EXPERIMENTAL INVESTIGATION ON GLASS TEXTILE REINFORCED MORTAR PANELS

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ABSTRACT

The alternative building material industry is seeing a boom as the infrastructure development, energy efficient low-cost housing and green building concept has increased in construction industry. Among the advanced alternative material, the ferrocement is one of the promising low-cost green material. The ferrocement consist of closely spaced multiple layer of wire mesh embedded in cement mortar. The main disadvantage is the chance of corrosion of wire mesh. Replacement of steel wire mesh with some other suitable material is a major concern. The glass textile fibre is readily available material and the glass textile reinforced mortar is an emerging technology that differ from the conventional ferrocement, where the textile fabric along with cement mortar used as standard material, it can be used as a substitute of wire mesh in composite structure. This study describes the results of testing glass textile reinforced panels reinforced with two and four layers and comparing them with conventional ferrocement panels. The main objective of the experimental test is to explore the possibility of replacing the wire mesh by TRM in ferrocement. Among the advanced alternative materials, the ferrocement is one of the promising low cost, green material. The experimental program is planned to study the behavior of ferrocement panel replaced with TRM. The investigation shows the TRM is effective and definitely a better alternative to the wire mesh and gives better understanding and knowledge of TRM.

Keywords: *Textile reinforced matrix, ferrocement, Flexural Strength, Ultimate Strength, Layers and Panels.*

I. INTRODUCTION

The union of reinforcement material and matrix is described as a composite material. The composite materials properties are better than the individual components properties. For strength and stiffness of the composite material the main load-bearing component is reinforcement. Fibre particles and flakes are included in reinforcement arrangement. Additionally, matrix protects it from chemical and physical damage and keeps the reinforcement in a given orientation. It is additionally in charge of the corresponding distribution of applied load between reinforcement element. Traditional materials like ceramics, polymers and metals are composite materials are generally employed do not satisfy the specific requirements of certain application. They may be designed to get a wide range of properties by altering ratios of process parameters and the type, constituent materials, their orientations and so on. Composite materials have low weight with high mechanical property which bring them as an ideal material for aerospace and automotive applications. Toughness, high fatigue resistance, thermal conductivity and corrosion resistance are other advantages of composites. High processing cost which avoid their wide-scale usage are the main disadvantage of composite. Fibre reinforcement basically contains continuous fibers and textile fabrics. Textile reinforced composite contains textile form as the reinforcement and a polymer for the matrix phase. 2D or 3D knitted fabric, woven fabric, braids, non woven, multiaxial fabric, stitched fabric can be used as textile material. This textile formation has their own fibre architecture and combination of properties like stiffness, toughness, strength and flexibility are interpret to a performance of composite to an extent. Unalike textile architectures give huge future for designing the composite properties.

II. OBJECTIVES

1. To study the flexural behavior of the glass textile reinforced cementitious matrix panel in comparison with conventional ferrocement
2. Conduct the comparative study to explore the possibilities of using glass textile reinforced matrix as an alternative to ferrocement.

III. EXPERIMENTAL WORK

The experimental program is planned and preliminary investigations were conducted on the materials as per IS standards. The specimens were prepared and tested

Table I: Details of the panels

SL no	Designation	Panels Details	No of specimens
1	2LFP	Ferrocement panels 2 layers wire mesh	6
2	2LGTRM	2 layers glass textile reinforced mortar panel	3
3	4LGTRM	4 layers glass textile reinforced mortar panel	6

A. Mix proportion

The cement mortar mix design is for grade MM 7.5 obtained as per IS: 2250-1981 guidelines. The proportion adopted as per mix design is 1:3 based on strength and workability water cement ratio was selected as per IS 5512- 1983, the matrix proportion is 1:3 with w/c ratio of 0.56 as it gives 125% of spread.

