

## FEM Analysis of Seabed Stabilization Method against Sea Wave Loading with Permeable Columns

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### ABSTRACT

The purpose of this study is to propose a stabilization method for seabed subjected to sea wave loading and verify the efficiency of the method through a FEM analysis. The principle of the stabilization method proposed in the study is the suppression of the seepage force inside the seabed. Since the seepage force is a kind of body force and is fundamentally related to the gradient of potential water head in the seabed, the unification of potential water can be effective for reducing the hydraulic gradient and the associated seepage force. In the method permeable columns which are installed into seabed near structures with a certain interval and depth are utilized for propagating water pressure from the surface to the inside of seabed.

**KEY WORDS:** *stabilization of seabed, sea wave loading, permeable column method, Finite Element Analysis*

### INTRODUCTION

Various types of seashore, offshore structures and port and harbor facilities such as breakwater, shore protection, quay wall and tower, are often damaged by wave loadings under stormy weather condition. In the damage the impact of water pressure on the structures induced by the sea wave loading is one of the major factors influencing the instability and/or destruction of the structures. At the same time the water pressure are applied to the surface of seabed which bears the structures as a foundation ground. Since the surface water pressure induces the fluctuating excess water pressure and shear stress in the seabed, the wave loading sometimes causes the instability of the structures as well as the seabed foundation ground. In the coastal

engineering, the mechanism of settlement of breakwater has been explained as "Scoring" which focused on floatage or movement of the ground material with respect to the flow velocity of seawater. The seabed is, however, lost sometimes in the range from seabed surface to the depth of several meters under stormy wave conditions in actually caused problems; Yamamoto (1977) and Okusa (1985) suggested from geotechnical viewpoint through their analytical discussion that this type of the seabed instability is caused by the wave loading on the seabed surface, and effective stress fluctuates. Zen and Yamazaki (1991) measured the fluctuation of excess pore water pressure and effective stress in the seabed at a breaker zone in a real ocean environment. Oka et al. (1995) conducted a field examination of a damaged port facility, break water, and found that the cause of the damage is closely related to the fluctuation of pore water pressure. Asahara et al. (2007) developed the calculation method for the wave-induced behavior of seabed-structure system in the framework of FEM.

The suppression of the wave loading, i.e. the reduction of the fluctuating seabed surface water pressure, is reasonably considered to be effective primarily for the stability of seabed-structure system; and the countermeasures such as breakwater and armor blocks have been proposed and employed for this purpose. The principle of the stabilization method proposed in this study is the suppression not of surface water pressure but of the seepage force inside the seabed. Since the seepage force is a kind of body force and is fundamentally related to the gradient of potential water head in the seabed, the unification of potential water can be effective for reducing the hydraulic gradient and seepage force. In the method the permeable long columns which are installed into seabed under and/or around structures with a certain interval are utilized for propagating water pressure from the surface to