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Research paper

Strengthening of Unreinforced Masonry with Fibre Reinforced Concrete

S. Gayathri[1], S. Kanchidurai[2*], P. A. Krishanan[3], K. Baskar[4]

[1,2]School of Civil Engineering SASTRA Deemed University, Thanjavur, Tamilnadu, India.
[3,4]Department of Civil Engineering, National Institute of Technology, Trichy, Tamilnadu, India.
**Corresponding author: Kanchidurai@civil.sastra.edu[2]*

Abstract

Unreinforced Masonry buildings are vulnerable because the walls and parapets aren't securely tried to the floors and roof. In an earthquake, parapets can break away, walls pull apart and the floors collapse. This paper presents the experimental study performed on the flexural bond strength of unreinforced brick masonry prism. Different percentage (1%, 2%, and 3%) of Hooked Steel Fibre was used. One of the most geometrical parameters of fibres is their length, diameter and aspect ratio. Masonry prism will be cast and tested as per the guidelines are given in ASTM E518/E518-15. The results of the flexural bond strength test of prisms with and without fibre discussed.

1. Introduction

Unreinforced Masonry (URM) buildings, many of which are of considerable historical and architectural importance, constitute a significant portion of the building inventory throughout the world, has recently retrofitted many public unreinforced masonry building to withstand earthquakes better. This paper presents the flexural bond strength loading on masonry prism having 370x220x100mm size with and without Hooked Steel Fibre (HSF). Masonry mortar 1:3 ratio as shown in figure 1. The previous research paper developed in the masonry structures and related to the fibre. Samuel et al. investigated these properties make fibre reinforced polymer materials, reinforced and unreinforced masonry structures are attractive for rehabilitating and strengthening[1], FRP materials are using of masonry structures to increase the shear and ductility and flexural strength[2].Fabrizio Greco et al. have studied the microscopically first failure surfaces takes higher-order deformation effects[3], a sensitivity analysis is carried out on the shear wall sample the different input numerical parameters[4].Ornela Lalaj et al. have studied the control specimen compared to increase in shear strength capacity up to 412%, mortar plaster are ferrocement, and polypropylene [5], the stiffness change and failure mode are more varied for strengthening techniques [6].Deniz Ucer et.al. The compression test of brick and mortar separately as well as wall prisms indicated that their strength was still higher than standard limits these wall pieces could be reused under appropriate conditions [7], the bed mortar was tested under shear loads to understand bed joints reliability [8]. Vivek Bindiganavile et al. the masonry impact resistance increased in fibers [9], the bond strength in stress sensitivity decreased with increase in the fibre [10]. Mohamed chemrouk et al. have studied the flexural strength and ductility and concrete strength of fibre reinforced concrete are improved in fibre content [11], the flexural strength was increased [12], the workability of concrete is important on the orientation and distribution of the fibres[13].





Fig. 1: Masonry mortar

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2. Test Program and Technique

To evaluate the masonry strength of prism, the strength of brick and flexural bond strength test of masonry prism were carried out. To evaluate the physical quality tests were conducted on cement, fine aggregate, coarse aggregate, bricks and hooked steel fibres.

Materials

To make the masonry prism cement mortar, bricks and hooked steel fibre were used to be available materials. Ordinary Portland Cement 53 grade was used as cement mortar. The specific gravity of the sand was found 2.60 g/cc as per the ASTM C128 [14]. The size of coarse aggregate is 12.5mm was used. The water absorption of the brick is 11.51% comparing to its dry weight. The properties of fibre are listed in table 1. Different percentage (1%, 2%, and 3%) of hooked steel fibre was used as shown in figure 2.

Table 1: Properties of Hooked steel fibre used

.Description	Specification
Length Lf (mm)	60
Diameter df (mm)	0.75
Aspect ratio (Lf/df)	80
Tensile strength (MPa)	1100



Fig. 2: Hooked Steel Fibre

Flexural Bond Strength of Masonry Prism

Totally eight specimens were prepared including six samples with fibre, and two specimens (control) without fibre, the masonry prism fabricated with three-bed joints and the dimension of masonry prism was 370 x 220 x 100 mm. The masonry mortar proportion 1:3 was maintained for eight specimens, fibre added six specimens and two specimens are without fibre (FS-NE02 & FS-NE03). Three-point loading method was performed as per the guidelines are given in the ASTM E518 [15]. All masonry prism curing is done by seven days. The entire test was carried out with 100 tone load capacity. Figure 3& 4 testing setup of with and without fibre masonry prism flexural bond strength loading.

