SINTEF

SINTEF Building and Infrastructure
Coast and Harbour Research Laboratory

MEMO

MEMO CONCERNS

TESTING OF ARTIFICIAL REEFS – REEF SYSTEMS GRIP REEF

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1 Introduction

The “Grip Reef” is a product from Reef Systems and consists of a circular, perforated concrete cylinder with PE (plastic) pipes inserted radially into the perforations. The reef may be applied standing, but will be more stable if applied lying down on the sea bed in Grip Reef mode. In this mode, parts of the pipes are removed to provide a stable footing.

The reefs are used to stimulate marine growth and to control erosion of the sea bed. SINTEF has tested the reefs in a wave tank. There was a dual purpose to the tests;

1. To quantify the blocking effect of the reefs in steady current, and thus obtaining an indication of the extent of the lee-zone behind the reefs;
2. To quantify hydrodynamic forces on the reefs under general conditions (waves and current), and to establish a method of predicting the forces on the reefs caused by waves and current.

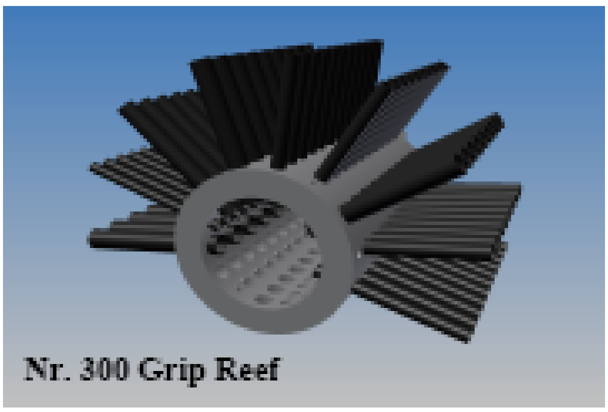

Figure 1 Grip Reef. In the tests, the scaled-up diameter of the core is 1.3 m and the length of one element is 2.35 m. The exposed length of one pipe is 2.15 m.

The reefs were tested in a scale of 1:10 in a current flume and a 2-D wave tank.

Note that he models that were used for tests differ slightly from the current Reef Systems products. The current version of the Grip Reef has a slightly greater diameter and smaller length of the concrete cylinder than those tested. The more recent versions have greater stability when applied standing upright, but used in the Grip Reef mode, the practical differences as regards these tests, are small.

2 Current test

The current flume is 0.5 m wide and 0.5 m deep. The tests showed that the reef will block the flow in the lee-zone in the same manner as a solid cylinder.

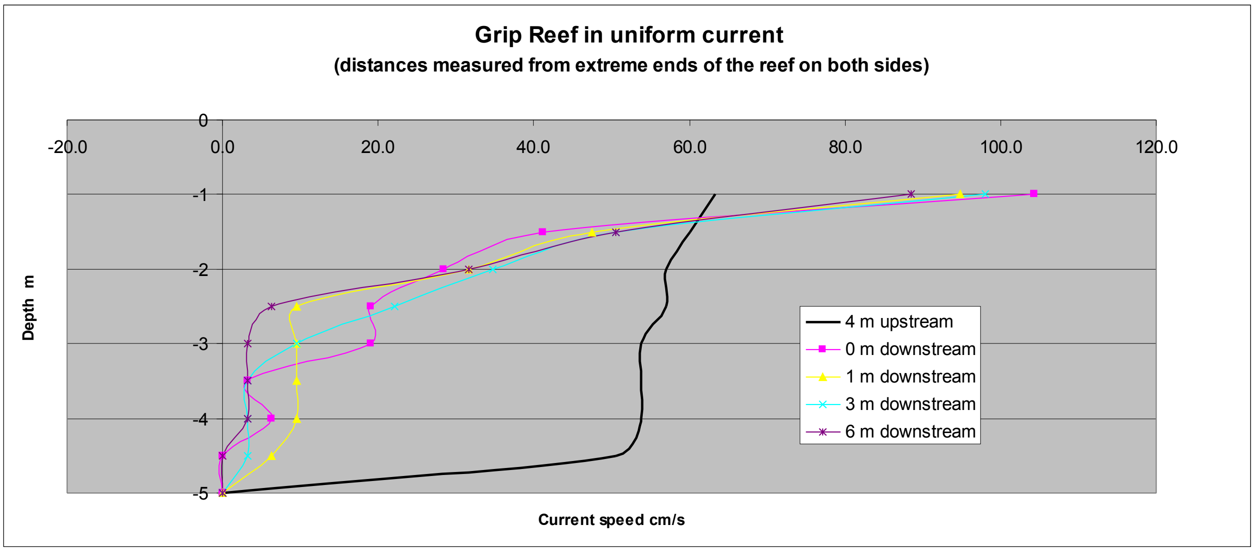

Figure 2 Results from steady current experiment. Average current speed is 56 cm/s (approximately 1.1 knots). The height of the concrete core is 1.3 m, and the greatest height of the reef (bottom to highest tip of the pipe) is 3.45 m.

