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主　論　文　の　要　旨

論文題目　**Development of Morphodynamic Model to Evaluate Artificial Reef and to Determine Mechanism of Beach Profile Change in Gravel Beach (礫浜海岸の地形変化特性の解明と侵食対策工の有効性を評価するためのモデル開発)**

氏　名　**KIM Shinwoong**

論　文　内　容　の　要　旨

The objective of this paper is the development of numerical model to evaluate the artificial reef in the gravel beach. The model, will be developed in this study, is based on the Fluid-Structure-Sediment-Seabed interaction Model (FS3M). It was developed by Nakamura and Mizutani (Nakamura and Yim, 2011; Nakamura et al., 2009; 2013; 2016; Nakamura and Mizutani, 2014) can consider the influences of infiltration and exfiltration applicable to fluid-sediment interaction phenomena. Furthermore, FS3M was already verified for the beach profile change due to the solitary wave (Nakamura and Yim, 2011), and the local scouring due to the jet flow (Nakamura and Yim, 2011) and tsunami (Nakamura and Mizutani, 2014). These researches presented the high accuracy of FS3M model, however it was only focused on sandy beach and the high computational cost still remained as limitation to reproduce long-term beach profile change. In this study, the hydraulic experiments are conducted to improve the understanding for morphodynamic and morphological change in the grave beach. Based on these results, a model that can be applied to the gravel beach by reducing the computational cost is developed.

In Chapter 2, the main item is the hydraulic experiments in gravel slope. To determine the mechanism of gravel profile deformation, the change in the spatiotemporal beach profile is investigated by hydraulic experiments under the regular and irregular wave

condition (Chapter 2.3). By utilizing these results, various experimental scenarios are investigated to reproduce ordinary morphological deformations such as berm formation, collapse, movement, and growth, under accretive wave conditions (Chapter 2.4). From this experiment results, the mechanism of berm collapse under the sedimentation type wave condition was determined. To understand groundwater circulation and its effect such as infiltration and exfiltration near beach face and break-point step, the dye test is conducted (Chapter 2.5). The morphological interrelation according to regular wave and irregular wave was investigated (Chapter 2.6). This is a preliminary study for applying the model, will be developed in this study, to the real beach. Whether the irregular wave component could be reproduced with the regular wave to reproduce same profile change was examined. Finally, by comparing and analyzing the experimental results with artificial reef, the wave field deformation and beach profile change were investigated to confirm the necessity of three-dimensional model experimentally (Chapter 2.7).

In Chapter 3, the governing equation of FS3M model for hydrodynamic and sediment transport are explained. A computational procedure for long-term beach profile change is proposed and incorporated into a three-dimensional coupled fluid-structure-sediment-seabed interaction model (Chapter 3.2). And the numerical experiments on long-term surface profile change in a gravel beach are conducted using the improved FS3M to examine the sensitivity of the size of numerical cells and model parameters involving sediment transport compared with Mizutani's experiment (Chapter 3.3) and new experiment designed in this study (Chapter 3.4).

In Chapter 4, a hindcast wave model was built using the SWAN model to estimate wave fields at the Ida beach (Chapter 4.2). To verify its accuracy, estimated results were compared with NOWPHAS wave data. Using hindcasted wave data in 2015, the characteristics of wave fields were analyzed (Chapter 4.3). Furthermore, wave fields on December 2015 was analyzed to determine the relationship between wave fields and beach profile change under high wave conditions. In addition, it is confirmed that the Owase's buoy data can be used for immediate data analysis of the change of shoreline and topography performed in previous studies (Chapter 4.4). Finally, the characteristics of wave propagation in Ida beach were investigated by using the hindcast wave and geomorphological information of Ida beach with FS3M model (Chapter 4.5).

Consequently, the beach profile deformation was reproduced by using the modified FS3M model. The numerical estimation method, which estimated beach profile evolution by using specific wave fields repeatedly, for long-term beach profile change was applied. The influence of gravel slope was reflected through the calibration using experiment result introduced in chapter 2. The model totally reproduced the

morphodynamics well on the gavel slope for not only the wave, water table, velocity near the seabed, and pore water pressure but also beach profile deformation. From this results, it was suggested that the improved FS3M is expected to be a useful tool in assessing spatiotemporal surface profile change in a gravel beach.