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Physical model studies on stability of geotextile sand containers

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Abstract

Coast parallel submerged breakwaters made of Geotextile Sand Containers (GSCs) are increasingly being incorporated into coastal management solutions because of their cost effective and environmentally friendly characteristics. These reduce the wave action on the lee side by forcing wave breaking and their stability is a function of the relative crest width, crest height, and the damage. The present work involves a physical model study on 1V:2H sloped trapezoidal submerged reefs constructed with 485 gm GSCs with different alignments like Perpendicular, Parallel, and Flemish. They have a height (h) of 0.25 m and varying crest widths (B) and are tested for stability for wave heights (H) of 0.1 m and 0.12 m and wave periods (T) of 1.5 s to 2.5 s in a water depth (d) of 0.3 m.

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Keywords: Geotextile sand containers; submerged breakwater; alignment of GSCs; wave incidence; breakwater damage.

1. Introduction

Geotextiles have been in an innovative way in the construction of breakwaters. Geotextile technology is currently being researched widely for use in coastal applications (Oh and Shin 2006). In the case of Geotextile Sand Container (GSC) structures, quarrying and transporting of rock are not required and this structure can be easily removed in the case of adverse unforeseen impacts. With the expected worsening of coastal erosion, a soft, and inexpensive solution will be a strong contender to replace a more conventional hard engineering solution as coastal

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communities which are highly developed will be severely affected. Such applications have made engineering construction eco-friendly, highly durable and economical while allowing the speedier construction. The ability to use local material and labour, makes construction easier and faster and possible in isolated areas. The use of GSC structures allows for a more flexible and adaptive approach that can be more easily modified if the desired outcome is not satisfactory or if the design conditions change. GSC structures can even be easily removed in the event that the GSC structure does not perform.

Extensive testing has been done on the hydraulic stability of single geotextile tubes (Pilarczyk, 2000; Recio and Oumeraci, 2009; and Dassanayake and Oumeraci, 2013), and these have been used in coastal protection works (Kudale, 2013 and 2015; Sundar, 2013; and Sundar and Sannasiraj, 2013). But the question about how a multi-layered structure performs is still open. However, current understanding of hydraulic stability of stacked GSC structures is limited and with better understanding, the potential for its future application is vast (Ramesh, 2014). The design of such a GSC structure for submerged reef breakwater could be both an innovative and low-cost solution for various coastal projects is the real motivator for the present study.

2. Objective

The objective of the present experimental investigation is to examine the stability of submerged reef constructed with GSC arranged in different alignments like Parallel, Perpendicular and Flemish.

3. Experimental details

3.1. Wave Flume

The wave flume of Marine Structures Laboratory of the Department of Applied Mechanics and Hydraulics, National Institute of Technology Karnataka, Surathkal which generates monochromatic waves is used to test the physical models of the GSC reefs. Fig. 1 gives a schematic diagram of the experimental setup.

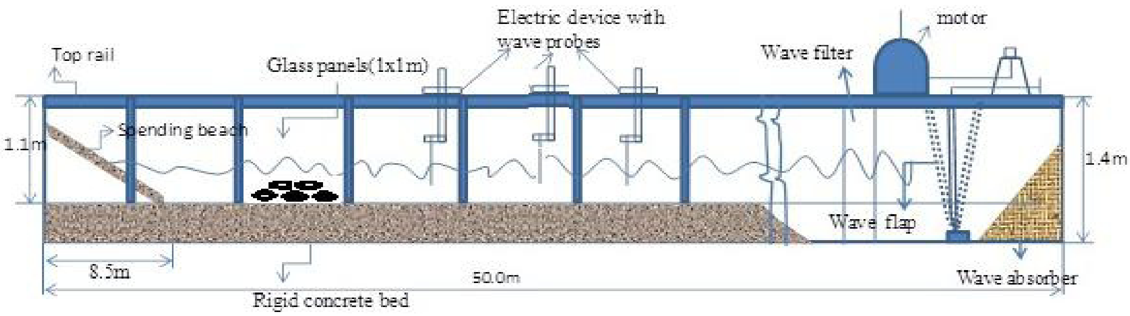

Fig. 1. Schematic diagram of experimental set up with GSC reef model

The wave flume is 50 m long, 0.71 m wide and 1.1 m deep. About 15 m length of the flume is provided with glass panels on one side to facilitate the placing and photography of test models. It has a 41.5 m long smooth concrete bed. Gradual transition is provided between normal bed level of the channel and that of wave generating chamber by a ramp. The flume has a 6.3 m long, 1.5 m wide and 1.4 m deep chamber with a the bottom hinged flap at one end which generates waves. The wave filter consists of a series of vertical asbestos cement sheets