Study on Wave Reflection Coefficient and Wave Runup Height on a Slope

Tomoya Inami, Hiromichi Tanaka and Tetsuo Sakurada
School of Marine Science and Technology, Tokai University
Shimizu, Shizuoka, Shizuoka, Japan

ABSTRACT

It is important for overtopping wave power generators to reduce the intensity of wave action that propagate on a front slope and to obtain a large overtopping volume. In a fundamental study of overtopping wave power generation, in this work, wave height, period, and the slope angle were varied and the wave runup heights of regular and irregular waves were measured. We sought to determine the dependence of the reflection coefficient on the slope angle and wave characteristics.

KEY WORDS: Reflection coefficient; wave runup height; wave power generation; overtopping type; wave steepness; surf similarity parameter.

INTRODUCTION

Global warming caused by the increase in the atmospheric CO2 concentration has given rise to abnormal weather and has influenced ecosystems across the world. This has catalyzed research and development of renewable energy sources in order to reduce the use of fossil fuels. While solar, wind, biomass, and geothermal energy generation methods are already practical and currently used as commercial power sources, the use of ocean energy other than in tidal power generation is currently only in the research and development stage.

Wave power generation methods can be roughly divided into eight classes of systems that transform wave energy into electrical energy (EMEC); the system under development by the authors belongs to the wave overtopping class (Tanaka, 2013). As shown in Fig. 1, when a wave ascends a slope, wave energy is transformed into potential energy and the energy of the flow produces a reservoir with a difference between the height of the water in the wave and the ocean surface. The overtopping wave power generation system generates electrical energy by using the torque received by a propeller to operate a dynamo. It is assumed that the overtopping wave power generator is not installed in the offing but rather around the front face of the offing breakwater in an offshore structure that receives the directly attacking wave.

In this work, in a fundamental study of overtopping wave power generation system, the wave height, period, and the angle of a slope are changed under the conditions of regular and irregular waves, and experiments are conducted varying the wave runup height in order to elucidate the relationships between the runup height, reflection factor, and wave energy. The waves impinging on the slope were examined separately in the case of the surging runup wave without breaking and in the case of the breaking wave with breaking in the runup. While previous studies by Miche (1944, 1951), Saville (1958), Hunt (1959), Savage (1958), Takada (1970), Mase (1993, 2003) and Tamada (2009) examined and compared the conventional wave runup of a short period, studies of the wave runup height based on the wave energy have been rare, motivating the present work.

EXPERIMENTAL DEVICE AND METHOD

In this work, wave power generation equipment was installed in front of the offing breakwater in the offshore structure that receives a direct wave. Therefore, it is important to evaluate the wave height and overtopping wave amount. The two-dimensional wave making channel at the Hydraulic Laboratory of the School of Marine Science and Technology of Tokai University with die length, width, and depth of 52.0, 1.0, and 1.5 m, respectively was used in experiments to create regular and irregular waves with the runup height of the wave at 30° from the slope of 10°. The obtained data were continuously recorded. The goal of the experiments was to continuously record and then analyze the data to understand the relations among the wave height, period, and slope angle.

![Fig. 1. Schematic of overtopping wave power generation equipment](image-url)