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Capacity Evaluation of Masonry-infill Strengthened with Wire containment Mesh

Abid Ali[1], Noor islam[2], Tahir Ahmad [3]

[1]University of Engineering and Technology Peshawar Pakistan
[2]Sarhad University of Science and Technology Peshawar Pakistan
[4]Department name, College
[3]University of Engineering and Technology Peshawar Pakistan

Abstract — *Masonry bricks construction is vulnerable to seismic forces and has been used around the world. This research is carried out on infill masonry wall constructed from half scaled bricks to stabilize the ductility and deformation of infill wall to reduce the cost and casualties. Three panel are designed for the direct in-plane loading and out-of-plane loading, with retrofitting technique using steel wire mesh and last panel is without steel wire mesh for simple prism test is perform on these three panel. The result shows the panel is constructed with retrofitting technique of in-plane and out-of-plane are more durable and stabilized as to simple masonry bricks wall construction*

Keywords- *out-of-plane, retrofitting, masonry wall, wire mesh.*

I. INTRODUCTION

Masonry construction is widely used around the world. The significant offer of the loss of human lives and properties amid past earthquakes has been ascribed to inadequately developed unreinforced masonry structures. Huge favorable circumstances have been developed to the welded wire mesh industry because of its less cost of steel fortification. Welded wire mesh is used as reinforcement for walls, elevated slabs on ground, pavements etc. it is used in industrial, agriculture, transportation sectors. The considerable destruction was caused by the earthquake which hit Balakot, Pakistan in 2005 was recorded which in result, caused a catastrophic destruction. The largest number of damages from the earthquake was registered in the building built from clay and stone brick blocks.

Quality control of masonry units and mortar that used to build masonry structures is performed rarely in the practices. Also, supervision during construction is often lacking. In last two eras about 96% of the loss of human life ascribed to earthquakes are caused in developing countries or least developing countries. About 75% of the fatalities ascribed to earthquakes are caused by the collapse of building and the greatest proportion is from collapse of masonry building (Coburn and Spence, 2002)

The result of earthquake damage investigations and studies conducted in earthquake prone regions has revealed that the masonry building would collapse within few seconds during the seismic movement, and become a major reason of human loss. Out-of-plane wall collapse is one the major causes of destruction of masonry building, particularly in building with flexible floors and roofs. For walls, which carry light gravity loads, out-of-plane loading typically induces a stability failure where a wall burst outward or topless over.

Shermi et.al investigated that using wire mesh enhanced the ductility and flexure behavior of masonry [1]. Andreas Triwiyono et.al have studied that the strengthened walls of flexural strength and ductility give 5 to 16 times higher values than non-strengthened walls [2]. Flexure strength was increased by steel-reinforcement [3]. S.B Singh et.al investigated the stress-strain curves of brick masonry and mortar [4], from that specific curve final points have been identified which would be useful for design performance of masonry [5]. Sachin B. Kadam et.al have also examined that the fortifying utilizing ferrocement bond bring about critical upgrade in shear quality and flexibility of unreinforced stone work [6]. M.A Najafgholipour et.al, has explored the joint out-of-plane and in-plane limits with full scale models and that specimens were indicated by the numerical modeling [7], this aspect ratio will be considered the masonry design protocol [8]. Hasim Ali khan et.al have studied about the under using geo synthetic increases in loading carrying capacity, in-plane strength, stiffness, geo synthetic and shear strength can be used to protect the building is aseismic areas [9]. Ismail M.I Qeshta et.al investigated that hybrid wire mesh and epoxy carbon-fiber composite concrete beam has more energy dissipation when it was compared to carbon fiber only [10]. Y. Lin et.al have studied that the use of cementitious composite shotcrete and near surface mounted reinforcing bars is used as a seismic strengthening for unreinforced masonry [11], application of ECC on unreinforced masonry walls can improve the out-of-plane behavior and its capacity [12].

Our study is on controlling the out-of-plane behavior of masonry infill wall by providing reinforcing to masonry wall.

II. MATERIALS AND METHODS

1) Materials Testing

Testing for all materials such as sand, cement and brick were performed according to ASTM standards. Sand of good quality was used and sieve analysis on fine aggregates was carried out according to ASTM-C136. The fineness result is shown in below **Figure 1.** Fineness modulus for sand was 2.50.