Construction Technique

Masonry mortar 1:3 (cement: sand) used in the masonry prism. from the exsisting literature study, it was noticed that coconut fibre or bar-chip fibre on the masonry but this paper HSF was taken in different percentage of fibre is used.



(a)



(b)



(c)

Fig. 3: Test setupof masonry prism with 1%,2% and 3% fibre



Fig. 4: Test setup of without fibre masonry prism

3. Results and Discussion

Flexural Bond Strength of Masonry Prism

Three-point flexural tests carried out the according to ASTM E518-15; to evaluate the flexural bond strength of the masonry prism tested was conducted. Maximum resistance and ductility factor offered by the specimen and development of cracks was noticed, modulus of rupture R= (P+0.75Ps) L/bd ^{2} table 2 and 3 show the results.

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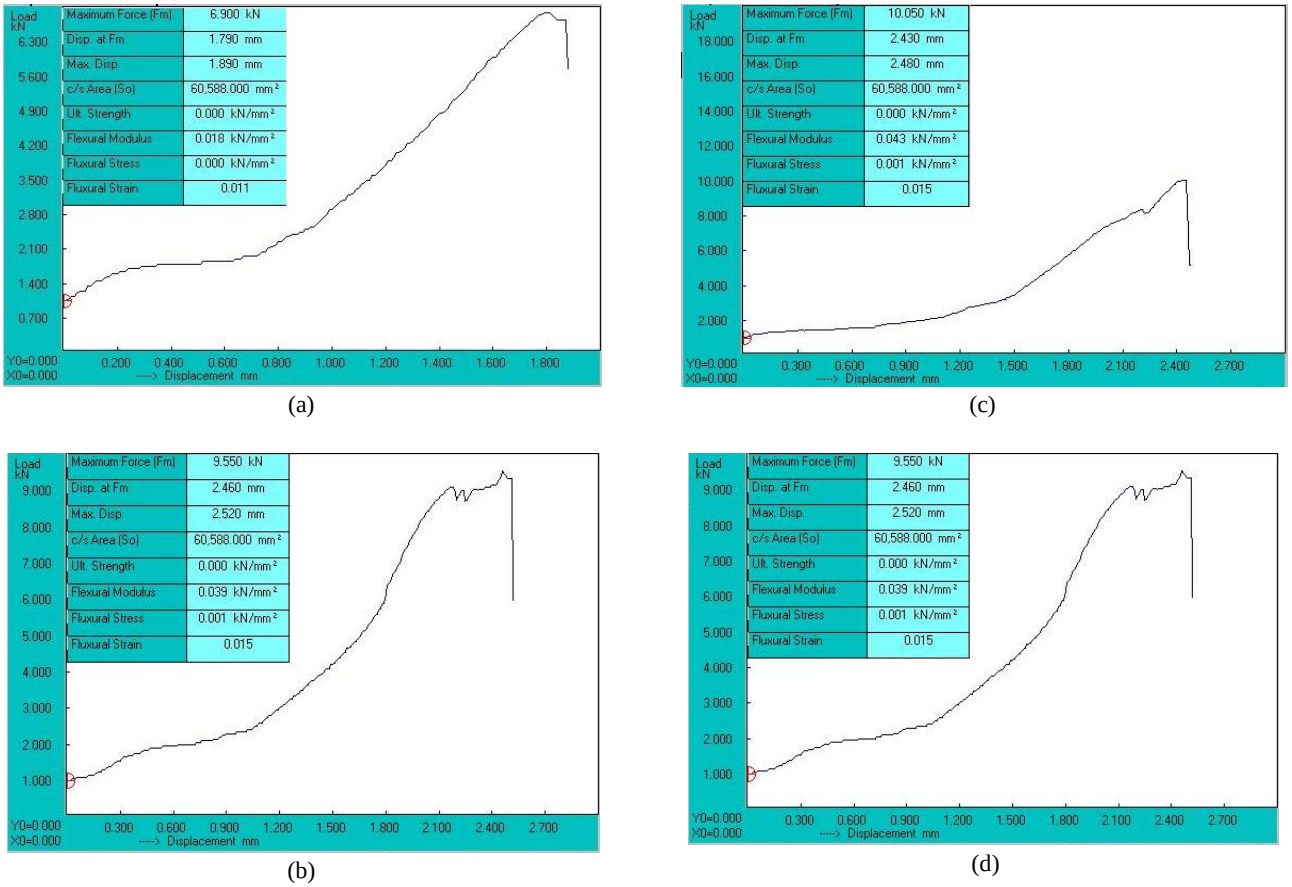

Fig. 5: Load Vs displacement curves of the with and without fibre tested specimens.

