Stability coefficients of Tetrapod, Rakuna-IV and Dimple depending on placement methods

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ABSTRACT

In this study, two different uniform placement methods are proposed for each of Tetrapod, Rakuna-IV, and Dimple armoring a rubble mound breakwater and the corresponding stability coefficients are determined by hydraulic experiments. The Tetrapod and Rakuna-IV show similar stability coefficients regardless of the placement methods, whereas the Dimple shows somewhat different stability coefficients depending on the placement methods. It is shown that the Dimple gives the largest stability coefficient, whereas the Tetrapod gives the smallest value. The uniform placement methods of Tetrapod and Rakuna-IV give slightly larger stability coefficients than the random placement, whereas the uniform placements of Dimple give much larger stability coefficients than the random placement. However, the small void ratio of uniform placements of Dimple requires attention because the blocks would behave like single layer system blocks so that brittle failure could occur.

KEY WORDS: Armor units; Dimple; placement method; Rakuna-IV; rubble mound breakwater; stability coefficient; Tetrapod.

INTRODUCTION

To prevent a rubble mound breakwater from erosion due to severe storm waves, an armor layer is placed on its slope. In the places where large quarry stones are not available, concrete armor units are often used. The Tetrapod is the oldest armor unit but is still widely used all over the world. The Tetrapod, as the name suggests, has four legs toward the vertices of a tetrahedron from its center. Armor units of similar shape such as Dimple, Rakuna-IV, and Tetra-Neo have been developed later.

The stability of armor units changes depending on the placement methods: random or uniform placement. In some countries, for example Korea, the uniform placement method is frequently used. The stability of armor units is represented by the stability coefficient in the Hudson (1959) formula. Stability coefficients for different armor units are presented in the Shore Protection Manual (U.S. Army, 1984). However, their applicability is limited because they were developed based on regular wave experiments and only random placement was used for concrete armor units. Recently several experimental studies have been performed for different uniform placement methods of Tetrapod (Gürer et al. 2005; Fabião et al. 2013) as shown in Figs. 1 and 2, but the stability coefficients were not presented. The stability of other armor units for uniform placement methods has not been investigated in detail. Moreover, it is important to maintain consistency in the experiment (i.e. using the same equipment operated by the same person) to compare the stability of different armor units.

Fig. 1. Placement methods of Tetrapod of Gürer et al. (2005)

(a) G-T-A                                          (b) G-T-B

Fig. 2. Placement methods of Tetrapod of Fabião et al. (2013)

(a) F-T-A                                         (b) F-T-B