Numerical sensitivity analysis for dynamic behavior on gravel beach

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1. Introduction

This study was intended to reproduce the topographic change in gravel beach and to investigate physical mechanism of gravel beach erosion in order to establish an effective countermeasure against erosion in Shichiri-mihama beach. As a part of the study, numerical verification and sensitivity analysis were carried out based on the experimental results conducted by Eguchi (2004). In the experiments, three different sediments were used, 0.1mm sands, 5mm gravels and 5mm plastic bolls, while only 5mm gravel case was adopted in this study.

2. Numerical setup

As a numerical model, a three-dimensional two-way coupled Fluid-Structure-Sediment-Soil interaction model (FS3M) developed by Nakamura and Mizutani (2013) was used. The beach profile calculation was conducted with the conditions (Table 1) for investigating the effects of parameters in the wave flume based on the experimental condition (Figure 1). Case B, C and E were to examine the effect of the position of shear velocity applying to sediment transport calculation, the thickness of in/exfiltration layer and the angle of repose on topographic change in gravel beach, respectively. Additionally, the effects of the grid-cell size (Case A) and topographic calculating interval (Case D) on topographic change were examined closely related to a numerical accuracy and effectiveness. The angle of repose of 30 degree was adopted except for Case E. The median grain size was 5.0mm. The gravel beach was installed above the impermeable slope with a thickness of 0.15m and a slope of 1/7.

3. Numerical result

In the coarse grid (A1-1 and A2-1), the bar was appeared clearly at around x = -0.5m despite of this type of bar scarcely observed in natural gravel beach. The bar size was reduced according to grid size smaller. As grid size became smaller, the berm position formed on the upper beach moved to landward and the berm crest height increased (Figure 2(a)). In Case B, the trend of topography change was clearly distinguished between 4.0dz and 5.0dz (Figure 2(b)). In the Case of

Table 1 The list of numerical modeling Case for reproduction of erosion

Case	Grid size*	Position of ν_{surf}	Update interval	In/exfiltration	Case	Grid size	Position of ν_{surf}	Update interval	In/exfiltration
A1-1	Coarse	2.0dz	100 waves	Considered 15mm	**A2-1**	Coarse	3.0dz	100 waves	Considered 15mm
A1-2	Fine in Z dir.	4.0dz			**A2-2**	Fine in Z dir.	6.0dz		
A1-3	Fine				**A2-3**	Fine			
B1-1	Fine	3.0dz	100 waves	Considered 15mm	**C1-1**	Fine	4.0dz	100 waves	1.0dz
A1-3		4.0dz			**C1-2**				2.0dz
B1-2		5.0dz			**C1-3**				4.0dz
A2-3		6.0dz			**C1-4**				No considered
B1-3		7.0dz			**A1-3**				15mm
D1-1	Fine	4.0dz	50	Considered 15mm					**Angle of repose(Deg.)**
D1-2			250		**A1-2**	Fine in Z dir.	4.0dz	100 waves	30
D1-3			500		**E1-1**				40
D1-4			1000		**E1-2**				45

* Coarse : dx = 0.02m, dz = 0.0115625m; Fine : dx = 0.01m, dz = 0.00578125m; Fine in Z dir. : dx = 0.02m, dz = 0.00578125m

