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Comparative Study of the Compressive Strength of Unconfined and Confined Brick Masonry Prisms Rehabilitated with Ferrocement Overlay

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Abstract: *This research paper presents comparative study of compressive strength evaluation of unreinforced brick masonry prisms and brick masonry prisms rehabilitated with ferrocement overlay. To evaluate the compressive strength six masonry prisms were in the laboratory with locally available construction method and were tested according to ASTM C1314. Three specimens were tested in compression without coating and three were tested after coating with ferrocement overlay. After testing the specimens under compression it was concluded that ferrocement overlay significantly increases the compressive strength of brick masonry prisms. Confining the specimens increases the ductility and changes the failure mode from brittle to ductile.*

Keywords- *Ferrocement Cement; Rehabilitation; Unreinforced Brick Masonry Prism; Compressive Strength*

I. INTRODUCTION

In Pakistan unreinforced masonry buildings is a common type of construction in rural, sub-urban as well as in urban areas. According to the report of World Housing Encyclopedia (WHE-2013), about 62.38% of the total buildings of Pakistan are unreinforced masonry buildings [1]. The type of masonry in these buildings depends on the local availability of materials. In those areas where bricks are easily available; these buildings are made of bricks while in other areas hollow or solid concrete blocks may be used. Bricks masonry construction ranges from typical one story houses (rural areas) up to three story buildings (urban areas). In most countries masonry is still used as traditional, non-engineered construction material. Due to the usage of poor quality construction materials and due to inherent weaknesses in the structural load carrying system this type of construction has performed poorly during recent earthquakes in Pakistan [1]. Those buildings which are constructed non-engineered; needs rehabilitation before earthquakes. Rehabilitation is the strengthening of structure before an earthquake [2].

II. METHODOLOGY

2.1 Sample Preparation

Total of six masonry prisms of size 19inches x 19inches x 9 inches were constructed from second class brick having an average compressive strength of 2244 psi and other locally available construction materials. Indigenous method of construction was adopted for the construction of specimens. Cement Sand mortar (C:S 1:4) with an average compressive strength of 740 psi was used as bonding interface for the construction of both confined and unconfined brick masonry prism. Compressive strength testing of mortar was carried out according to ASTM standard C 109/C 109M and the bricks were tested according to ASTM standard C67. Compressive strength test of mortar and bricks using universal testing machine is shown in Figure 1. Unconfined Specimens (US) were named as US-1, US-2 and US-3 while Confined Specimens (CS) were named as CS-1, CS-2 and CS-3. UC brick masonry prisms sample, prism with steel wire mesh and plastered steel wire mesh prism are shown in Figure 2. Unconfined prisms were cured for ten days, thrice a day. After 14 days three specimens out of six UC specimens were confined with a galvanized steel wire mesh of gauge 19 (0.0425in diameter) with the help of screws as shown in Figure 2 (b). After connecting steel wire mesh to the prisms a mortar of 1:3 (Compressive Strength = 1125 psi) was prepared and was applied on both side of the specimens. The thickness of the mortar was kept 0.5 inch. After Plastering the confined samples were cured for 28days. Plastered specimen is shown in Figure 2(c).

(a) (b)

Figure 1: Compressive strength test (a) Mortar (b) Brick

(a) (b) (c)

Figure 2: Samples (a) Unconfined Prism (UP) (b) Steel wire mesh applied to prism (c) Plastered prism

2.2 Experimental Setup

Experimental setup for testing the specimens consist of Universal Testing Machine (UTM), load cell, dial gauges and data acquisition system. The load cell was placed at the top of the specimens to record the vertical compressive load. Two dial gauges of maximum capacity 1.5inch were mounted on both sides of the specimens to record deformations in the specimens. The numerical reading of load cell and dial gauges were recorded by the data acquisition system. The experimental setup for testing the specimen is shown in Figure 3.

