Use of Fiber Reinforced Mortar and Its Application in masonry Structures

Avinash Mishra[1] Somnath singh[2]
[1,2]Department of Civil Engineering
[1,2]Rajkiya engineering college Azamgarh.

Abstract— In india brick masonary is very common Structure built with brick units bonded together by mortar .Brick usually having a higher strength and stiffness compared to mortar. Further mortar is usually cementitious material having little tensile strength and showing brittle behavior. Use of suitable reinforcement in mortar could significantly enhance the performance of brick masonry for crack, shear, bond, compression, toughness and resistance. The aim of this paper is to analyze the improvements in the strength of mortar by using fiber. By performing appropriate experiments, an attempt was made to analyze the properties of fibre reinforcement mortar and its application in masonary work. An attempt was made to cast the cement sand mortar with a mixture of fibres in different volume and observing its compressive and tensile strength. The shear and compression bond tests were performed at different mix proportion of fibre reinforcement prepared units made with FRM and plain mortar .The tests were carried out according to ASTMC 780 and Indian specifications. After addition of fibre in mortar the compressive, tensile strength increases and toughness also increases and ultimate deformation decreases. The cost of Fibre reinforced masonry is slightly more than plain mortar but it was felt that FRM Unit has better crack propagation so it becomes a good alternative of earthquake resistant building in which simple mortar is used.

Key words: Fiber Reinforced Mortar(FRM), Brick Masonary, Mortar

I. INTRODUCTION

Cementitous materials are brittle and weak in tension while they can resist large compressive stresses. Embedding materials capable of resisting tensile loads, and having them take the load after the surrounding cementitious matrix has cracked, is a standard method of addressing this inherent weakness of cementitious matrices. Such reinforcements can either be short fibers, continuous reinforcements, or even in the form of a fabric. examples of this principle are normal cement concrete and fibre reinforced concrete. in brick and stone masonry cement mortar is broadly used in India. This research is focused on use of fiber in brick masonry. Now, use of reinforcement in the mortar is essential in order to improve the performance in terms of shear bond, compression and cracking characteristics. a variety of short polymer fibers have become easily available in India, and their use could be a reasonably cost effective method of enhancing the ductility and strength of the mortar, and also the brick masonry made using such fibers reinforced mortar (FRM).

II. PROPERTIES OF MATERIAL

A. Fibre:

The study of fibre reinforced composite become generally recognized that the major significant effect of fibre addition to the brittle cementetious matrix is the increment of toughness and post cracking load carrying capacity. The different type of fibres are acrylic, armid, carbon, nylon, polypropylene etc. now in india carbon, glass and polymeric fibres are available. But in this paper polyster fibres are choosen for analyzing the performance of short fibres in mortar and masonary units due too their better performance specially in tensile strength and ultimate elongation percentage. Here we use RECRON 3s in the study and the properties of RECRON fibre is given below:

Chemical Family	Modified polyester
Material Identification	Polymer
Physical and Chemical Properties	
Physical State	Solid (fiber)
Appearance	White
Cross Section	Triangular
Melting point	>250^{0}c
Soluble in Water	Insoluble
Density	1.4g/cc
Elongation(Length wise)	45 to 65%
Tensile strength(Length wise)	~600 MPa

Table 1: Fibre Properties

B. Cement:

Portland Pozzolona Cement is used for preparing mortar. Properties of PPC determined and given in the table:

Properties	Average
Standard consistency	30.5
Initial Setting time (min.)	35
Final Setting time (min.)	600
3-days compressive Strength (MPa)	23.3
7-days compressive Strength (MPa)	34.5
28-days compressive Strength (MPa)	45.1
Specific Surface (m^2/kg)	298.4

Table 2: Properties of Cement

C. Bricks:

Bricks were prepared from clay collected from agricultural land, hand molded and fired after sun drying. Bricks in general were well burnt and can be classified as first class bricks. The following properties of bricks were renowned as per IS 2222:1991

	Length(mm)	Breath(mm)	Height(mm)
Sample 1	231	111.7	74
Sample 2	228	111.2	73.4
Sample 3	235	111.5	74.8
Avg.Dim.(mm)	231.34	111.45	74.06

Table 3: Dimension of characteristic of bricks

D. Sand:

In analysis local sand is used. The natural river sand passing through the 4.75 mm sieve is used.The results, in terms of particle size distribution are given below:

Sieve size (mm	Weight retained(kg)			% Cumulative weight Passing		
	Sample 1	Sample 2	Sample 3	Sample 1	Sample 2	Sample 3
4.75	0	0	0	0	0	0
2.36	0.1	0.10	0.15	10	10	15
1.18	0.15	0.15	0.20	25	25	35
600µ	0.20	0.15	0.27	45	40	48
300 µ	0.20	0.25	0.27	65	65	75
150 µ	0.35	0.35	0.25	100	100	100
Total Weight	1.0	1.0	1.0	=245	=240	=220
			Fineness Modulus	2.45	2.40	2.2
Average Fineness Modulus=2.35						

Table 4: Sieve analysis of different type of sand

III. EXPERIMENTS

A. Mortar cubes:

Mortar cubes were prepared and tested to recognize the result of different mortar proportions on compressive strength.. 3 Samples are prepared for each proportion. 353.3 cc is approximated the volume of materials required for preparing a sample 50 cm² specimen. A total of 96 specimens were cast and for each proportion, 3 specimens are tested at 7 and 28 days a per the details given in Table.

Fig. 1: mortar cube

Cement Mortar Proportion	% of fiber	Water cement ratio	Volume of material required for 353 c.c				
			Weight of cement (gms)	Weight of sand (gms)	Weight of fibers (gms)	Volume of water (ml)	Notation used
CM(1:3)	0	0.45	180.26	540.79	0.0	82.0	M 30
	0.1		180.26	540.79	0.49	82.0	M 31
	0.25		180.26	540.79	1.24	82.0	M 32
	0.5		180.26	540.79	2.47	82.0	M 33
CM(1:4)	0	0.48	135.0	540.0	0.0	64.0	M 40
	0.1		135.0	540.0	0.49	64.0	M 41
	0.25		135.0	540.0	1.24	64.0	M 42
	0.5		135.0	540.0	2.47	64.0	M 43
CM(1:5)	0	0.52	109.0	545.0	0.0	55.0	M 50
	0.1		109.0	545.0	0.49	55.0	M 51
	0.25		109.0	545.0	1.24	55.0	M 52
	0.5		109.0	545.0	2.47	55.0	M 53
CM(1:6)	0	0.55	90.0	540.0	0.0	50.0	M 60
	0.1		90.0	540.0	0.49	50.0	M 61
	0.25		90.0	540.0	1.24	50.0	M 62
	0.5		90.0	540.0	2.47	50.0	M 63

Table 5: Cement mortar proportions used in the experiments

B. Brick masonry units using FRM:

The cement: sand ratio in this study was constrained to 1:4 and 1:6. In all the units leveling is done by spirit level. right angles are maintained.5 layers of brick masonary is done. Three specimens were tested under each condition and Table 4.1 shows the average compressive strength and variation for the different cases for 7 days and 28 days respectively

Fig. 2: Brick masonary

S. No.	Types Of Unit	First Crackin g Strength (fcr)	Ultimate Compressiv e Strength (fbwp) Mpa	Mortar Compressiv e Strength (fmk)	Brick Crushing Strength(fb p) MPa	Kbwp
1	BMUC60	0.6	1.3	4.9	15.6	0.14
2	BMUC61	1.1	2	6.2	15.6	0.2
3	BMUC62	0.9	1.6	6.1	15.6	0.16
4	BMUC40	0.8	2.1	18.23	15.6	0.12
5	BMUC41	1.5	2.9	20.4	15.6	0.16
6	BMUC42	1.3	2.7	21.2	15.6	0.14

Table 6: Compressive strength for masonry units

IV. CONCLUSION AND FUTURE SCOPE

The BM-Us were tested in compression and shear. From the compressive test it was found that, compressive strength of masonry units with FRM is 15 to 20 % more than plain mortar specimens. the effect of using FRM in brick masonry, using appropriately designed brick masonry units (BMUs) using CM (1:4) and CM (1:6) with 0%, 011%, and 0.25% of fiber content is studied. The specimens without fiber failed soon after the development of crack and indicate a brittle failure. Just after the peak load, the load carrying capacity was lost completely. The crack traverses completely through the bricks and the mortar. But the specimens with different fiber contents resist load even after the development of cracks, due to the transfer of load from matrix to the fibers bridging across the cracks.

Studies in the aftermath of recent earthquakes have shown that failure of brick masonry building caused enormous loss of life and property, with the failure of the mortar joints very prominent. Now, with brick masonry buildings being the mainstay of the Indian housing and building sector at large, it is important that we find out ways and means to improve the performance of such buildings under an earthquake load. For that we have to improve their lateral load carrying capacity and ductility. One of the options available to engineers is to improve the performance of masonary structures.

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