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Study on Coastal Levee Reinforcement Using Double Sheet-Piles with Partition Walls

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There is a fear that coastal levees will sink by liquefaction due to large earthquakes such as the Nankai Trough earthquake in Japan. To overcome this damage, as one of the major countermeasures, the application of double sheet-pile walls to coastal levees has been proposed. In this study, to enhance the performance of this countermeasure, the authors focus on installing partition walls perpendicular to sheet-piles. By the shaking model test and numerical analysis, remarkable inhibition of the levee deformation/settlement was confirmed.

INTRODUCTION

The severe seismic damage to the coastal levees in Japan's Tohoku region was caused by the 2011 earthquake off the Pacific coast of Tohoku (Oka et al., 2012). Large earthquakes such as the Nankai Trough earthquake are also predicted to occur in the near future, and it is feared that coastal levees will sink by liquefaction. As a countermeasure against large earthquakes and tsunamis, the double sheet-piles installation method (Fig. 1) has been proposed, and its effectiveness has been confirmed by model tests and numerical analyses (Otsushi et al., 2011; Fujiwara et al., 2013). The faster the levee damage is reduced, the quicker it will be feasible to recover the function of the levee. Thus, personal and physical damage can be minimized. Accordingly, in this study, with an aim to further enhance the settlement inhibition effect, a fundamental study focusing on double sheet-pile walls with partition walls was performed (Fig. 2a). Here the partition walls are sheet-pile walls that are installed perpendicular to the double sheet-piles. In harbor quays, for instance, partition walls are applied to coastal levees in practice and are generally spaced approximately every 5–10 m. In this study, first, we performed shaking model tests using a steel plate as the model of partition wall. Second, we reproduced the results of shaking model tests with high accuracy using a two-dimensional (2-D) effective stress analysis program, LIQCA2D12 (LIQCARI, 2012). However, in actual structures, the partition walls are steel sheet-pile walls; thus, shear distortion is generated at the joints when external force is exerted perpendicular to the extension direction of the levee, as shown in Fig. 2b (Ohori et al., 1984). Finally, the authors modified the 2-D analytical model accordingly to consider the joint of the partition wall and investigated the effect of the shear distortion using the modified model.

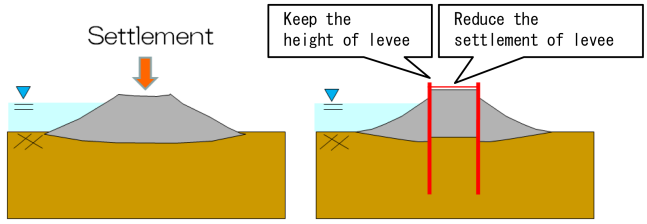
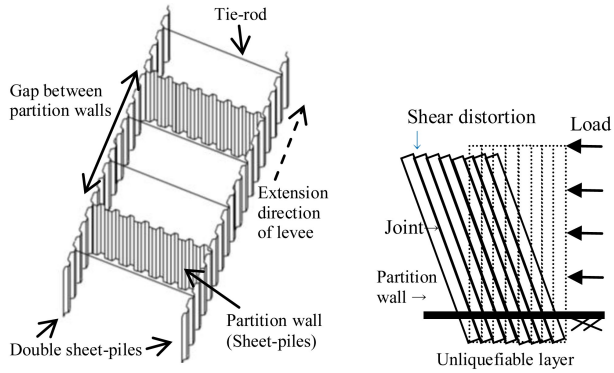


Fig. 1 The effectiveness of the double sheet-piles countermeasure



(a) Double sheet piles with partition walls (b) Shear distortion

Fig. 2 Partition wall

EXPERIMENTAL STUDY

Test Procedure

The shaking model tests were performed under a 1 g condition. A centrifuge test is more appropriate to reproduce the real

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KEY WORDS: Levee reinforcement, sheet-pile, liquefaction, partition wall, shaking model test, numerical analysis.