

Study of Ferro cement in Strengthening of Brick Masonry Columns

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Abstract - Brick is one of the widely used materials for the construction of walls in building. In many cases the walls built are get failed due to excess lateral loads. Generally bricks cannot withstand to a large amount of lateral loads. Ferrocement casing given to the brick wall gives an additional strength to wall and ferrocement casing is the use of the wire mesh on the wall and dry mortar is sprayed in it. The main advantage if ferrocement is in which it can be moulded into any shape. Different types of steel wire mesh are taken and casing is done in ferrocement masonry column and the strongest column with higher strength is calculated. The column with use of 0.354mm mesh has higher resistance to lateral load.

Keywords - Brick, lateral load, steel wire mesh, ferrocement

I. INTRODUCTION

The common brick is one of the oldest materials and it is extensively used for load bearing walls in a low rise buildings. In India more than 35% of buildings have been constructed in brick masonry. Brick masonry columns are provided commonly in low rise buildings. Brick is having higher fire resisting capacity than concrete or stonework. Compared to stonework, it is easy to construct connections and openings in brickwork. Ferrocement-brick composite as a new type of construction consists of brick core and ferrocement casing, which is a form of cement-sand mortar reinforced steel wire meshes with or without steel bars of small diameters called skeletal ferrocement. Ferrocement encased brick masonry structures can considerably increase the load carrying capacity and moment resistance of brick masonry. The brick masonry columns are subjected to concentric axial load and ultimate compressive strength of brick masonry column with surface treatment by ferrocement is reported. Results of control specimen without ferrocement are compared with brick masonry with ferrocement. During investigation, good agreement was observed. Ferrocement is used increasingly in many constructions, when it is advantageous over R.C.C constructions. One of the major advantages is that it can be cast into any complicated shape without costly formwork.

II. LITERATURE REVIEW

SINGH, KAUSHIK, and ANAND PRAKASH have tested brick masonry columns encased by ferrocement. They concluded that mean failure load was lowest for unplastered columns and highest for columns encased with ferrocement with sand: cement ratio of 2:1 and the failure load was double.

NAYAK and JAIN have conducted tests on specimens varying the thickness of masonry in which masonry act as a filler material, thickness of ferrocement layer and type of wire mesh used to study the effect of these parameters on the strength and performance of the composite. It was concluded that the composite construction in masonry and ferrocement can be used with advantage in various applications.

AL-RIFAIE and MOHAMMED tested 12 ferrocement brick masonry composite columns up to failure. It was concluded that the failure loads of the composite increased up to three times of plain masonry columns and the failure is ductile.

ABID A.SHAH had conducted an experimental program on columns 221 x 221 x 784 mm made from burnt brick clay 221x221x55 mm. All specimens were tested under axial compression. End conditions for each of the test specimen were kept similar. For the uniform distribution of load, rubber pads of 245x245x6.125mm in size were placed at both ends of specimen and were covered with steel plate's dimensions 392 x 392 x 6.125 mm. Ferrocement encased specimen was instrumented with strain gauges at mid-height of the specimens.

AMBROSE VINAYAK PARASHRAM made a experimental study on the brick masonry columns of height 1.5 m encased with different types of steel wire meshes such as welded mesh, woven mesh, chain mesh, chicken mesh, expanded mesh, Watson mesh etc., it was found that the columns encased with chicken mesh's, maximum failure load was high.

OBJECTIVES AND RESEARCH SIGNIFICANCE

The main objective of this study is to evaluate the capability of the strengthening the un-reinforced brick masonry columns and to make the strengthening process more effective, safe and economical. The significance of this research is

- * To strengthen the brick masonry columns with ferrocement.
- * To make a comparative study between the different sizes of the meshes with cement mortar encased to the brick masonry columns.
- * To provide an economical solution to the structure.

III. MATERIALS AND METHODOLOGY

1. Cement

The physical properties of the cement used in present investigation is Portland Pozzolana Cement (PPC) of 53-Grade was shown in table 1.

TABLE 1 PHYSICAL PROPERTIES OF CEMENT (PPC 53-GRADE)

PROPERTIES	VALUE
Grade of cement	53
Initial setting time	25 minutes
Specific gravity	3.15
Fineness test	6 %

2. Compression Test on Cement Cubes

Compressive strength of cement is determined by compressive strength test on mortar cubes compacted on steel mould. The specimen is in the form of cubes 70 mm x 70 mm. At the end of 24 hours remove the cube from the mould and immediately submerge in fresh clean water. The cube is taken out of the water only at the time of testing (after 28 days).



