STUDY ON SHAPE EFFECT OF INTERLOCKING BRICKS ON RESISTANCE OF MASONRY STRUCTURES

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INTRODUCTION

Earthquake-related disasters have caused loss to human society ever since the past time. For the past 2 decades only, the casualties caused by the earthquake covered more than 55% of the global casualties due to the natural disasters with more than USD 600 billion economic losses [1]. The collapse of the masonry structures played a major role on increasing the loss of the earthquake in the countries in the world's most earthquake disasters-prone areas such as Indonesia, Philippine, Nepal, and many countries in the Asia and America [2] [3]. In those areas, the use of the masonry building can be considered as one of the oldest types and very common in which many of the commercial, historical and monumental structures are built and remained until today due to its inexpensive construction material and easy availability.

Easy and implementable reinforced method was introduced in this study through interlocking bricks to prevent those massive losses. Interlocking system of the brick is a system to reinforce bricks by manipulating the shape of the brick to interlock each other even without mortar. In this scenario, the joint failure of the bricks which is only resisted by the mortar, can be decreased since the interlocking between bricks resists the external force after the failure. In this study, the static loading test using the interlocking walls which has the dimension of 18 cm × 18 cm × 10 cm with the various shape as shown in **Figure 1** was conducted to understand the interlocking mechanism. The shape effect on the force-displacement relationship was investigated through diagonal compression test to analyze the performance of various shapes of interlocking bricks during the in-plane loading condition.

TEST METHOD

Four kinds of mortar-less test specimen, namely, cosine-sided, triangle-sided, obtuse-angled, and right-angled walls were tested. The right-angled wall has the largest interlocking, followed by the obtuse-angled wall. The cosine-sided and the triangle-sided walls have less interlocking compared to the right-angled and the obtuse-angled walls. The normal walls were not tested since they have no interlocking and cannot resist the gravity without mortar. Each specimen contains 4 units: top, middle left, middle right, bottom. The bricks were specially made from a mortar consist of 60% sands, 15% water and 25% high early strength Portland cement. Every specimen is made at the same time and in the same manner so that the effect of the difference in the unit's properties can be minimized. All walls are connected without mortar so only brick's surface friction and interlocking mechanism resisted the load. Here, the universal material testing machine as shown in **Figure 2** was used to apply the load to the specimen. To observe the behavior of the interlocking bricks, displacement history and loading history are recorded and plotted to identify the failure of the units.