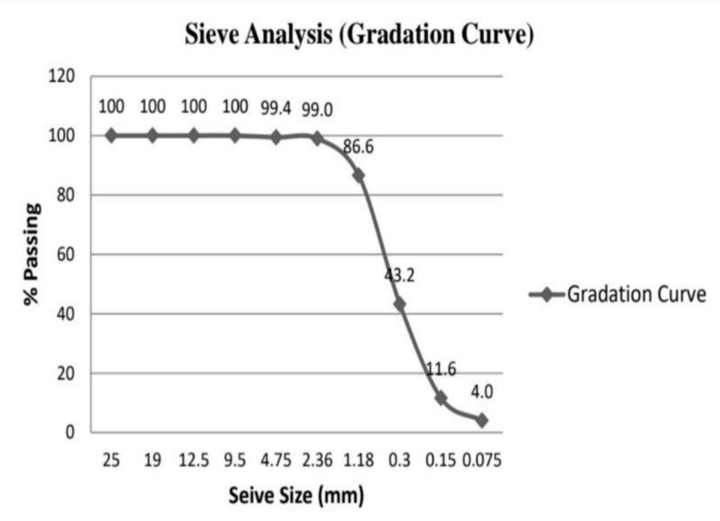

Figure 1 shows sieve analysis of sand

Specific gravity for the fine aggregates was 2.67. Similarly, water absorption was 13.50% according to ASTM C-68-30. Similarly, Cement of fine quality was used for which the initial and final setting time was 32mins and 128mins respectively. Wire mesh of 2inch diameter was used for reinforcement of the specimens. The yielding strength of wire mesh was 40ksi. Half scale bricks were used having dimensions (4.5 x 2.25 x 1.5) inches as shown in **Figure 2**

Figure 2 shows half scale bricks

Water absorption test was carried out on the brick samples, which was noted as 13.08%. Similarly, Compressive test was performed on brick sample for determining the compressive strength of bricks, which was 1200psi.

2) Preparation and Testing of Masonry Prism

Two prisms specimens (609.6mm x 609.5mm x 57.15mm) were constructed using half scaled bricks. One specimen was unreinforced masonry wall and the other was reinforced with wire mesh on both sides with 4inch c/c and 2mm of wire diameter. Both samples are shown in **Figure 3.**

(a) **(b)**

Figure 3: (a) Preparation of the unreinforced masonry prism (b) Preparation of panel reinforced with wire mesh

3) In-plane Testing

In-plane testing was performed on both specimens; reinforced and unreinforced masonry samples as shown in below **Figure 4**. The specimens were placed diagonally in UTM and vertical uniformly load was applied using load cell. Load was applied incrementally on specimens until splitting was observed as shown **Table 1 and Table 2**.

Figure 4. Diagonal crack in masonry prism

Compression tests on Masonry Prisms (2'x2') as per ASTM C-1314			
S.no	**Max. Load**	**Area**	**Compressive Strength**
	(Tons)	**(mm^3)**	**MPa**
1	1.75	69677.28	0.25
2	1.55	69677.28	0.22
		Average	**0.23**
With containment		**Standard Deviation**	**0.02**

Table no 1 shows the values of in plane result with containment

Compression tests on Masonry Prisms (2'x2') as per ASTM C-1314			
S.no	**Max. Load**	**Area**	**Compressive Strength**
	(Tons)	**(mm^3)**	**MPa**
1	0.99	69677.28	0.14
2	0.85	69677.28	0.12
		Average	**0.13**
Without containment		**Standard Deviation**	**0.01**

Table no 2 shows the values on of in plane without containment

4) **Out-of-plane Test**

Test setup was designed, whereby vertical load was applied on the wall horizontally by the UTM, to stimulate out of plane failure, specimen was supported on sides why kept hollows in center. Load was applied on both reinforced and unreinforced masonry prism as shown in **Figure 5 and Figure 6**. Out of plane results was calculated by the peak load as shown in **Table 3 and Table 4.**

