Improvement of a Suction Rate Formula from the Bottom of the Sheet Pile of a Coastal Dike

Masafumi Ioroi
Graduate School of Science and Technology, Tokai University, Japan

Yoshimichi Yamamoto
Graduate School of Science and Technology, Tokai University, Japan

Yoshitaka Oshima
Fujimi Consultants, Japan

ABSTRACT

There are many cases in which coastal dike or seawalls are broken by waves lower in height than the design height. And, they don’t usually received waves of great power, because they are constructed on very shallow coasts or sand beaches. The causes of the destruction are erosion, scouring, and suction. Therefore, it is important for us to establish the prediction methods of the suction rate from their bodies. In this paper, we improve Ioroi et al.’s formula so that the suction rate is gotten with high accuracy by using the settling velocity of Rubey. Then, we consider the influence of the uniformity coefficient and dry density. Moreover, we examine getting the suitable values of the flow velocity and the excess pore pressure using CADMAS-SURF.

KEY WORDS: Suction; suction rate formula; coastal dike; coefficient of uniformity; dry density; VOF method.

INTRODUCTION

In the case of a coastal dike or a seawall in a beach or a shallow area, there are a few of field cases that those were destroyed directly by strong wave force and a lot of field cases that erosion and scour in front of them and suction from their bodies caused by the continuing action of waves bring the destruction gradually. That is, it is said the causes of the destruction are mainly erosion, scour and suction. Yamamoto et al. proposed the method which can predict whether dikes and seawalls are broken or not by using the net resistance force and the wave overtopping rate, and found the more grain diameter of backfilling materials becomes large, the more net resistance force becomes large. Moreover, it is important for us to develop a prediction method of the suction rate also. Ioroi et al (2012) proposed the empirical method for predicting the suction rate of backfilling materials from the lowest edge of the coastal dike by big waves. The proposed method can take the influence of the median diameter of backfilling materials in account, and they confirmed that the calculation values using the proposed formula agreed with experimental values and a field value very well.

In this paper, we improve Ioroi et al.’s formula so that the suction rate is gotten with high accuracy by using the settling velocity of Rubey. Then, we reveal the influence of the uniformity coefficient and dry density to the suction rate using experimental data. Moreover, we examine getting the suitable values of the flow velocity and the excess pore pressure using CADMAS-SURF.

SUCTION EXPERIMENT

Experiment Setup

The experimental setup used in this study consists of a water channel 0.5m wide, 0.8m high, and 22m in entire length and a ball-screw-driven wave generator, as shown in Fig. 1. Vertical two dimensional regular and irregular waves can be generated using this setup.

![Fig. 1 Experiment setup.](image-url)

Side walls are made of acrylic boards stiffened with angle irons.

Experimental Method

Case1

The break of the Hirono coastal dike in Shizuoka Prefecture by typhoon no. 9 in 1997, which is a typical disaster case caused by the repeated action of waves, was reproduced. In the actual case, waves with a significant wave height of 6.91m and a significant wave period of 13.9s occurred. In this experiment based on the Froude law, the model scale was determined as one-thirtieth, and the significant wave height and the significant wave period of the model were 22.33cm and 2.65s.