Fig.1 Mortar Cubes on steel Mould, Demoulding of cubes, Compression Testing of the Cubes

TABLE 2 COMPRESSION TEST ON CEMENT CUBES – RESULT

S.No	SIZE OF CUBE	AREA (mm ²)	LOAD (Kg)	STRESS (N/mm ²)
1.	70mm x 70mm	4900	29000	58.06
2.	70mm x 70mm	4900	27000	54.05
3.	70mm x 70mm	4900	26000	52.05
Compressive Strength				54.72

For 53 grade cement, the compressive strength should be 53 N/mm² or above. Therefore, the cement used was 53 grades.

2. Brick

TABLE 3 PHYSICAL PROPERTIES OF BRICK

PROPERTIES	VALUE
Compressive Stress	9.8 N/mm ²
Water Absorption	9.01 %

3. M-Sand

Manufactured sand (M-Sand) is an alternate material for river sand in concrete construction. Manufactured sand is procured from hard granite stone by crushing. The crushed sand is of cubical shape with ground edges, washed and graded to as a construction material. The size of manufactured sand (M-Sand) is less than 4.75 mm.

TABLE 4 PHYSICAL PROPERTIES OF M SAND

PROPERTIES	VALUE
Specific Gravity	1.64
Void Ratio	0.496
Porosity	32.77 %
Bulk Density	1.72 g/cc

IV. EXPERIMENTAL PROGRAM

Experimental study was made on well burnt first class bricks. The experiment is done on bricks of size 23 x 10 x 7.5 cm. Portland Pozzolana Cement (PPC) of 53 grades and M-Sand was used for cement mortar. The wire meshes of sizes 1 mm thickness, 0.707 mm thickness, 0.354 mm thickness, were used as the ferrocement. 12 number of brick columns were constructed and cured for 10 days. Out of 12, 3 columns each was encased with three different size of wire mesh and were plastered. After the plastering the columns were well cured for 25 days. All specimens were tested up to failure load. Cement mortar of mix 1:4 ratio was used for the construction and plastering of the brick pillars.



Fig 2. Construction of the Brick pillars



Fig 3. Plastering of Brick pillar

The different sizes of meshes that are used are as follows

Mesh-1 - 1 mm thickness

Mesh-2 - 0.707 mm thickness

Mesh-3 - 0.354 mm thickness

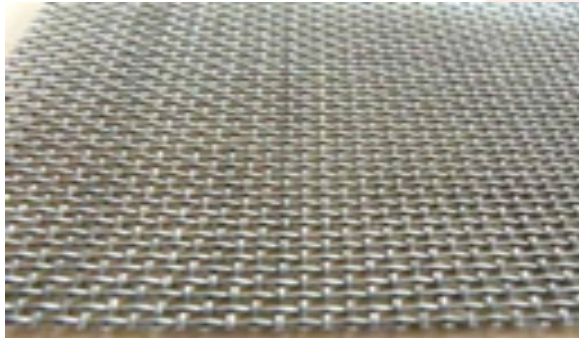


Fig 4. Mesh 1 - 1 mm thickness

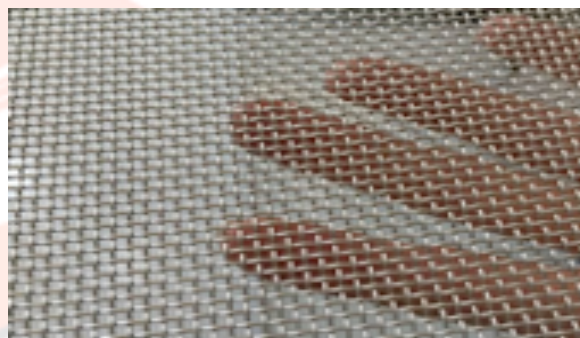


Fig 5. Mesh-2 - 0.707 mm thickness

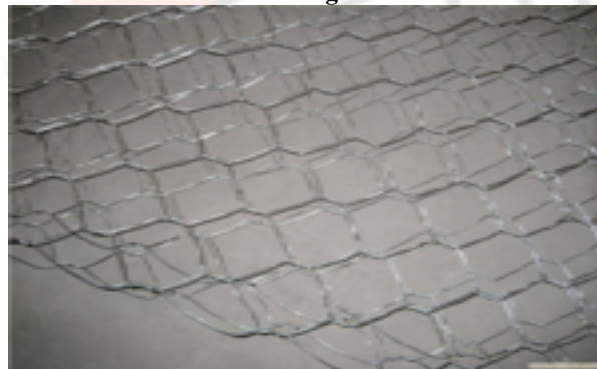


Fig 6. Mesh 3 - 0.354 mm thickness

All the pillars were tested under the axial compression load using a structural loading frame. For the uniform distribution of the load a steel plate of size were used. For the measurement of strain the displacement device was set up at the top of each specimen to measure the linear strain.

