Study of Large-scale Physical Model Test on Force Characteristics of Seawater Intake Riser

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ABSTRACT

In the present study, experiments were conducted using TIWTE’s Large Wave Flume (456m long, 5m wide and 12m deep) to investigate the wave force characteristics of seawater intake riser under different wave conditions. The experiment results show that, the higher incident wave height, the longer wave period and the smaller immersed water depth of seawater intake riser lead to the increased of total vertical force with other conditions unchanged. The uplift force on the top slab is affected by the submerged water depth and wave shape above the top slab. When the wave was not broken, the smaller the submerged water depth was, the greater uplift force on the top slab received. When the wave was broken, the wave energy decayed rapidly, and the uplift force on the top slab decreased accordingly. The experiment results show that the design of pressure relief holes have an effectively reduce on wave force on the seawater intake riser.

KEY WORDS: Large-scale physical model; intake riser; wave force; porosity; submerged depth.

INTRODUCTION

In the coastal power plant water intake and outfall engineering, the seawater intake riser is often designed at the end of intake pipe. Generally, the seawater intake riser is submerged and subjected to the action of waves directly. The stability of seawater intake riser is a key problem in design, because its stability is related to the normal operation of the coastal power plant. When the intake head is subjected to too large wave force, it may cause displacement of the intake riser and then disconnect from the connection of the sea pipe. This paper takes the Hassyan clean coal power plant project in Dubai as an example, this project adopts a complicated structure of seawater intake riser, and a number of pressure relief holes are arranged on the top slab to reduce the impact of waves. The complex structure brings difficulties to the accurate simulation of the numerical model, so it is necessary to carry out the physical model test to verify the stability of the seawater intake riser structure. Specially, the experiment was conducted in TIWTE’s Large Wave Flume (2014) (456m long, 5m wide and 12m deep), the larger geometric scale was used in the experiment to minimize the effect of scale effect on test results. In this way, more real experiment data and phenomena could be obtained. The existing researches about wave force on underwater structures and large scale physical model are mainly from physical model, formula computing and numerical model aspects. Kuiper G (2007) studied the dynamic stability of free- hanging water intake riser. Magda W (1997) studied the wave- induced uplift force on a submarine pipeline buried in a compressible seabed with two-dimensional finite-element simulation. Liu H (2015) studied the wave uplift force imposed on the the bottom of superstructure of a pillar wharf. Kunisu H (2010) investigated the wave force characteristics acting on the Submerged Floating Tunnel. Roy P D (2006) studied the wave force on vertically submerged circular thin plate in shallow water with numerical simulation method. Kubota S (2014) tests the wave force and stability of new flat type concrete block with large openings for submerged breakwater. Mizutani N (1993) calculated the wave force on a submerged sphere. Kostykov A A (2001) formed the formulas for computation of the wave resistance and lifting force of bodies submerged in a liquid. Dohmen (2005) studied the sheet flow and suspended sediment due to wave groups in large wave flume.

EQUIPMENT AND MODEL ARRANGEMENT

The experiment is carried out in in TIWTE’s Large Wave Flume, see Fig. 1. The wave flume is 456m long, 5m wide and 12m deep. At one end of the flume, the wave generator is set, which is electromotor servo driving and absorption-type wave generator, and the regular and irregular waves can be generated. The capability of wave generator is as follows: The maximum water depth: 8.0m, the range of wave height: 0−3.50 m, the range of wave period: 2.0−10.0s.

The wave calibration of wave height is measured by 5m measuring range resistance-type wave gauge. The total vertical force of intake riser is measured by six-component total force sensor and the uplift force on the top slab is measured by point pressure sensor.