The graph shows that there must be significant cross-flows in the lee-zone, but it also shows that the reef has a blocking effect which extends beyond (above) the 1.3 m diameter of the concrete core. The current speed near the bottom within the first 6 m from the reef is very small, and will create conditions for settling of non-suspended sediments that are brought over the reef.

Structures that are located inside the lee-zone will experience a significant reduction in bottom shear stresses and consequently have less erosion around them.

Measurement of horizontal forces on the reef gave equality between measurements and theoretical calculations using the Morison formula for an effective diameter $D_{eff} = 1.9\ D_{core}$, where D_{core} is the diameter of the concrete core, and the drag coefficient $C_d = 1.0$.

2.1 Waves test

The wave tests were done in a small section of a larger tank with a water depth = 1.0 m. The reefs were subjected to irregular waves with a specified significant wave height H_s and peak spectral period T_p of a JONSWAP spectrum ($\gamma = 2.5$).

It was assumed that the forces on the reef could be described by a Morison type expression based on the concrete core and using either a coefficient to describe the increased diameter, or using a D_{eff} concept (similar to the current forces calculation).

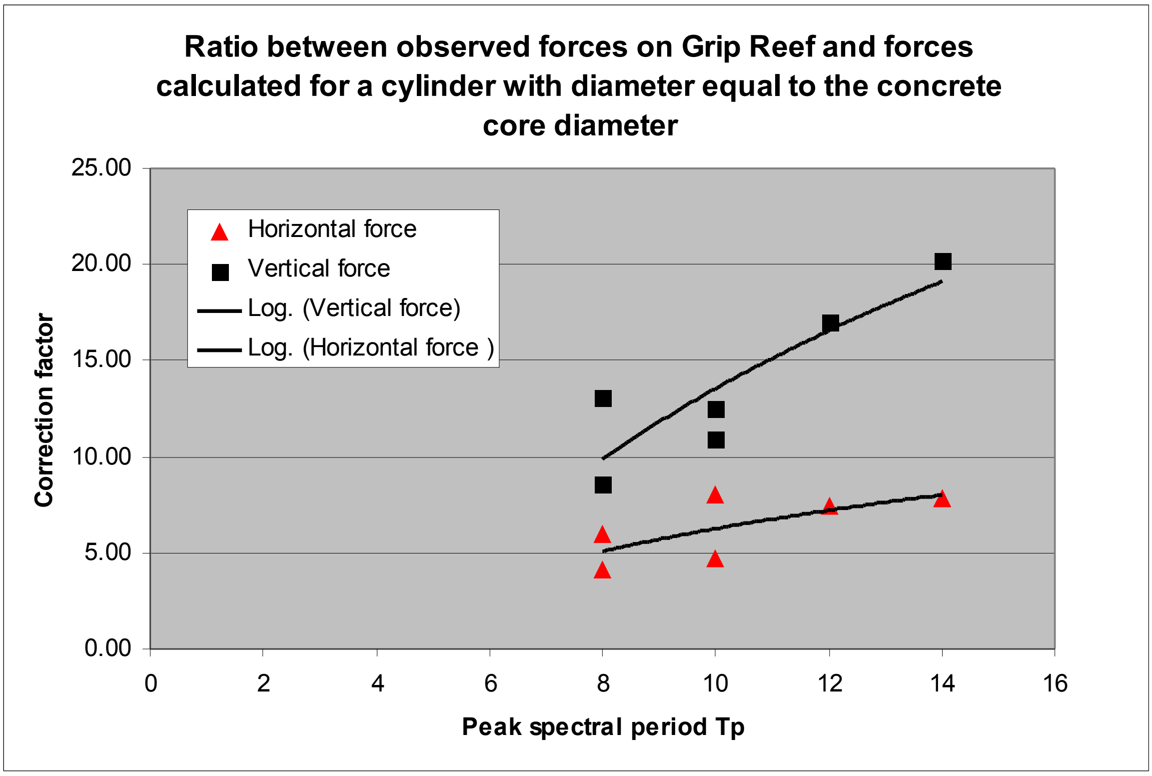

Figure 3 Ratio between observed forces on Grip Reef and forces calculated for a cylinder with diameter equal to the concrete core diameter (1.3 m).

Figure 3 shows that the horizontal forces on the reef were from 5 – 8 times greater than results from conventional theory using the concrete core indicate. The vertical forces are 10 – 20 greater. However, the ratio increases consistently with the peak spectral period, leading to the conclusion that the correction factor can be found when the peak spectral period is known.

An even more simple relationship is found by introducing the D_{eff} concept, which shows that a good fit between observations and theory is found for $D_{eff} = 2.85\ d_{core}$.

3 Conclusions

The tests show that the Grip Reef has a proven ability to create a lee-zone in steady current, which will cause a break in the transport of bedload and near-bottom sediment flows. The reefs are expected to be efficient measures against local erosion. Structures that are located inside the lee-zone will experience a significant reduction in bottom shear stresses and consequently have less erosion around them. Further tests are planned to demonstrate this effect and quantify it, if possible.

This effect will also be closely monitored in the planned full-scale tests at Ystad, Sweden.

The tests have also shown that the forces on the reefs may be calculated using traditional calculation tools and methods if a coefficient to account for the contribution of the PE pipes is introduced.