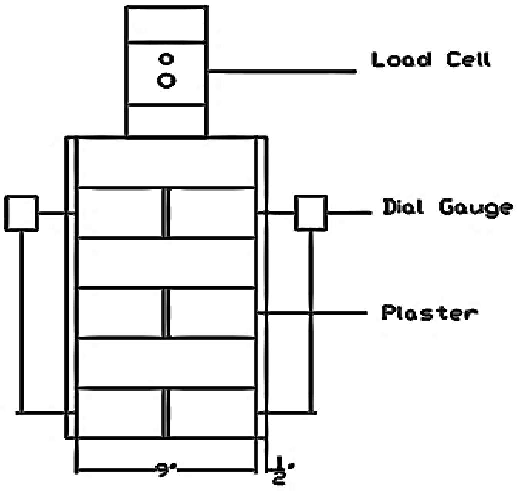

Figure 3: Experimental Setup for testing the specimen under compression

2.3 Testing of Specimens

Specimens were tested according to ASTM C1314. Three brick masonry prisms (US-1, US-2, US-3) with no wire mesh and three brick masonry prism confined with ferrocement overlay (CS-1, CS-2, CS-3) were tested at the age of 28 days. The tested specimens and test set up is shown in Figure 4. The failure pattern of unconfined specimen was characterized by vertical crack whereas failure pattern of confined specimen was characterized by vertical crack at a side followed by slide and spalling of plaster.

Figure 4: Testing of brick masonry prism (a) Unconfined; without wire mesh (b) Confined; with wire mesh

III. TEST RESULTS

Compressive strength of confined and unconfined samples of brick masonry prisms were tested as per the test setup explained in section 2.2 and 2.3. Two dial gauges were attached to measure the linear deformation of the test specimens till the failure of the prism. The load vs. deformation curve of the confined and unconfined specimens is shown in Figure 5. Experimental results depicts that the unconfined prism exhibits earlier crack showing less ductile behavior and having less compressive strength capacity. On the other hand confined brick masonry prism with ferrocement overlay showed improved compressive strength capacity with increased ductility. It has also showed that the failure mode was transferred from brittle to ductile behavior. The average compressive strength of confined masonry prism was increased by 10.73% as compared with unconfined masonry prism. Details of the maximum compressive strength for unconfined and confined specimens are given in Table 1.

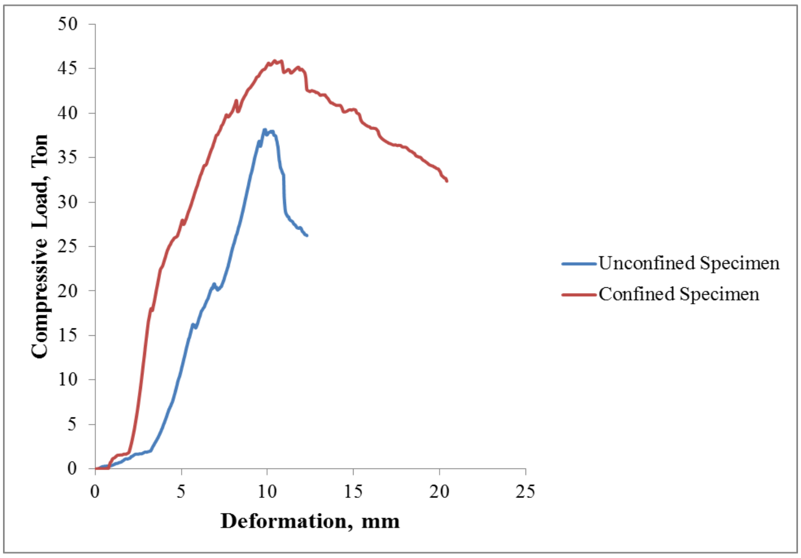

Figure 5: Load vs. Deformation Curve of Unconfined and Confined Specimen

Table 1: Maximum Compressive Load of Unconfined and Confined Specimen

S.No	Specimens	Maximum Compressive Load, Ton	Maximum Compressive Load, lb	Surface Area of Specimens, in^2	Maximum Compressive Strength, lb/in^2	Average Compressive Strength, lb/in^2
1	US-1	38.16	84,104.64	171	491.84	462.20
2	US-2	35.73	78,748.92	171	460.52	
3	US-3	33.69	74,252.76	171	434.23	
4	CS-1	45.90	101,163.6	185.25	546.09	517.78
5	CS-2	41.62	91,730.48	185.25	495.17	
6	CS-3	43.04	94,860.16	185.25	512.07	

IV. CONCLUSIONS

From the compression test results as shown in Figure 5 it is concluded that the compressive strength of masonry prism increases with confinement. Due to confinement compressive strength of masonry prism was increased by 10.73% as compared with unconfined masonry prism. The deformation capacity of the prisms was also increased due to confinement. Confinement also improves the failure mode of the masonry prisms. In case of unconfined prisms clearly visible vertical cracks were observed while such vertical cracks were not observed and cracks with spalling of plaster occurred in the case of confined masonry prisms before reaching the maximum compressive load.

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