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EXPERIMENTAL STUDY OF PARSIAN PORT BREAKWATER TOE STABILITY

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1 INTRODUCTION

The stability performance of toe layer in structures with single-layer concrete armoures such as accropods and Xblocks is more crucial regarding their fast instability propagation and failure mechanism. This paper presents the case study concerning toe stability of Pasrsian port breakwater by experimental tests on physical model in Tarbiat modares university wave flume. Parsian industrial port is located in the south of Iran at Persian Gulf coastline. Its nineteen berths in final phase will be protected by approximately 1500 meter breakwater which at the most critical section, W5, reaches the sea bed level of -25 m.C.D. Figure 1. In concrete armored breakwaters, heterogeneous packing could increase the porosity in top rows and eventually result in instability. Therefore the number of rows in which the concrete units can be placed would be limited. According to the SUGRA guidance for Accropode units, this the maximum number of rows shall be 20, which leads designers to consider toe berm for breakwaters in deep water. Hence, it was vital to conduct a comprehensive physical model study.

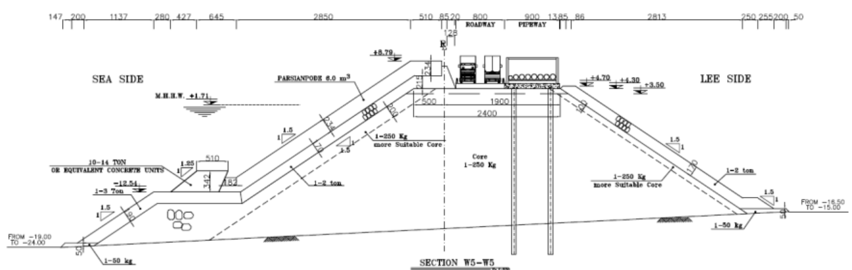

Figure 1. Prototype section W5.

There has been several formulas to design the toe layer, however in design stage and this paper expressions by Gerding(1993)-Van der Meer(1998) has been selected to further study. In the preliminary stage of breakwater design, by limiting N_{od} to the level of 0.5, toe layer of section W5 equals to 12.03 ton was calculated. Physical model of section W5 was built by the scaling factor of 50.36 and was built and test specifications were determined as Table 1.

Table 1. Test specifications.

Return period	H_s (cm)	T_p (s)
100	10.4	1.3

2 DISCUSSION

During the experimental study on the toe stability of the Parsian breakwater, different cube units and placing patterns were tested to achieve a minimum level of damage.

2.1 Accropode units with or without sacrificial rock layer

By implementing the test replicating a 100-year return period wave, N_{od} equal to 0.25 was recorded while the test of 1.2 times of design wave resulted in the complete collapse of the toe layer. Therefore, the idea of using sacrificial rock layer in front of concrete units was tested. By placing the rock in front, N_{od} in concrete units was reduced to 0 and 0.18 in different levels of return period respectively.

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Figure 2. Toe layer consisting of three rows of Accropode units- after implementing the test of 1.2 times Hs

2.2 Concrete cubes with or without rock layer in front-Cube1 and Cube2

In order to get the acceptable result, different placement patterns, a variety of cube units in tonnage (cube1 and cube2), and the presence of the rock layer in front of cube units were tested. Figure 3 shows the damage in the toe layer during the test with wave height corresponding to a return period of 100-year. Approximately 20 percent of cube1 units moved more than 1 D_n from their initial position (N_{od}=0.6). Hence, the toe layer consisting of cube1 units and the sacrificial rock layer were tested (Figure3.b). Although the toe layer remained stable after running the test of design level, by performing the test of 1.2 times of design level about 10 percent of cube1 units dislodged. The result of these tests reveals that using cube1 units with or without sacrificial toe couldn't meet the stability criteria.

