Journal of Civil Engineering and Environmental Technology
p-ISSN: 2349-8404; e-ISSN: 2349-879X; Volume 6, Issue 5; July-September, 2019, pp. 332-335

http://www.krishisanskriti.org/Publication.html

Behavior of Hollow Concrete Block Masonry Wall under Cyclic Compressive Loading and Bending Flexure When Retrofitted with Ferro Cement

Mohd Arham Siddiqui

Technical Officer, CED, Nuclear Fuel Complex-Kota Project, Department of Atomic Energy
E-mail: arham.mohd@gmail.com, arham@nfc.gov.in

Abstract—*Masonry is a construction material widely use around the world due to its low cost and construction easiness, now days hollow concrete blocks are widely used as masonry units, from past earthquake studies and damage assessment it has been observed that masonry structures was mainly failed when subjected to lateral and vertical loading. The aim of study is to investigate the behavior of 1200mm x 800mm x 200mm retrofitted hollow concrete block masonry wall under axial cyclic compressive loading and in bending flexure with respect to masonry wall under same loading condition by investigating the obtained stress-strain and force-displacement envelope curves in context to performance and effectiveness of retrofitting.*

1. INTRODUCTION

"The ferrocement is a type of reinforced concrete in thin elements, currently constituted by micro-concrete of hydraulic cement, reinforced with thick layers of continuous netting, in wire, with a relatively small diameter. The net may be metallic or in other materials "[1], it also define as reinforced concrete in guise of thin elements with very high performance as regards the resistance to extension, the ductility, the resistance to impact[2]. Ferrocement possesses a degree of toughness, ductility, durability, strength & crack resistance which is considerably greater than that found in other forms of concrete construction it can be used in various structural members subjected to different type of stresses. As a compression member, hollow columns with horizontal stiffners can be cast in ferrocement. Columns or walls in concrete, RCC, stone or brickwork can be encased in ferrocement to increase their strength due to confinement. Members subjected to membrane stresses like shells, domes, pyramids can be casted very easily; and being a homogenous material, full section of member is utilized in resisting the membrane stresses; however, the ductility ratio was found to be decreased with increase in steel ratio [3] and also and due to very small crack widths under service load it is superiorly extensible for greater use in water-retaining constructions and other similar constructions where crack width is a design criterion [4].A ferrocement shell improves the flexural behaviour of RCC beams, although there is no increase in the moment carrying capacity of under reinforced beams. However, the moment carrying capacity increased by 9 per cent and 15 per cent for balanced and over reinforced sections respectively. The National Disaster Mitigation Agency (NDMA), Government of India, also accepted the use of ferrocement and its flexural behaviour depends upon various parameters such as mortar, type of wire mesh, orientation of wire mesh etc. This shows very little research has been conducted in the area of retrofitting of hollow concrete block masonry wall with ferrocement to enhance its in-plane behaviour. The main objective of this paper is to investigate and improve the understanding of the load-displacement behavior, deformation behavior and crack pattern of hollow concrete block masonry wall when retrofitted with ferrocement with respect to control sample masonry wall.

2. TESTING METHODOLOGY

Basic properties of constituent materials namely cement, fine aggregates and steel bars has been determined in accordance with relevant Indian standard illustrated in table 1 and seven hollow block [5] masonry wall panels of size 1200mm x 800mm x 200mm with 8mm diameter bar @200mm center to centre were casted with 1:6 mortar as shown in figure 1 and figure 2and tested under two point loading condition considering simply supported end condition as shown in figure 3. The testing of walls is done with the help of hydraulic operated jack connected to load cell. The load is applied to the wall with the help of load cell and value is obtained from the data acquisition system, which is attached with the load cell at a distance of span/3; out of seven walls two are control wall, which are tested, after 28 days of curing to find out the load carrying capacity and rest walls are stressed up to 50 percent of the safe load obtained from the testing done on the control wall.

The specimens were tested using flexural testing machine; load is applied @ 0.5KN/Sec, the behaviour of the walls was keenly observed from beginning to failure and appearance of

the first crack, the development and the propagation of cracks due to the increase of load were also recorded. The loading was continued after the initial cracking load and was stopped when the wall was just on the verge of collapse.

Table 1: Properties of Constituent Materials

Characteristics	Observed Value	Codal Limits
Consistency of Cement [6]	34	-
Fineness of Cement as retained on 90 micron sieve [7]	0.5%	<10%
Specific Gravity	3.2	-
Setting Time (Initial)	35 min	>30 min
Setting Time (Final)	5 Hrs	< 10 Hrs
Compressive Strength 28 days (Mpa)	48.7	43
Specific Gravity of Sand	2.6	Within limits
Grading Zone [8]	III	III

Hollow Masonry Wall Description

S.No.	Designation	Dimension (mm)	Reinforcement	Remark
1	W1	1200x800x200	8mm@200mm c/c	Without mesh
2	W2	1200x800x200	8mm@200mm c/c	Without mesh
3	WM1	1200x800x200	8mm@200mm c/c	With mesh
4	WM2	1200x800x200	8mm@200mm c/c	With mesh
5	WM3	1200x800x200	8mm@200mm c/c	With mesh
6	WM4	1200x800x200	8mm@200mm c/c	With mesh
7	WM5	1200x800x200	8mm@200mm c/c	With mesh