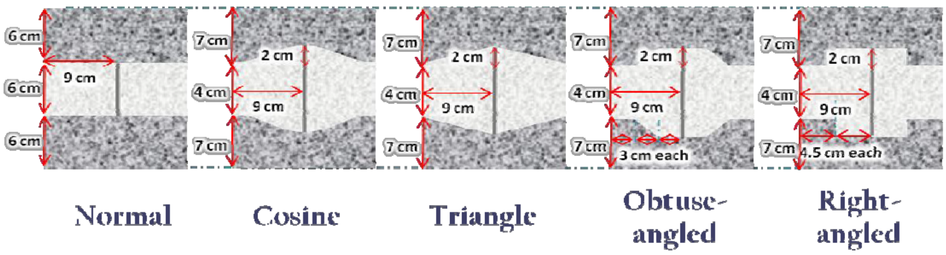

Figure 1. Interlocking brick specimen dimension

Figure 2. Universal testing machine

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TEST RESULT

Two sets of each interlocking shape were tested. **Figure 3** shows the force-displacement relationship of each interlocking wall. Both the right-angled and the obtuse-angled walls with larger interlocking showed similar behavior between specimen no.1 and no.2. The main characteristic of these walls is that they all exhibited two peaks before the system is completely failed, and two peaks corresponds to the failure of the top and bottom bricks. On the other hands, the cosine-sided and the triangle-sided walls with less interlocking showed unstable performance between specimen no.1 and no.2. As for the cosine-sided walls, specimen no.2 showed a single peak at the displacement of 1.4 mm whereas specimen no.1 showed 2 peaks and the 2nd peak took place at the displacement of 3.5 mm. The same tendency was observed in the triangle-sided walls where specimen no.2 showed the large displacement of 4mm at the last peak load. It is considered that the specimen no. 2 of the cosine-sided wall and the specimen no.1 of the triangle-sided wall had already experienced sliding at the interface due to the gravity and they had the larger interlocking than the other specimen when the loading started. The difference in the interlocking performance seems to be caused by the imperfection of the surface shape of bricks at the interface. Also, it is found that the interlocking walls with less interlocking showed slightly larger peak load with larger displacement compared to the interlocking walls with larger interlocking. The larger interlocking system is easier to get failed due to the stress concentration at the corner.

CONCLUSION

As the conclusion, it was shown that 2 specimen of the right-angled and obtuse-angled walls showed similar behavior, but those of the cosine-sided and triangle-sided walls showed different behavior due to the imperfection of the surface shape. It is found that the specimen with less interlocking shows the slightly larger peak load and larger displacement due to the less stress concentration at the interface.

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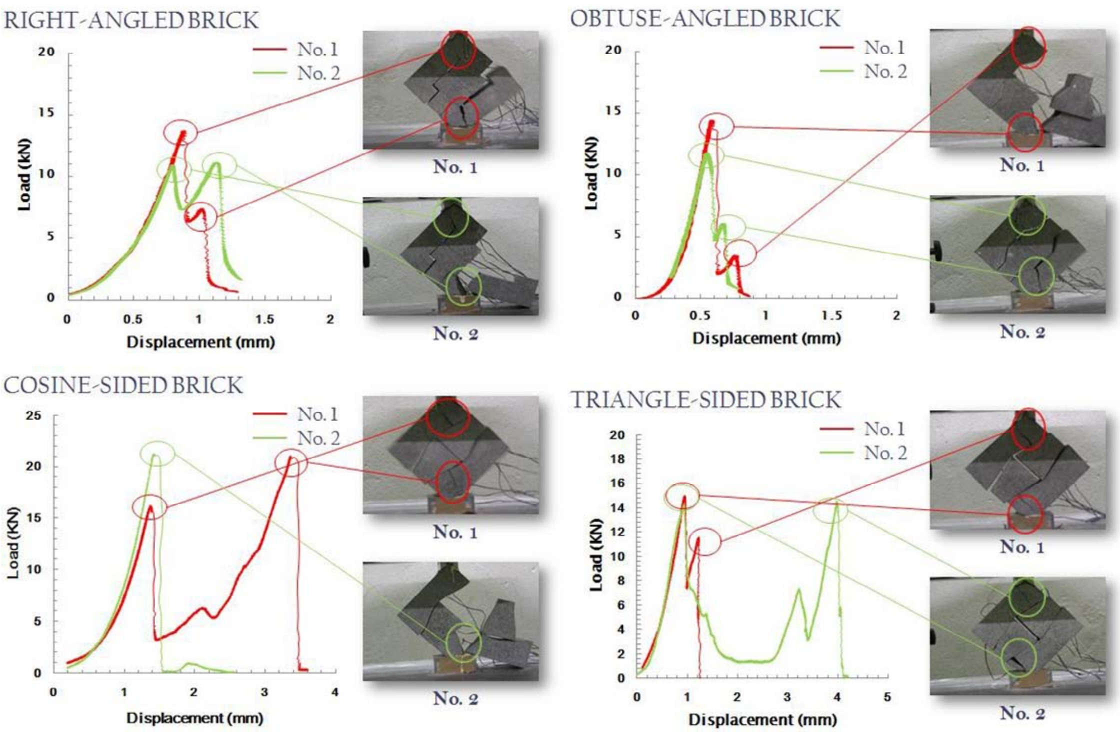

Figure 3. Diagonal compression test result on interlocking bricks