

Numerical analysis on Deformation of Submerged Structures composed of various size materials using DEM

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ABSTRACT

In the most of previous studies on deformation of discontinuous structures using DEM in field of coastal engineering, elements of structures have been assumed that it is composed with uniform materials or received fixed wave force, despite of actual submerged structures are composed with various size materials and influenced by complicated fluid field. The goal of this study is to develop a new model for analysis of seabed deformation using discontinuous structures composed with various size materials. As the first phase, a model using DEM, which can compute the deformation of the submerged structures composed with various size materials, such as rubble mound structures, was proposed. A model test was carried out and then the validity of the model was discussed.

KEY WORDS: Distinct Element Method; Seabed liquefaction; Submerged breakwater; VOF; Morrison model; Rubble mound structure; CADMUS-SURF

1. INTRODUCTION

In numerical analysis on deformation of submerged structures such as rubble mounds, cavern formation process in sandy beach, and seabed liquefaction, Distinct Element Method (DEM), which has been proposed by Cundall, P. A. (1971), is recently used well. DEM has the essential applicability for analysis of fissured rock structures and discontinuous structures on seabed. However, in the most of DEM analysis of the previous studies on submerged structures, elements of structures were assumed that it is constructed with uniform materials (Araki, Kotake, Kanazawa and Deguchi, 2001, Araki, Yanagihara and Deguchi, 2003), despite of actual submerged structures are constructed with various size materials. Therefore, the structures were divided into same size elements and analyzed. Furthermore, it was assumed that waves acting on the structures are dealt with simple cyclic condition for

the stable computation, and the wave forces were acted on the just surface layer for simplicity. The results of analysis with assumed seabed or submerged structures are significantly different from those of actual states.

And in case of analysis on deformation of submerged structure caused by wave force, though the sequential interactions of wave field and sectional deformation of structure is an important factor, previous studies were rarely considered.

The goal of this study is to develop a new model for analysis of seabed deformation using discontinuous structures, which consist of various size materials. As the first phase, we proposed a model that the deformation of the submerged rubble mound structures composed with various size materials can be computed.

The proposed model in this study has two sub-modules. One is wave computation module by CADMUS-SURF (Coastal Development Institute of Technology, 2001) based on VOF (Hirt and Nichols, 1981) and SMAC method. And the other is structure computation module by DEM. In the wave module, Morrison model was adapted in order to determine wave forces.

In this study, we tried to compute the deformation of the rubble mound structure with various size materials on seabed and the deformation of seabed. The wave field to a porous mound structure is computed by CADMUS-SURF. And the deformation of structure is computed using DEM module. The wave forces are acted not just surface area, but those are acted into all elements in the structure, and then the behaviors of all elements are traced. Furthermore, interaction of wave and sectional deformation of structures is considered and the influences due to the configuration of coefficients in analysis on the deformation of the submerged structure are investigated.

2. WAVE ANALYSIS

2.1 Reproduction of wave field

In this study, for computation of wave field, CADMUS-SURF is