Table II: Compressive strength test results of mortar cubes

Sl. No	Proportion	days	Compressive strength (N/mm^2)	Avg. comp strength (N/mm^2)
1			17.12	
2		7	17.39	17.16
3			16.98	
4	1:3		23.07	
5		28	21.26	24.13
6			28.08	

B. Casting of Panel Specimens

Totally 15 panels were casted and tested, the specimen's size was selected to suit the capacity of the test equipment available in laboratory. All panels were 750 X 450 mm with 40mm thick. The clear cover of 5mm was provided on all faces.

Fig 1 (a): Preparation of reinforcement

Fig 1 (b): Casting of panel specimens

C. Flexural Strength Test

The assumed loading was two-point loading. The load is transferred to panel using two 25mm rods, to have a pure bending in the panels. The load was applied using the control valve in the UTM with constant increment up to the ultimate load or failure load. The initial load applied was 40kg and 80kg respectively for longer span and shorter span. To calculate the deflection of the panel dial gauge readings were noted at every interval of load

The deflection at the center point of the panel was measured by using dial gauge. The load was incremented manually, the load increment is 40kg for longer span and 80kg shorter span and the readings of dial gauge were taken at each interval. The measured deflection results were tabulated. The load at the corresponding load to the first crack was noted down. At increment of every load the propagation of old cracks and appearance of any fresh crack were clearly marked. The respective load levels were marked. The crack pattern was painted using pen marker and the photographs of each of the panels were taken after failure. the duration of testing for each panel was around 1 hour.

Fig 2: Flexural testing of panels

IV. RESULTS AND DISCUSSION

After testing of all the panels, first crack load, ultimate load and max deflection were noted and tabulated in table below.

Table III: Test results for longer span

Panel Designation	Load At First-Crack (kN/m^2)	Ultimate-Load (kN/m^2)	Deflection (mm)
4LGTRM-1LS	11.18	12.75	4.73
4LGTRM-2LS	10.20	11.96	4.128
4LGTRM-3LS	11.37	13.37	5.01
2LGTRM-1LS	7.12	8.83	2.931
2LGTRM-2LS	6.67	7.85	3.387
2LGTRM-3LS	6.67	8.24	3.458
2LFP-1LS	6.13	9.18	3.657
2LFP-2LS	7.65	9.57	5.28
2LFP-3LS	5.88	7.45	3.21

Table IV: Test results for shorter span

Panel Notation	Load At First-Crack (kN/m^2)	Ultimate-Load (kN/m^2)	Deflection (mm)
4LGTRM-1SS	20.01	23.15	3.642
4LGTRM-2SS	17.65	18.33	3.325
4LGTRM-3SS	18.44	20.01	3.698
2LFP-1SS	10.20	12.00	3.021
2LFP-2SS	10.98	12.00	3.358
2LFP-3SS	9.42	11.77	2.998

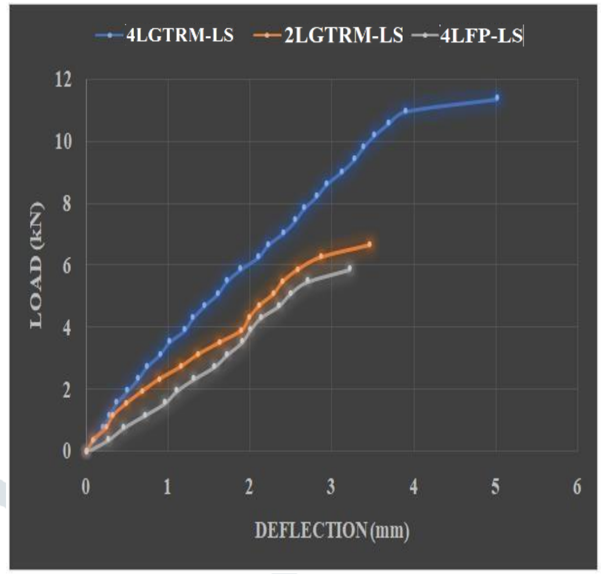

Fig 3 (a): Combined Load vs Deflection curve of glass textile reinforced panel and ferrocement panel in longer span.

