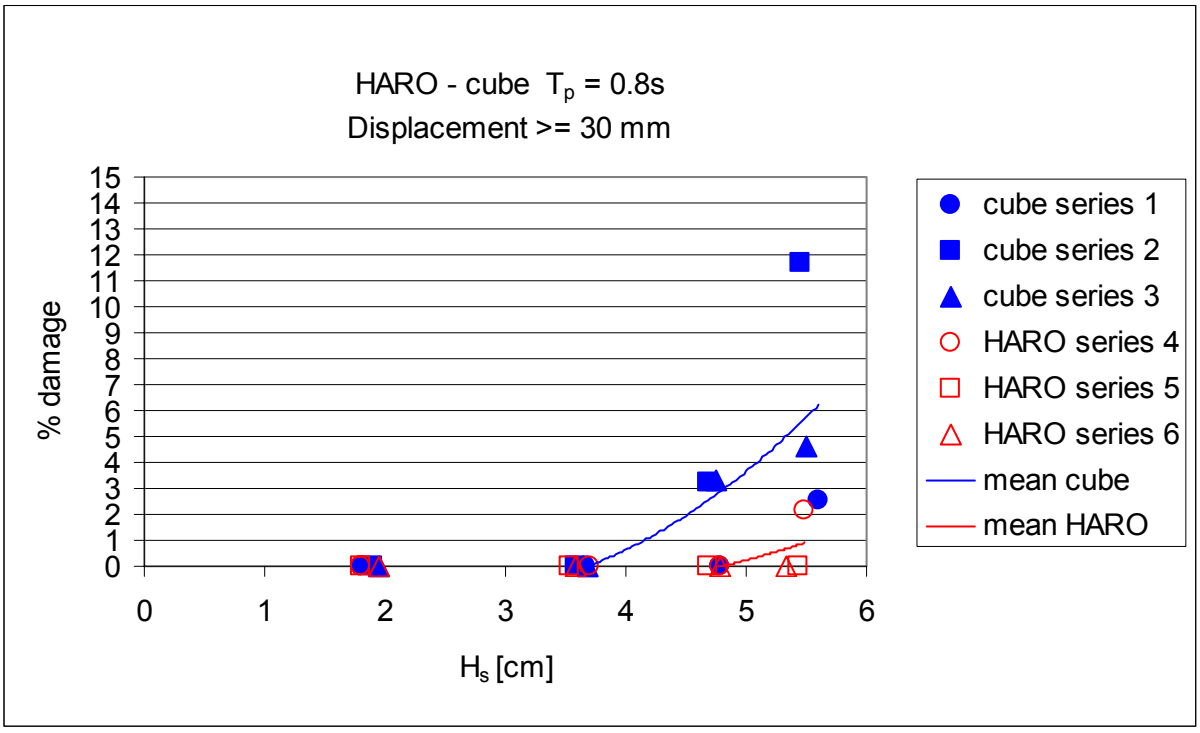

Fig. 3. *Damage as a function of the measured significant wave height H_s.*