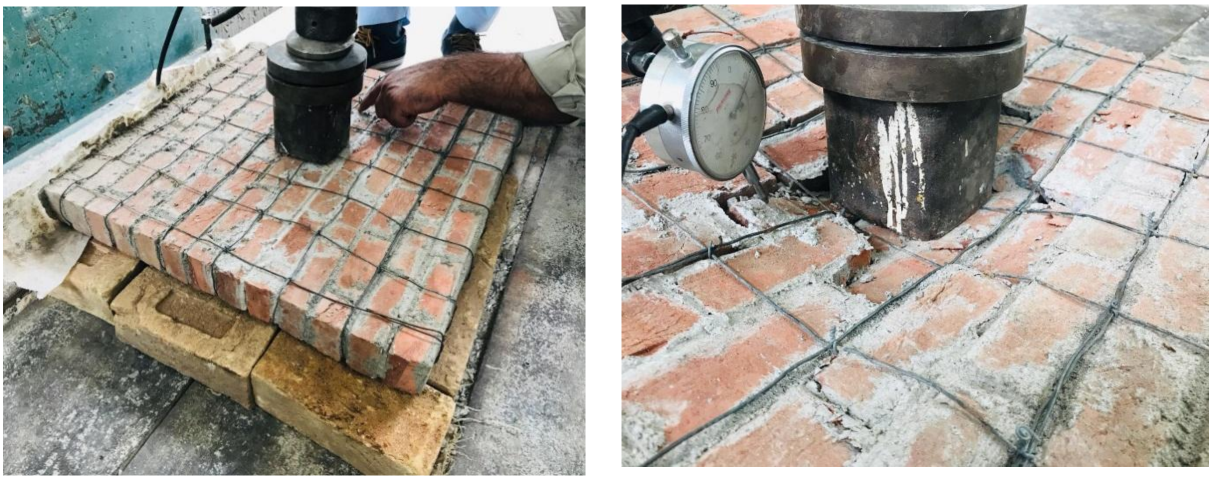

Figure 5 shows test setup of out-of-plane masonry prisms with containment

Figure 6 shows test setup of out-of-plane without containment

Direct Out-Plane Shear tests on Masonry Walletts (2'x2') as per the RILEM Specifications				
S.No	**Max. Load**	**Area**	**Compression Strength**	**Tensile Strength**
	(P)	**(A)**	**σ_o = 0.707 P/A**	**σ_t = 0.50 P/A**
	(Tons)	**(mm^3)**	**M Pa**	**M Pa**
1	1.22	69677.28	0.12	0.09
2	1.02	69677.28	0.10	0.07
		Average	**0.11**	**0.08**
With containment		**Standard Deviation**	**0.01**	**0.01**

Table no 3 shows the values of out-of-plane result with containment

Direct out-Plane Shear tests on Masonry Wallets (2'x2') as per the RILEM Specifications				
S.No	**Max. Load**	**Area**	**Compression Strength**	**Tensile Strength**
	(P)	**(A)**	$\sigma_o = 0.707$ **P/A**	$\sigma_t = 0.50$ **P/A**
	(Tons)	**(mm^3)**	**MPa**	**MPa**
1	0.79	69677.28	0.08	0.06
2	0.75	69677.28	0.07	0.05
		Average	**0.08**	**0.05**
	Without containment	**Standard Deviation**	**0.00**	**0.00**

Table no 4 shows the values of out-of-plane result with containment

III. CONCLUSION

Test result revealed that both of masonry infill reinforced and unreinforced performed effectively but the performance of the reinforced with wire mesh containment was relatively better than the ordinary simple bricks masonry infill.

- ✓ Half scale brick unreinforced was less stabilized and was in brittle in nature as comparatively to reinforced masonry prism
- ✓ Direct in-plane share panel was more stable and strengthened then simple infill wall
- ✓ Reinforced masonry panel shows ductile behavior as compared to unreinforced masonry prism
- ✓ Results shows that the average difference between the strength of reinforced and unreinforced masonry prism was 10%.
- ✓ Reinforced Masonry infill showed resistance towards the failure and less damage was observed as compared to unreinforced masonry prism
- ✓ Out-of-plane failure was controlled by using the wire mesh containment technique

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