V. DETAILS OF BRICK MASONRY COLUMNS

NO. OF SPECS	DESCRIPTION	MESH SPACING (mm)
3	BRICK MASONRY COLUMNS PLASTERED WITHOUT ANY MESH.	-----
3	BRICK MASONRY COLUMNS PLASTERED WITH STEEL WIRE MESH.	1.000
3	BRICK MASONRY COLUMNS PLASTERED WITH STEEL WIRE	0.707

	MESH.	
3	BRICK MASONRY COLUMNS PLASTERED WITH STEEL WIRE MESH.	0.354

VI. RESULT

COMPRESSIVE STRENGTH OF BRICK MASONRY COLUMNS

DESCRIPTION	PILLAR NO	COMPRESSIVE STRESS (N/cm ²)	MAXIMUM COMPRESSIVE STRESS (N/cm ²)
Brick masonry columns plastered without mesh-3 nos.	1	80.00	80.00
	2	68.04	
	3	78.43	
Brick masonry columns plastered with mesh of size 1 mm thickness-3 nos.	1	74.91	84.44
	2	59.05	
	3	84.44	
Brick masonry columns plastered with mesh of size 0.707 mm thickness -3 nos.	1	68.94	83.23
	2	63.20	
	3	83.23	
Brick masonry columns plastered with mesh of size 0.354 mm thickness -3 nos.	1	113.71	113.71
	2	76.81	
	3	101.34	

STRESS-STRAIN CURVE

The relationship between the stress and strain for a particular material is defined as stress-strain curve for a particular material. It is unique for each material and is found by recording the amount deformation (strain) at distinct intervals of tensile or compressive loading (stress). These curves suggest the properties of a material.



Fig.7 Stress-strain curve of the Brick masonry columns

ORDINARY PLASTERED BRICK MASONRY COLUMN

The brick masonry columns plastered without any steel wire mesh is subjected to the compressive axial load and strain measuring device is fitted to the side of the columns to measure linear strain. The graph for different specimens are given below

Fig.8 Stress-strain curve for specimen -1

Fig.9 Stress-strain curve for specimen -2

Fig.10 Stress-strain curve for specimen -3

BRICK MASONRY COLUMN PLASTERED WITH STEEL WIRE MESH -1 mm thickness

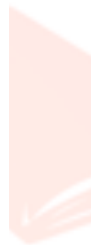
The brick masonry columns plastered with steel wire mesh of size 1mm thickness is subjected to the compressive axial load and strain measuring device is fitted to the side of the columns to measure linear strain. The graph for different specimens is given below.

Fig.11 Stress-strain curve for specimen -1

Fig.12 Stress-strain curve for specimen-2

Fig.13 Stress-strain curve for specimen -3**BRICK MASONRY COLUMN PLASTERED WITH STEEL WIRE MESH-0.707 mm thickness**

The brick masonry columns plastered with steel wire mesh of size 0.707 mm thickness is subjected to the compressive axial load and strain measuring device is fitted to the side of the columns to measure linear strain. The graph for different specimens is given below.

**Fig.14 Stress-strain curve for specimen-1****Fig.15 Stress-strain curve for specimen-2****Fig.16 Stress-strain curve for specimen-3****BRICK MASONRY COLUMN PLASTERED WITH STEEL WIRE MESH-0.354 mm thickness**

The brick masonry columns plastered with steel wire mesh of size 0.354 mm thickness is subjected to the compressive axial load and strain measuring device is fitted to the side of the columns.

Fig.17 Stress-strain curve for specimen-1**Fig.18 Stress-strain curve for specimen-2****Fig.19 Stress-strain curve for the specimen-3****CONCLUSION**

- The Compressive Strength of Brick Masonry Column without mesh is 80 N/cm².
- The Compressive Strength of Brick Masonry Column with 1 mm, 0.707 mm, 0.354 mm thickness ferrocement is 84.44 N/cm², 83.23 N/cm² and 113.71 N/cm²
- The Compressive Strength of Brick Masonry Column with 1 mm thickness ferrocement is 1.05 times higher than that of brick masonry column without ferrocement.
- The Compressive Strength of Brick Masonry Column with 0.707 mm thickness ferrocement is 1.04 times higher than that of brick masonry column without ferrocement.
- The Compressive Strength of Brick Masonry Column with 0.354 mm thickness ferrocement is 1.42 times higher than that of brick masonry column without ferrocement.
- Therefore Ferrocement Encased Brick Column shows consistently the higher compressive strength than the brick column without Ferrocement and hence Ferrocement Encasement improves the compressive strength of brick column.

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