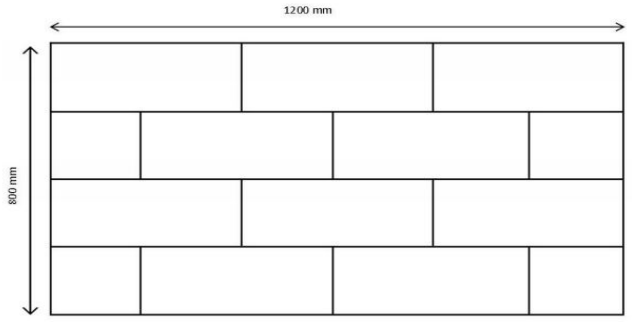

Figure 1

Loading Arrangement

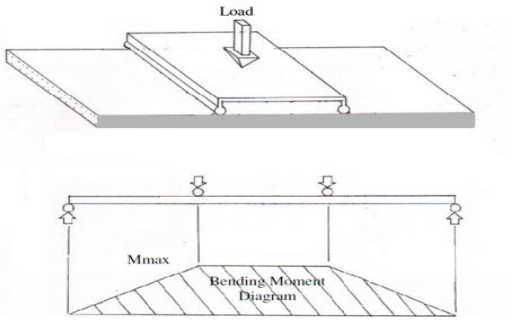

Figure 2

3. FAILURE PATTERN AND CAUSES

Tests on walls reveal that moment carrying capacity of walls increases with increases in percentage tensile reinforcement. In walls, cracks initiated at middle third portion of the beam where bending moment happens to be maximum in pure bending case. Cracks appeared at tensile zone and progressed upward with the increase of load. At ultimate load, reinforcing started to yield which cause mortar joint to open and hence cracks appeared at mortar joint, only flexural cracks appeared at middle third portion of wall as shown in figure 3. Almost all cracks appeared at mortar a joint which happens to be the weakest portion of masonry walls. The achievement of lateral stability by gravity places a practical economical limit on the size of the structure. This has led designers and builders to seek ways in which these massive bearing walls could be decreased in thickness without losing their stability in the process. These demand led to evolution of plain masonry into the composite system which is termed as reinforced masonry. Concrete block work strengthened by steel bars is termed as reinforced block work or reinforced masonry