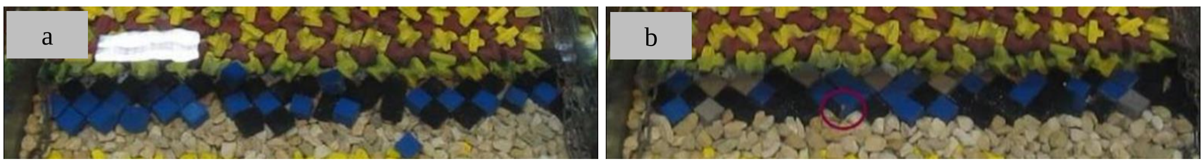

Figure 3. Three rows of cube1- a: after implementing the test of Hs-b: with sacrificial rock- after the test of 1.2 times Hs

It was supposed that by increasing the tonnage of cube units by three times, toe layer would remain stable even without the rock layer in front. Different patterns of placing cube2 units, Parallel and perpendicular to the section, were tested. Both patterns experienced an unacceptable level of damage by conducting the test of H_s equal to 12.2 cm, as seen in Figure 5 and 6. It seems that due to the higher pressure difference between the front and the rear side of units, the cubes in perpendicular to the section were demolished.

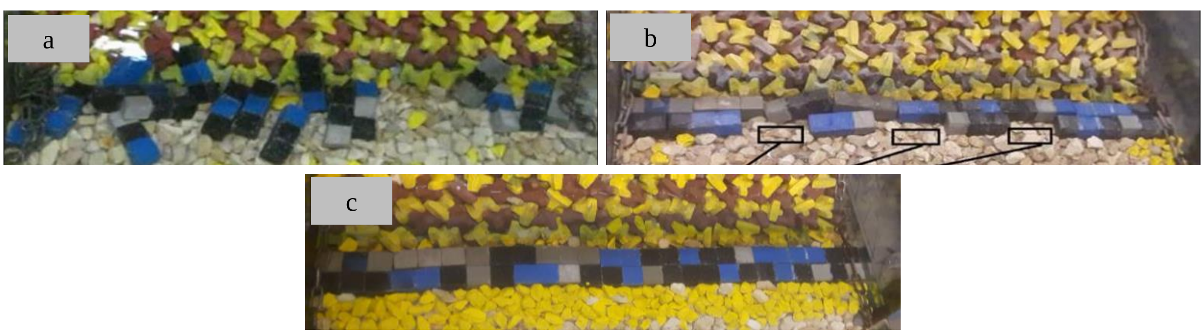

Figure 4. Cube2- after implementing the test of 1.2 times Hs-a: perpendicular-b: parallel-c: parallel with sacrificial rock

3 CONCLUSION

This study investigates the stability of the toe layer on physical model of the Parsian breakwater. In this regard, different concrete units with different patterns of placement and influence of the rock layer in front of the structure were studied. The experimental results show that using sacrificial in front of concrete units reduces the moving of units significantly (Figure 5). In fact, sacrificial rock layer decreases destabilizing pressure while passing both the crest and trough of waves.

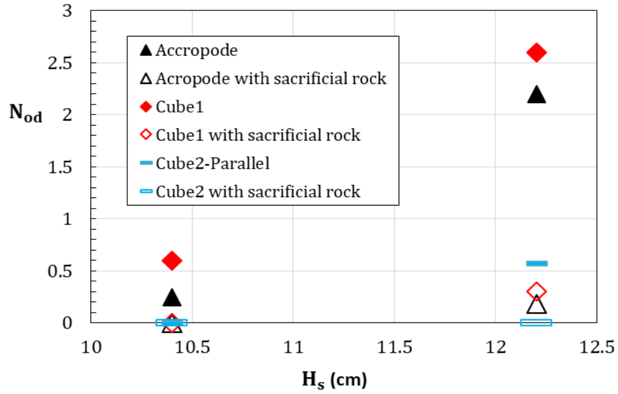

Figure 5- Damage result in different toe units

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