TESTING OF BRICK WALL PANELS WITH AN ANCIENT MOTAR MIXTURE FOR FLEXURAL STRENGTH

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ABSRACT

The objective of this research was to determine the compressive and flexural strength of a wall panel constructed using an ancient mixture and compare the results to a standard masonry wall. The ancient mixture which consisted of paddy -husk- ash, Calicut roof tile powder, hydrated lime powder and anthill clay, was utilized to construct a wall panel .Another standard masonry wall panel was built for comparison.

The wall built using the ancient mixture was initially tested for compression; till it was completely fractured .A value of 75 kN was obtained and multiplied by a factor of 0.3 and used as a pre compressive load for the flexural experiment. Using two perpendicular point loads, the flexural strength tests for both masonry walls was conducted. The wall constructed using the ancient mixture fractured to a force of 15kN, while the masonry wall cracked at a load of approximately 19kN. From the results obtained, it can be concluded that the panel built using the ancient mixture behaved very similarly to the masonry wall.

***Keywords**:* compressive strength, flexural strength, ancient mixture.

1. INTRODUCTION.

Based on the historical information, ancient stupas were constructed entirely of bricks and the bricks were bonded together using clay slurry, called butter clay (navanita mattika). The load was thus transmitted from one brick directly to another and not through an intermediary mortar layer as a consequence of very thin clay slurry layer. One side of the brick was left rough so that the clay slurry could be trapped in its crevices, providing an adhesion that prevented any lateral movement.

However, the objective of this study is to determine the compressive and flexural strength of the wall panels, where the load is transmitted from one brick to another through the mortar layer, built in using the ancient mixture and to compare them with the properties of the wall panels built in using the standard cement-sand mixture.

For these purposes, three wall panels were constructed and tested according to standard test requirements. as indicated in BS 5628: part 1: 1992.[4]. Bond strength of partly wetted bricks are generally higher than dry and saturated bricks Samarasinghe[1], hence the wall panels were constructed with the use of partly wetted bricks. The ancient mixture as suggested by Mutukumarana. L[3] is a composite mortar as shown in figure 1 and it boasts the combination of paddy -husk- ash, Calicut roof tile powder, hydrated lime powder anthill clay and water completes a chemical reaction which eventually produces a mixture as strong, as elastic and as durable as conventional cement mortar. The increased performance in flexural bond capacity of composite mortars was clearly depicted through the studies conducted by Rao et al [2]. Finally, this paper compares the behavior of the two wall panels on compressive and lateral loadings respectively.

Figure: 1 Ancient material mixture

2. TESTING ARRANGEMENT

In order to achieve above mentioned objectives, one

masonry wall panel and three wall panels using the ancient mixture were constructed and used as the test specimens as stated in BS 5628: part 1: 1992.[4]

Figure: 2wall panel built using the ancient mixture

Figure: 3 the wall built using the masonry mixture

Cement, Ant-hill-clay, Burnt paddy husk ash, Hydrated Lime, Powdered Calicut roof tile were mixed in a one is to one proportion (10 kg of each ingredient) with 4-4.5 liters of water to make the ancient mortar as shown in Figure 1.

For the cement sand mixture, the mix proportion of 1:6 (5 kg of cement and 30 kg of sand) with addition of water was used to make standard cement mortar.

2.1 Description of materials

1. Burnt clay bricks: In Sri Lanka, burnt clay bricks are typically manufactured by following the manual molding process and then are burnt in kilns. In this experiment the locally found burnt clay bricks are used. The dimensions of the brick used were; height 6cm, width 14.5cm and length 21.5cm.

2. Sand: the type of sand used in this experiment was ordinary river sand obtained from the market

3. Cement: the ordinary Portland cement was used in this experimental programme.

4. Ant- hill clay: ant-hill clay obtained from the nearby neighborhood was also used as an ingredient of the mixture for this experiment the approximate amount used was 10kg.

5. Burnt paddy husk ash:Paddy husk which is freely available in Sri Lanka was obtained from a nearby paddy field. This husk was burnt and sieved. Finally 10kg of the fine husk ash was used as an ingredient for this experimental programme.

6. Hydrated Lime: 10kg Calcium hydroxide also known as hydrated lime was obtained from a nearby hardware store and added as an ingredient to the mixture.

7. Powdered Calicut roof tile: The final ingredient to the mixture was 10 kg of powdered Calicut roof tiles; this ingredient was obtained initially in the form of a roof tiles and later the roof tiles were crushed and then sieved to obtain a fine powder to be used for the experimental programme.