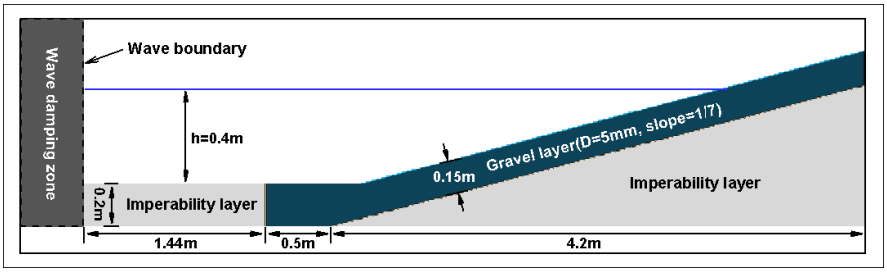

Fig.1 A sketch of a numerical wave tank

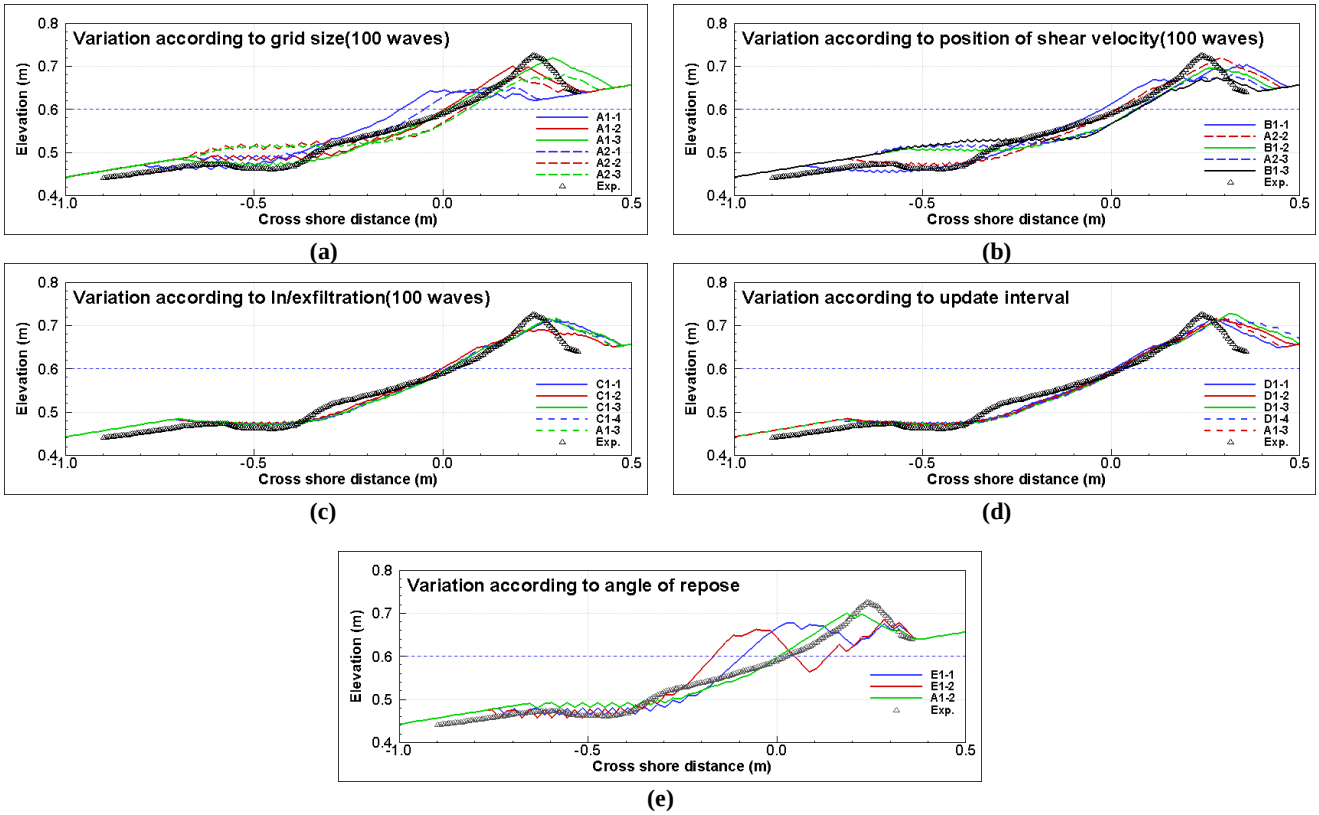

Fig.2 Numerical and measured final gravel beach profiles

using and over 5.0*dz*, the close depth was appeared above 0.5m elevation and the berm crest height was appeared lower than 0.7m (each 0.696m, 0.680m and 0.673m). On the other hand, in the Case of using and less 4.0*dz*. The close depth was appeared around 0.47m and the berm crest height is appeared higher than 0.7m (0.703m and 0.720m, respectively). The berm position was very similar except for the Case B1-1. In the Case B1-1, two berms were formatted and shoreline was advanced to offshore direction more than other cases. In the Case C and D, there was little effects of in/exfiltration and update interval factors on the trend of topographic change (Figure 2(c) and (d)). In the Case E, the berm was advanced seaward as the angle of repose increased (Figure 2(e)).

4. Conclusion

In this study, the numerical simulation of gravel beach topographic change was carried out. In the experiment results, the berm crest is appear at x = 0.24 and z = 0.725 and the Case B1-2 (x = 0.26) showed the most similar crest position to experimental results. The most similar crest height was observed in the Case D1-3 (z = 0.726). Detail of the numerical results will be presented in the conference.

Reference: [1] Nakamura and Mizutani(2013) : Coastal Eng., Vol. 69, No. 2, pp. I_1026-I_1030. [2] Eguchi(2004) : Nagoya Univ., Dissertation, 28p.