Study of the Wave Absorbing Ability of Vegetation on a Revetment by the Physical Model Test

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ABSTRACT

A physical model experiment based on a 1:10 model scale is performed to test the wave absorbing ability of vegetation on a revetment. In this test, the vegetation arrangement, trees rows, submerged depth and different planting locations are considered to analyze the absorbing effect. The study reveals that the vegetation can reduce the wave height and overtopping water within a limited scope of wave height and that vegetation is not harmful to the stability of armor blocks on the revetment. For improving the absorbing effect, the following rules apply: a rectangular arrangement is better than a quincuncial arrangement; a half-submerged water depth is better than an all-submerged depth; vegetation planted on the slope is better than on the shoulder and top of the revetment; and more planted rows are better for wave absorbing. Considering the actual project in the Tianjin Center Fishing Port, the best absorbing effect of the vegetation involves trees planted on the slope of the revetment, for which wave breaking occurs on the branches and leaves of the trees.

KEY WORDS: Wave absorbing; vegetation; revetment; physical model test.

INTRODUCTION

The topic of this study is the leisure operation area of the Tianjin Center Fishing Port. For the randomly sowed shrubs, sea weeds, and other plants in the sediment barrier, the inner port and outer slope of the revetment have partially survived, and sea weed flourishes to a large degree at the northeast side of the outer revetment; as a result, the harbor is now becoming a wetland ecological landscape port. At the same time, the matured gross plants exist in the interspaces of the fence panels on the revetment. This paper focuses on the wave absorbing ability of these plants.

The previous applications and research studies on the wave absorption effect of revetment vegetation mostly considered riverway levees, dykes and inshore tidal flats (Ji et al., 2005 and Zhao et al., 2010). Song (1997) and Fu (1997) conducted prototype observations for the wave absorption effect of Spartina alterniflora Loisel and polyethylene artificial seaweed, respectively. In an experimental study, Bai et al. (2005) analyzed the slopes of a wave prevention forest and the revetment bottom slope, as well as the impact of the bottom slope elevation on the vegetation wave absorption; Huang & Ji (2005) and Ji et al. (2006) analyzed the impact of a wave prevention forest on the riverbank wave run-up and wave pressure; Yang (2003) and Zhang (1965) each provided a calculation formula of the wave absorption coefficient of the wave prevention forest under different situations; and Mei et al. (2011) analyzed the wave absorption effect of tidal flat vegetation under the action of long waves by using the numerical value method.

In harbor engineering, for a limited set of factors, such as inshore wave conditions and engineering practice, the application of vegetation to achieve wave absorption is not common. In this study, a physical model test is established to conduct section test for the existing vegetation situation of east-breakwater in the Tianjin Center Fishing Port and the wave absorption effect of the vegetation on revetments are discussed.

TEST CONDITIONS

Test section

Fig. 1 shows the scope of the east-breakwater in the Tianjin Center Fishing Port. In this study, we selected the preliminary design section of the east-breakwater at a +1.0 m mud surface elevation as the reference section; the section structure is shown in Fig. 2. The mud surface elevation of the section is +1.0 m, the shoulder elevation is +3.0 m, the breakwater top elevation is +6.0 m, and the parapet top elevation is +7.5 m. The fence boards are laid from the section sea-side shoulder to the top, and the slope between the shoulder and the top is 1:2; 200-300 kg of block stones are laid below the shoulder at a slope of 1:3. Because, in this study we mainly investigated the wave absorption effect of the vegetation, in this test, we temporarily did not consider the parapet structure. Therefore, the breakwater top elevation of the section is +6.0 m in the model design.