Crack Pattern

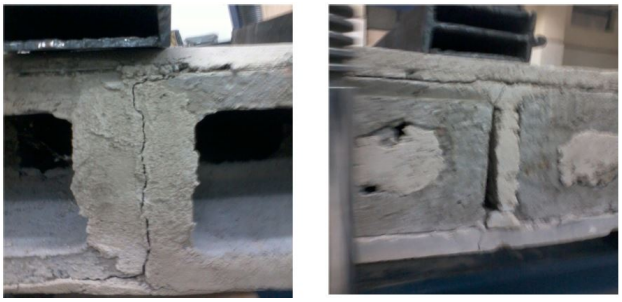

Figure 3

Normalized Load Displacement Curve of Un-Retrofitted Wall

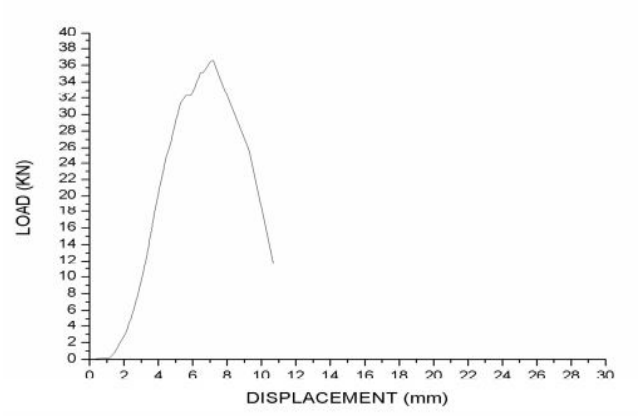

Figure 4

Normalized Load Displacement Curve of Retrofitted Wall

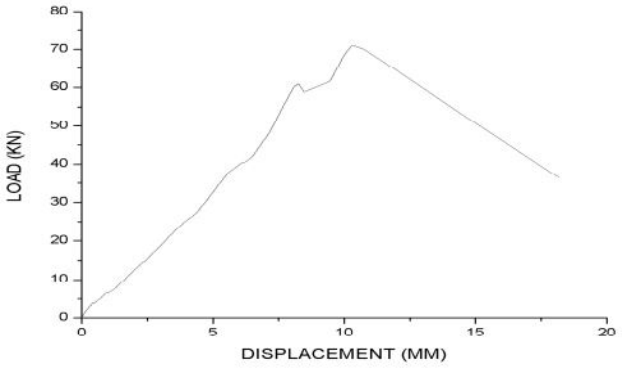

Figure 5

Normalized Stress-Strain Curve of Un-Retrofitted Wall

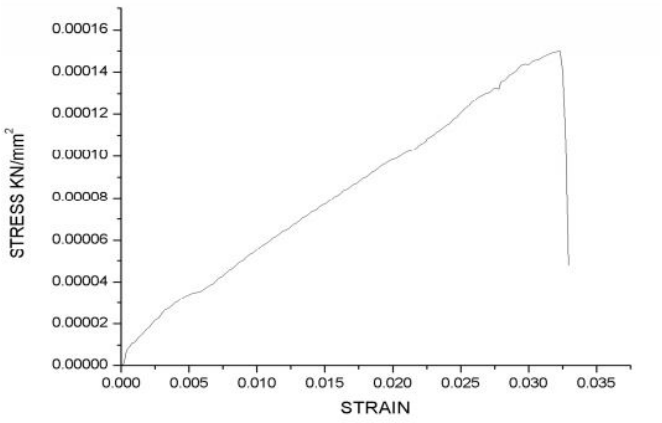

Figure 6

Normalized Stress-Strain Curve of Retrofitted Wall

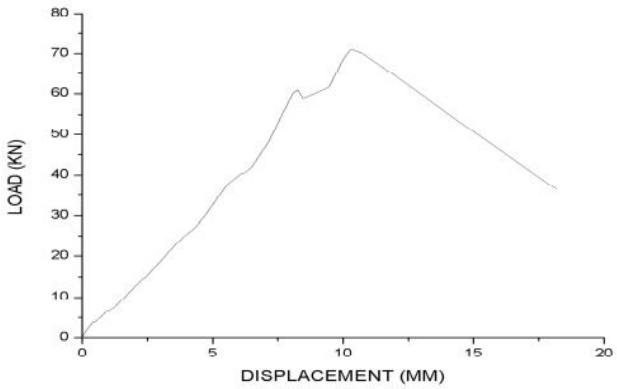

Figure 7

4. RESULT AND CONCLUSION

With stated methodology normalized graphs of load-displacement and stress –strain has been plotted for control sample (un-retrofitted wall) and retrofitted wall as shown in figure 4 to figure 7. It has observed that recovered strength after repair of a ferrocement element could not be generalized. The type of loading, number of mesh reinforcement layers, cement-sand water content mix, and other related properties had effects on the strength recovery factors. Experimental and analytical results indicated that the recovered strength could be roughly estimated to be approximately 70% of the original strength for compression, 90% for tension and 100% for flexure. Because of the structural integrity and the reparability, ferrocement can be an appropriate substitute to commonly used construction materials.

- Premature failure is possible if mesh is not properly wrapped and plaster does not fully penetrate into it. Mortar strength has comparatively smaller influence on failure load.
- The mortar governs the non-linear behavior of masonry.
- It was noted that the ferrocement coating on masonry walls increases the compressive strength. Ferrocement specimens having one layer of wire mesh wrapped around showed an increase in failure load of up to 40% as compared to controlled specimen. The excessive mortar thickness applied to cover wire mesh leads to premature cracking. Also the premature cracking can occur if the ferrocement is not properly cured. The biggest advantage of the ferrocement is the fact that it does not disintegrate after failure unlike normal masonry walls, hence reducing the falling hazard. The ordinary masonry (C2) walls fail suddenly leading to brittle failure; however the ferrocement walls crack at slightly lower loads but the

subsequent widening and growth leading to failure happens at greater loads.

- The initial cracks become visible at mortar a joint which happens to be weakest portion of masonry. Cracks propagated along mortar joint and some cracks also propagated through blocks. The initial cracks appeared at middle third portion of wall where the bending moment happens to be maximum in pure bending case.

- It is also noted that the retrofitted wall shows ductile failure and absorb more energy.

- The construction of reinforced masonry hollow block wall is feasible, since they possess a load carrying capacity greater to that of brick wall.

REFERENCES

[1] ACI Committee 549-R97: *State-of-the-Art Report on Ferrocement*, ACI 549- R97, in Manual of Concrete Practice, American Concrete Institute, Farmington Hills, Michigan, 1997, 26 pages.

[2] Naaman, A.E. (2000) *Ferrocement & Laminated Cementitious Composites*, Techno Press 3000, Ann Arbor, Michigan, USA, 2000.

[3] Ezzat H. FahmyAl-Kubaisy, *Applying the Ferrocement Concept in Construction of Concrete Beams Incorporating Reinforced Mortar Permanent Forms,* International Journal of Concrete Structure and Materials Vol. 8,No.1,pp 83-97,March 2014

[4] Al-Kubaisy, M.A. and Jumaat, M.Z. (2000) ―*Flexural Behaviour of reinforced concrete slabs with ferrocement tension zone cover*, Construction and Building Materials, 14: 245-252.

[5] Indian Standard *IS: 2185-1979 (Part-1)*, Hollow (Open or Cavity Block

[6] Indian Standard *IS: 4031 -1988 (Part-4),*Determination of consistency of standard cement paste

[7] Indian Standard*IS: 4031 -1996(Part-1),* Determination of fineness by dry sieving

[8] Indian Standard I*S: 2116-1980,* Specification for sand for masonry mortar