第Ⅲ部門

Study on earthquake resistance of strip-steel reinforced earth wall considering moisture state of embankment using dynamic centrifugal model tests

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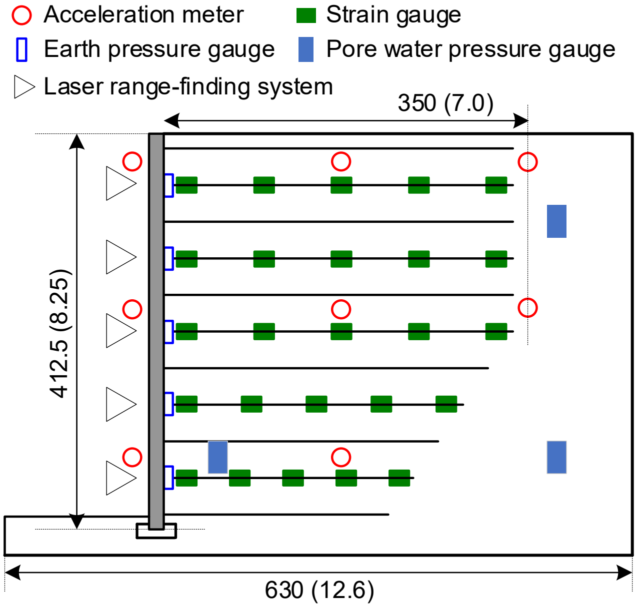
1. Introduction: Reinforced earth wall used to be recognized as an excellent earthquake resistant structure. However, in recent years, it has been shown that high water content of soil in strip steel reinforced earth wall brought by the seepage of ground water and rainfall infiltration will lead to a damage of reinforced earth wall after earthquakes happened[1]. According to Shimura et al.[2], it is pointed out that resistant force of reinforcement in moist sand is lower than in dry sand. Until now, there are many researches about earthquake resistance of reinforced earth wall. However, most of the research use dry sand as soil material, there is little research focus on water containing state of ground. In this study, stability of strip steel reinforced earth wall under moisture state is investigated using dynamic centrifugal model tests.

2. Experiment Condition: Centrifugal model test is conducted in Disaster Prevention Research Institute (DPRI) of Kyoto University. In this experiment, a rigid soil container (length 630 mm × width 150 mm × height 500 mm) is used for shaking table test under centrifugal acceleration of 20 g. Moist Yodogawa levee sand (ρ_s = 2.661 g/cm^3, D_{50} = 0.28 mm, w_{opt} = 13.7%, ρ_{dmax} = 1.838 g/cm^3) is used in this experiment with optimum water content. Wall structure (412.5 mm height × 140 mm width × 3 mm thickness in model scale) is built on a foundation with 25 mm (model scale) height. Schematic figure of experiment model is shown as Figure 1.

Length of reinforcement (6 mm width × 0.5 mm thickness in model scale) is designed by pull-out test using the same soil materials. Length of reinforcement from bottom in turn is 250 mm, 275 mm, 300 mm, 325mm, 350mm (model scale). And ribs (6 mm × 6 mm in model scale) with a thickness of 1.6 mm are adhered on surface of reinforcement. The interval of ribs is 30 mm (model scale).

When centrifugal acceleration reached to 20 g, step 0 is set to be step 0. In this study, tapered sinusoidal wave with a frequency of 2.0 Hz, were input 8 times, from step 1 to step 8 with a gradual increase in acceleration from 1.0 m/s^2 to 8.0 m/s^2. One example of input waves is shown as Figure 2.



Unit: mm (in parentheses, it is a prototype size, Unit: m)

Figure 1: Schematic figure of experiment model.

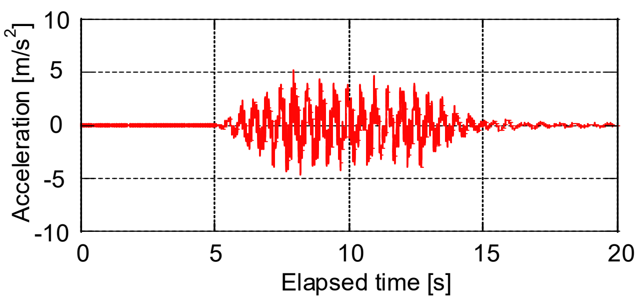


Figure 2: Example of input wave (Step 4).

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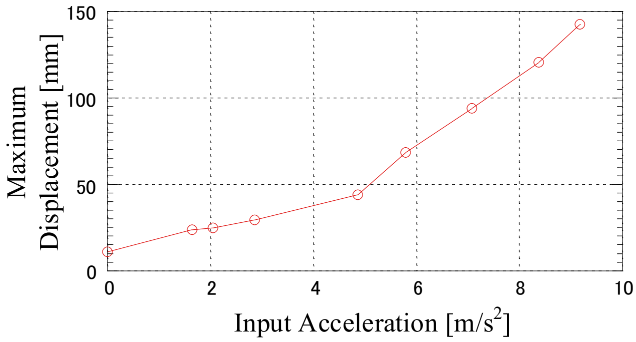


Figure 3: Relationship between Maximum displacement of wall and input acceleration.