2.2 Testing for compression load

Figure 4: Testing arrangement for compression loading

All wall panels were tested for a uniformly distributed compression load. To transfer the externally applied concentrated load as a uniformly distributed load at the top of the wall, I-section beam was placed at the top of the wall as shown in Figure 1. It should be also noted that the I–section beam was place on the top of rubber pad in order to avoid stress concentrations. Furthermore, three displacement gauges were placed at top two corners and the top midpoint of the wall as shown in the Figure 5. Using this testing arrangement, the compression load is increased with a loading rate of 0.15 kN/s.

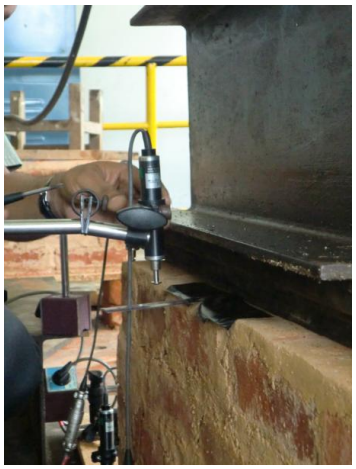

Figure: 5 arrangements of displacement gauges for compression test

2.3 Testing for flexural load

In order to determine the flexural strength of wall panels, each wall was loaded laterally as shown in Figure 6. Two line loads were used for this experiment. The two line loads were applied through two vertical solid steel poles. The reason for applying the line loads perpendicularly was due to the absence of interlocking within the bricks. When providing perpendicular loads, the contact area governs the panel's capacity on loading. The wall panel was supported using two steel poles placed 19 cm from the edge of the wall as shown in Figure 6 and 7

A load cell was set up laterally as shown in Figure 6 to measure the lateral load. Furthermore, two displacement gauges as shown in figure 8 were place at the mid height and at the top of the wall to measure the lateral displacement of the wall.

It should be noted that the pre compressive load of 0.3 times the ultimate compressive load, which is obtained from the previous experiment, was applied before testing for lateral load.

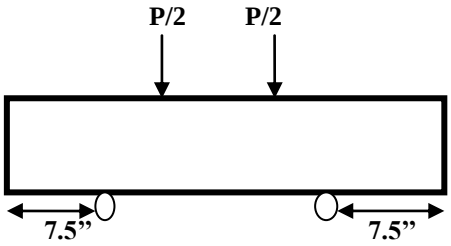

Figure 6: Top view of the flexural testing arrangement.

Figure 7 lateral loading arrangement

Using this arrangement the flexural test with a loading rate of 0.02kN/s was conducted for both panels i.e. the panel constructed using the ancient mixture and the standard masonry panel. .

Figure 8: Displacement gauge setup

3. RESULTS AND DISCUSSION

In the following text, the results obtained from the compressive and flexural tests are discussed.

3.1 Results obtained from compression test

The panel constructed using the ancient mixture was loaded initially with 1kN. Then gradually the load was increased by 0.5kN. The panel fractures at a load of 45.5kN for a time period of 5.19 min.

The diagrams below shows the wall panels after fracture due to compression.

Figure 9: wall panel fractured due to compression loading

3.2 Results obtained from flexural test

The maximum compressive load obtained from the previous experiment was multiplied by a factor of 0.3.This gave us a value of 13.65kN. This load was rounded up to 15kN and used as the pre-compressive load while conducting the experiment.

The panel built with the ancient mixture cracked when the lateral load reached a value of 16kN, and the standard masonry wall indicated initial signs if cracking at a value of 19kN.

The diagram below shows tension cracks formed due to flexural deformation

Figure 10: Tension cracks formed due flexural deformation

The graph obtained from the results of the flexural experiment is shown in the following diagram.

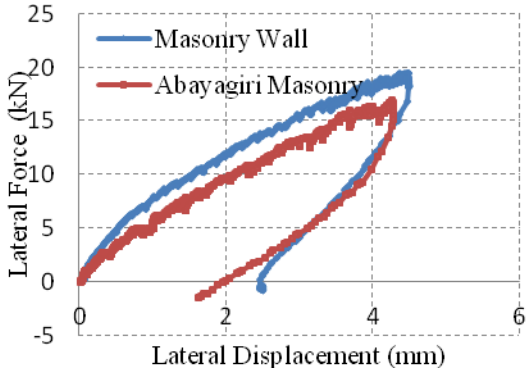

Figure: 11 Graph of loading and unloading of both walls

The graph is a tri-linear graph where the first region shows the behavior of both panels in elastic range. In the second region of the graph the stiffness reduces because the tensile forces reach yield point forming tension cracks which reduces the effective cross section area of the brick.

The third region of the graph shows the compressive forces reaching the yield point and causing compression crushing. After unloading a permanent deformation is observed.

The percentage difference obtained from the graph between the point of fracture of the two panels is 17.5 %

CONCLUSION

From the values obtained and with reference to the graphs plotted, it can be concluded that the ancient mixture behaves similarly to normal cement mortar used in the 21st century.

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