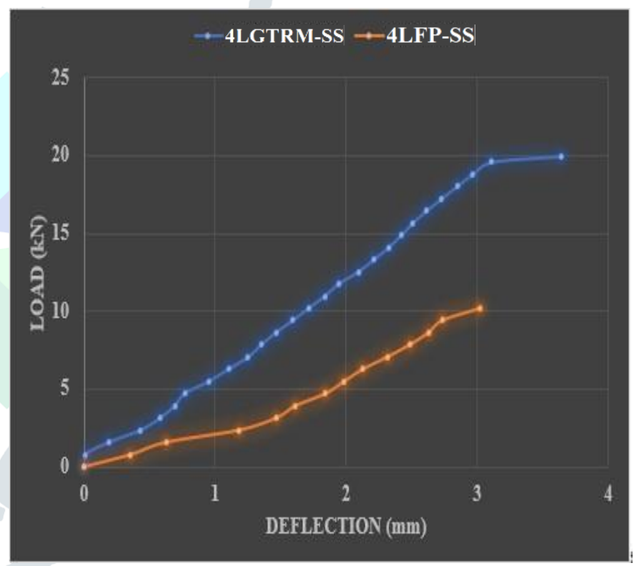

Fig 3 (b): Combined Load vs Deflection curve of glass textile reinforced panel and ferrocement panel in shorter span.

A. Combined load vs deflection curve

To understand the behavior of glass textile reinforced panel in flexure, the average behavior of combined load vs deflection curve was drawn for both longer span and for shorter span and presented in figure3 (a) and 3 (b) from the curve it is observed that the conventional ferrocement panel and glass textile reinforced mortar showed similar behavior up to cracking load i.e. the curve shows linear variation. But the glass textile reinforced panels showed more stiffness than conventional ferrocement panel. The glass textile reinforced panels show more ductile behavior than conventional ferrocement panel. The glass textile reinforced panels with 2 layers and 4 layers carry more load than that of the conventional ferrocement panel.

B. Crack pattern

Cracks were observed and marked and photograph are presented in Fig 4 (a) and 4 (b).

Fig 4 (a): Crack pattern of two point loading flexural test in longer span

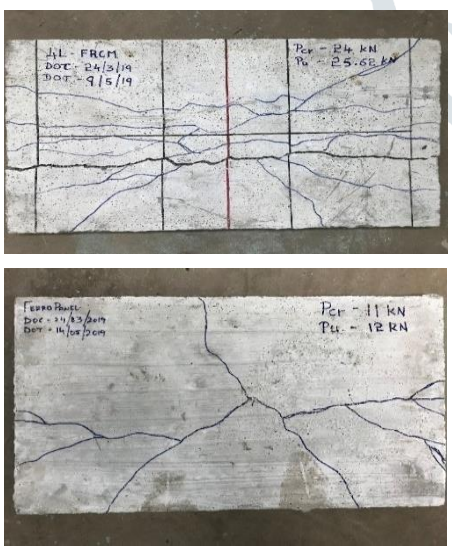

Fig 4 (b): Crack pattern of two point loading flexural test in shorter span

V. CONCLUSIONS

Based on the experimental investigation conducted on ferrocement and glass textile reinforced mortar panels following conclusions can be made

1. Fabrication and construction of glass textile reinforced panels are easier compared to conventional ferrocement panels.
2. The cracking load as well as breaking load increases as the number of glass textile reinforcement layer is increased, further research needed to decide the optimum value.
3. The load carrying capacity of the glass textile reinforced mortar panel substantially increased. The increase in cracking load is around 40.7% when tested along longer span and 46.5% for shorter span when compared with conventional ferrocement panel.
4. The ultimate load carrying capacity of glass textile reinforced mortar panel is higher than conventional ferrocement panel it is about 35% more when tested along longer span and 42% along shorter span.
5. The crack pattern shows when tested along longer span it behaves as one-way slab and when tested along shorter span behaves as two-way slab.
6. The glass textile reinforced panels are corrosion free and a serious limitation of ferrocement is that the steel reinforcement in the existing mortar system is highly prone to corrosion.

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