3. Experiment Result: The maximum horizontal displacement of wall structure is shown as Figure 3, when input acceleration is around 9.2 m/s^2, the displacement of wall structure is 142 mm (1.7 % of total height of wall structure). Stability criterion of reinforced earth wall is 3 % of total height, in this experiment, although input acceleration is very large, maximum displacement of wall structure is not larger than the criterion. Figure 4 shows the change of water pressure with time. Although the pore water pressure changed during vibration. The changed values are very small. In order to check distribution of water content inside reinforced earth wall, the sample taken from each layer after shaking shown as Figure 5. From the figure, it can be known that water flow downwards to bottom layer during the centrifugal test, which is caused by centrifugal acceleration. The vector figure of reinforced earth wall after vibration is shown as Figure 6. The ground move downwards and near to wall structure is confirmed. The average settlement of ground is 560 mm.

4. Conclusion: In this study, the centrifugal model test of reinforced earth wall using ground materials under optimum water content is conducted, the basic dynamic characteristic of it was confirmed. In future, the influence of different water content in ground on reinforced earth wall will be discussed.

Reference: 1) Ogata et al.: A damage survey of reinforced earth wall in the 2011 off the Pacific coast of Tohoku earthquake and a case of recovery by strengthening the drainage function. *6th landslide disaster symposium,* 2012. 2) Shimura et al.: Influence of initial pullout history on additional displacement under constant pullout load in steel strip reinforced earth wall *JSCE Chugoku Branch Research meeting* 2016.

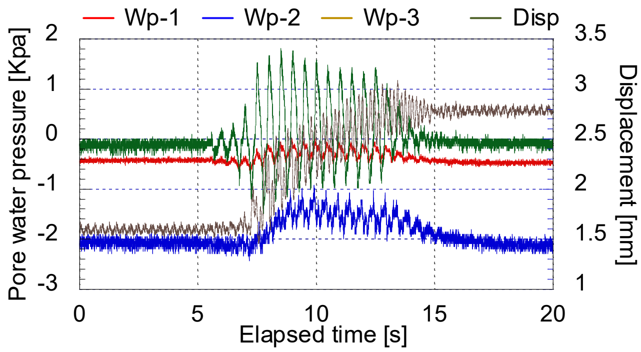
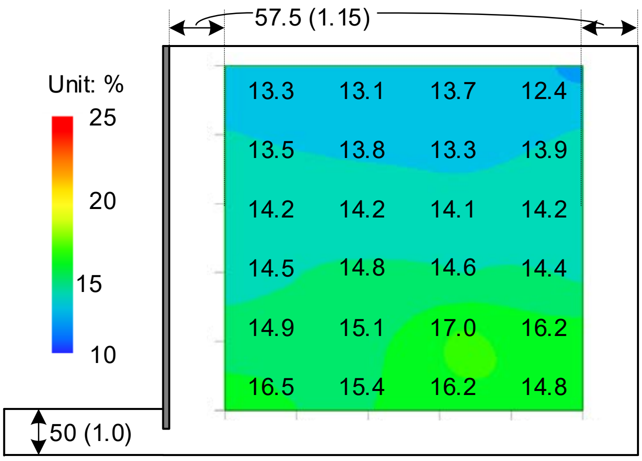


Figure 4: Pore water pressure-maximum displacement Change with time



Unit: mm (in parentheses, it is a prototype size, Unit: m)

Figure 5: water content distribution after earthquake vibration

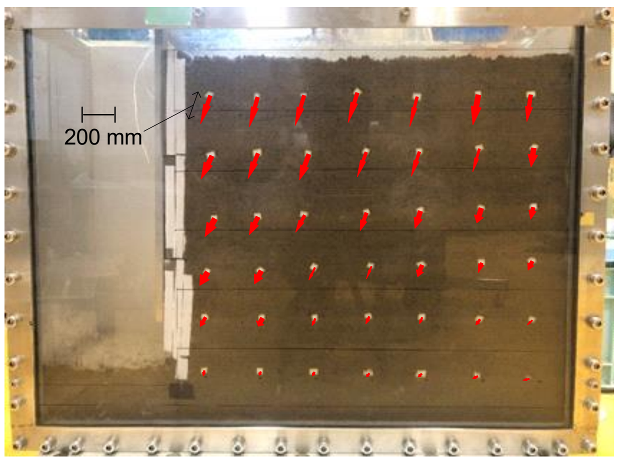


Figure 6: movement of ground after vibration.