Seismic Stability of Dry Masonry Block Retaining Wall Structure with a Resistance Plate using Laboratory Model Tests

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1 Introduction

Two types of block masonries are in practice to construct retaining walls: dry and wet masonry. In a case that a certain safety factor against sliding cannot be secured in wet masonry retaining wall, there is a method to enhance the sliding resistance by providing a projection at the block bottom. However, this method has not been used much in clayey ground because the contact between the projection and surrounding ground becomes loose. At the same time the construction cost is also relatively high. When the effect of projection in the clayey ground is properly mobilized, the construction of retaining wall can achieve an excellent safety with minimized construction cost.

The dry masonry type of retaining wall has an advantage of being environment friendly as well as economically efficient. However, it generally withstands the sliding of blocks due to friction of filling coarse material. So, it is considered unstable when compared with wet masonry retaining wall. It is therefore compensated by adding a projection into each block or by using the block with an engagement structure through the method of unifying each block. An alternate method to enhance the sliding resistance by connecting each block with wood has also been studied. However, more effort is still required to eliminate the anxiety of the stability of blocks. When enough sliding resistance is achieved in dry masonry retaining wall compared to wet masonry retaining wall, the advantages in relation to construction, economy and environment can be achieved.

Incorporating these concerns, we have developed a dry masonry block retaining wall construction technique, in which a new plate is introduced at the boundary between upper and lower blocks. In this study, we investigate seismic characteristics of the dry masonry block retaining wall structure with a resistance plate using a model test. The test consists of one dimensional seismic excitation for a 1:10 model. Then, we discuss the influence of residual displacement of the dry masonry box on materials, position of the box and frequency. As a result, we understand that the influence of the resistance plate reduces the residual displacement.

2 Overview of proposed dry masonry block structure with a resistance plate

Fig. 1 shows a conceptual diagram of the dry masonry block structure with a resistance plate. Each block used in the present structure has a side wall connecting the right and left of the front wall and rear wall, which is characterized by bottomless plate, as shown in the figure. Newly added resistance plate is perpendicular to the horizontal boundary surface between the upper and lower blocks, which is set up by keeping a space from the inner surface of the rear wall. Then, each inner space of the block and the space behind the block are densely filled with a coarse-grained

Fig 1. Schematic diagram of dry masonry block structure with a resistance plate.
material. As a result, a confining layer is produced in the space between the resistance plate and the rear wall, which is named as rear confining layer.

3 Outline of conducting model tests

All model tests were conducted by applying one dimensional acceleration loading apparatus. The size of the model made of 10mm thick wood pieces was 230mm of front wall width, 210mm of depth and 99mm of height. In this model test, the steel plate used was 2.3mm thick, 100mm high and 185mm wide.

Horizontal acceleration was applied through the seismic shake table, which was set at 0 to 5Hz of frequency. In order to measure lateral displacement of the block and the vertical displacement on the surface of the block, we measured them at each frequency step by a ruler directly. A typical gravel soil was used as filling material and foundation ground, whose physical properties are summarized in Table 1.

4 Results and discussions

Fig. 2 shows the results of seismic load acting on the block. The frequency of 4.0 to >4.5 means the value of displacement at 4.5Hz which is subtracted from the value at 4.0Hz. The figure also shows the results of lateral displacement of block body with and without resistance plate against applied seismic load, respectively. It can be confirmed from the figure that the lateral displacement and frequency have increased with the increase in the load in all cases.

It means that the sliding of the block is suppressed as the block body becomes smaller against the same frequency. Here, the effect of resistance plate on the sliding of the block is discussed from the perspective of relation between lateral displacement and frequency. It is clear that although the frequency in the cases becomes much greater, the lateral displacement becomes smaller. For instance, the lateral displacement has been reduced to less than 1/5. In addition, the effect of resistance plate of sliding is clearly dependent on the direction.

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