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PARAMETRIC STUDY OF MASONRY WALL RETROFITTED BY ENGINEERED CEMENTITIOUS COMPOSITES

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In this research, the effect of Engineered Cementitious Composites (ECC) on the performance of unreinforced masonry walls has been parametrically studied via experimental and numerical methods. The results of this study indicated that there is a direct relationship between increasing the ECC layer thickness and the retrofitted wall shear strength. In addition, by increasing vertical pre-compression stress, the retrofitted wall shear strength caused by the ECC layer decreased. Besides, the retrofitted wall shear strength caused by the ECC mortar in both sided retrofitting was twice as much as that of one sided.

INTRODUCTION

Engineered Cementitious Composites (ECC) are a special class of Fiber-Reinforced Cement-based Composite materials (FRCC), typically reinforced with polyvinyl alcohol (PVA) fibers (Kesner, 2004). Recently, several studies have been carried out on the effect of ECC mortar on the performance of masonry structures. These structures include bearing unreinforced masonry walls, masonry infilled reinforced concrete frames and masonry wallettes. Generally, it has been shown that ECC has a significant role in improving the behavior of these retrofitted structures (Lin et al., 2014; Deng, 2018). The ECC layer thickness, vertical pre-compression levels and one or both sides retrofitting of the walls are parameters that can influence the performance of retrofitted Un-Retrofitted Masonry (URM) walls . These parameters have been discussed in this paper.

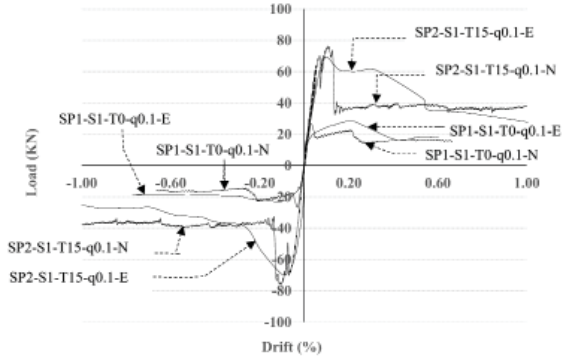
EXPERIMENTAL PROGRAM, NUMERICAL MODELING AND RESULTS

In this study, two half scale wall specimens, including reference and retrofitted wall were tested under quasi-static lateral loading according to Figure 1-a. Dimensions of the wall were considered at half scale as 2000 × 1400 × 110 mm. The ECC mortar applied on one side of the wall with thickness of 15 mm. The wall average vertical pre-compression stress was 0.1 MPa. The ECC material used in this study consisted of ordinary Portland cement, fly ash, fine silica sand, water, superplasticizer and 2% of PVA fibers by volume. Portland type II cement and sand passing 4 mm sieve were used to prepare the cement mortar. Clay bricks with dimensions of 215 × 110 × 65 mm (length × width × thickness) were used.

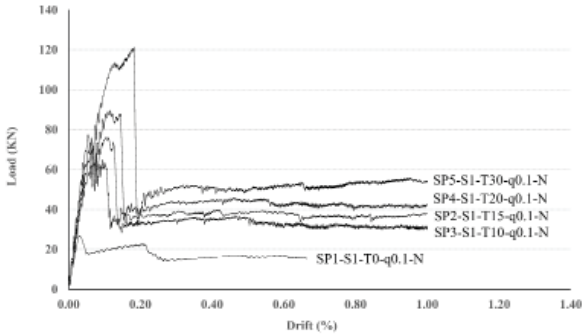
The numerical model applied to this study was created using the software ABAQUS (2013). The validation of the numerical model was carried out based on the experimental results. As shown in Figure 1-b, considering the reference and retrofitted wall capacity curves, there is a good agreement between numerical and experimental results. Therefore, the model can be appropriately used in a parametric analysis. The parametric analysis was performed for the assessment of the influence of different parameters on the behavior of the retrofitted URM walls. The parameters taken into account were: vertical pre-compression level q = 0.1, 0.5 and 1 MPa; variation of the ECC thickness TECC= 10, 15, 20, 30 mm and one

or both sides retrofitting of the wall. The specimens numbering is in the form of "SP-S-T-q-E or N" where SP =number of specimens, S= one or both sides retrofitting of the wall, T= thickness of the ECC layer, q= vertical pre-compression stress and E or N= experimental or numerical method, respectively. The influence of the ECC layer thickness and vertical pre-compression stress on lateral strength of walls is shown in Figure 1-c and Figure 1-d, respectively.

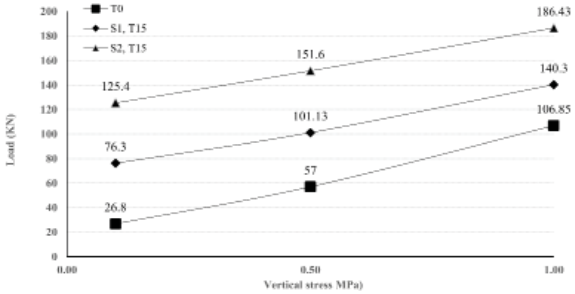
(a) Test setup



(b) Validation of numerical results



(c) Influence of the ECC layer thickness in lateral strength of walls



(d) Influence of vertical pre-compression stress in lateral strength of walls

Figure 1. Test setup, experimental and numerical result.

CONCLUSION

Based on the present parametric study, the following results have been obtained:

- Effect of ECC layer thickness: The experimental results indicated a 142% increase in the shear strength of the retrofitted wall compared to that of the reference wall. The numerical results showed for the ECC layer thicknesses 10, 20 and 30 mm, the shear strength of the retrofitted wall compared to that of the reference wall increased as 184%, 234% and 352%, respectively.
- Effect of vertical pre-compression levels and one or both sides retrofitting of the walls: For the wall retrofitted on one side, with increasing vertical pre-compression average stress of 0.1, 0.5 and 1MPa, the retrofitted wall shear strength increased as 142%, 80% and 30%, respectively, compared to that of the reference wall. Besides, in the case of the wall retrofitted on both sides, with increasing vertical pre-compression the above-mentioned levels, the retrofitted wall shear strength increased by 370%, 180% and 70%, respectively, compared to that of the reference wall.

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