Table 2: Flexural bond strength test results on masonry prism

Specimen	Addition of fibres '%'	Maximum load 'kN'	Average	Specimen weight 'N'	Span 'm'	Modulus of rupture 'Pa'
FS-NE02	0	6.25	6.125	255.35	0.250	0.866
FS-NE03	0	6.00		255.35	0.250	0.832
FS-F1.1	1	6.9	6.65	259.80	0.263	0.953
FS-F1.2	1	6.4		259.80	0.263	0.886
FS-F2.1	2	9.55	7.75	259.80	0.252	1.235
FS-F2.2	2	5.95		259.80	0.264	0.825
FS-F3.1	3	10.05	9.48	259.80	0.263	1.376
FS-F3.2	3	8.9		259.80	0.265	1.222

Table 3: Results of ductility factor on masonry prism

Specimen	Yield		Ultimate		Ductility factor
	Py (kN)	Δy(mm)	Pu(kN)	Δu(mm)	Δu/Δy
FS-NE 02	5.8	1.85	6.25	1.90	1.027
FS-NE 03	5.5	1.55	6.00	1.70	1.097
FS-F1.1	6.5	1.65	6.90	1.70	1.030
FS-F1.2	6.2	2.53	6.40	2.80	1.107
FS-F2.1	8.7	2.19	9.55	2.40	1.050
FS-F2.2	5.6	2.15	5.95	2.30	1.069
FS-F3.1	8.4	2.18	10.05	2.42	1.100
FS-F3.2	7.8	1.50	8.90	1.80	1.200

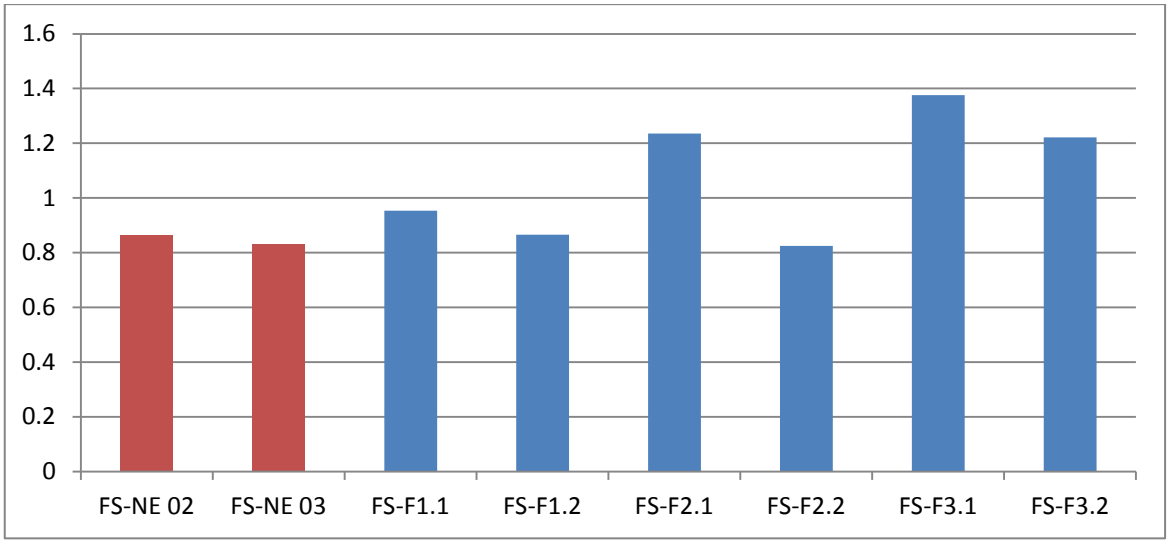

Fig. 6: Modulus of rupture for the with and without fibre tested.

4. Conclusion

The flexural bond strength of masonry prisms testes was carried out as per guidelines are given in the ASTM. The test results as follows

- The significant flexural bond strength improvement was noted in all steel hooked fibre addition
- The 1% of hooked steel fibre addition with compared to the weight of cement, 8.57 percentage of flexural strength was increased naturally when added 2% of fibre and 3% of fibre the flexural strength improvement 26.53 and 54.77percentage were noted.
- Modulus of rupture of masonry prism and its energy absorption capacity is reached better value than the control specimen
- The ductility factor values are considerably improved, and apparently, it shows the durability of the masonry prism

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