Ferrocement Composite Members Under Uniaxial Compression Using LGS Channel

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Abstract- The present work aims at providing structural design and methods of manufacturing of structural components designed using ferrocement panel and light gauge steel. The method of construction suggested promotes fast construction, making it advantageous, economical in many situations. Total twelve numbers of specimens are prepared with three different specifications; each size has four specimens of sizes 200mm X 300mm, 200mm X 450mm, 200mm X 900mm respectively. Also used LGS channel of size 89mm X 49mm X 0.75mm. Two specimen of each type are connected through only screwing and rest specimens by self tapping screw with epoxy. These composite specimens are tested under direct uniaxial compression. Expectation from this research is that this research will be used as guidance for future research on composite system for building construction.

Index Terms — Ferrocement, LGS, Ferrocement-LGS composite, Epoxy, Self tapping screw, Compressive behavior of composite section etc.

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1 INTRODUCTION

For the fast building of a structure with better results than the conventional scheme, a new innovative building method is needed and it should be more cost-effective when it comes not only to significant projects but also to tiny projects. Ferrocement is a type of thin reinforced concrete framework in which a brittle cement-sand mortar matrix is reinforced with various layers of thin wire mesh or tiny rods of tiny diameter, evenly spread throughout the composite matrix. Because of its specification of durability and strength and its tiny thickness, Ferrocement has taken an important position among the parts used for building, making it a component appropriate for building many lightweight structures.

There are two primary structural members families in steel building. One is the familiar group of plate-built hot-rolled forms and members. The other, less familiar but increasingly important, consists of cold segments made of sheet steel (LGS). These are cold-formed steel (LGS) structural members. Light gauge steel section will be used for the fabrication of the ferrocement panel.

Because of increased charging ability and stiffness, the use of composite structure in structures is becoming common. In the construction industry, the composite construction system is increasingly being used.

A large number of civil infrastructures around the world are in a state of serious deterioration today due to carbonation, chloride attack, etc. Moreover, many civil structures are no longer considered safe due to increase load specifications in the design codes or due to overloading or due to under design of existing structures or due to lack of quality control.

In order to maintain efficient serviceability, older structures must be repaired or strengthened so that they meet the same requirements demanded of the structures built today and in future. The present study is motivated by fascinating idea generated by work of Dr. Arun Purandare investigations on possibility of LGS-Ferrocement composite buildings. Application of composite construction system is appropriate for private and public sector buildings like a commercial building, industrial and warehouse building, stadium, hospital, schools, housing etc.

Figure 1.1Casted ferrocement-LGS composite specimen

2 OBJECTIVES

1. Experimental investigation behavior of LGS ferrocement composite under uniaxial compression with respect to following parameters.
   A. Use of epoxy as adhesive between LGS and ferrocement panel.
   B. Effect of slenderness ratio.

2. Comparison of experimental results with existing code stipulations.

1. METHODOLOGY

For research on composite section, total 12 no. of specimen of ferrocement panel with different slenderness ratio such as

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200x300mm, 200x450mm, 200x900mm are casted .Mortar mix of M30 is used to cast panel of cement sand -1: 3, water-cement ratio 0.34 is used. Admixture SPRMC APC 1000H is used to increase the workability. In panel used 2 layer of square welded wire mesh of 1mm dia. with 20mm c/c spacing. Spacer bar of 4mm dia. is used to maintain the spacing between two layers of mesh. Light gauge steel LGS C section of 89 x 49 x 14 x 0.75 mm connected with epoxy and self tapping screw with 150mm at their locations. Analytical Study of LGS Channel by using IS: 801-1975 (cl 6.6)

Case 1- Ferrocement panels and LGS channel connected with only by Self tapping screw.

Case 2- ferrocement panels and LGS channel connected with epoxy and Self tapping screw

4 EXPERIMENTAL PROGRAM

4.1 Constituents of Ferrocement Panel and LGS

Ferrocement panel of 600mmx900mmx18mm was casted with cement-sand proportion of 1:3 and w/c ration is 0.34. Cement used for casting ferrocement panel was OPC 43 grade and crush sand of 1900kg/m^3 density was used as a fine aggregate passing through 2.36mm sieve. Admixture was added to achieve workability at low w/c ratio. Admixture added is 1.2% of cement weight. Reinforcing arrangement consists of 2 layers of square welded wire mesh of 1mm dia, 20mm c/c opening and spacer rod of 4mm dia was to maintain spacing between layers of wire mesh. Spacer chair was used to provide cover to the mesh. LGS channel section with lip was used. Section property of channel section is given in figure 2. Elastic modulus of steel is E=200 x 10^3 N/mm^2 and grade of steel F_y is 500. Provision of holes in ferrocement panel for connecting panel with LGS section was done by means of driving nails in the mould before placing mortar and removed 30 minutes after the casting. Ferrocement panel is cut into the size of 200mmx900mmx18mm to meet the specimen requirement. Cut strip of ferrocement panels were connected to LGS C section at the top and bottom compression flange with self tapping screw at predefined screw spacing.

Figure 4.1Casting of Ferrocement Panel

4.2 Test setup

The testing of individual ferrocement panel and LGS channel were done on Compression Testing Machine (CTM). The testing of ferrocement-LGS composite members was done in Universal Testing Machine (UTM). The capacity of UTM is 100 tons. Dial gauge is used to measure deformation. Least count of dial gauge is 0.01mm.

Figure 4.2 Individual ferrocement panel and LGS channel

Table 4.1

No.	Type-Code	Nominal W	Measured Current, mA	Measured PF	Measured THD %	Measured VA	Measured VAR
Unit 1	SC- C000 136- 3W	3	32	0.35	90	8	8
Unit 2	Spot - MR16	3	37	0.51	87	8	7
Unit 3	Spot - MR16	6	32	0.52	83	7	6
Unit 4	Bulb T-L4B42- 6W	6	29	0.75	141	7	5
Unit 5	Bulb, E14-Guarrantee 20160607	4.8	32	0.32	77.9	2	2
Unit 6	A 65- transparent	9	39	0.89	13.0	8	5
Unit 7	E27-865779	8.7	65	0.36	76.4	4	4
Unit 8	Tornado, CFL	12	29	0.49	78.7	11	10

4.2.1 Assembling of ferrocement- LGS composite specimens

a. Composite with screw- Self tapping screws are used to connect ferrocement panel and LGS channel.
b. Composite with screw and Epoxy – Green stick product epoxy is used for connecting both panels and

LGS to each other.

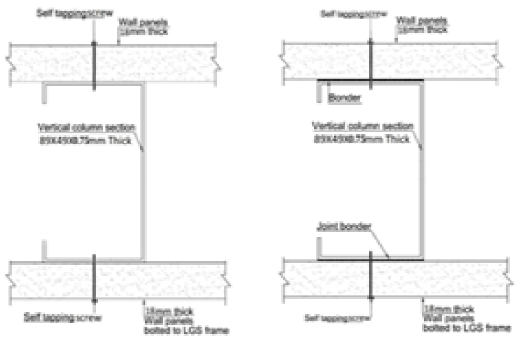


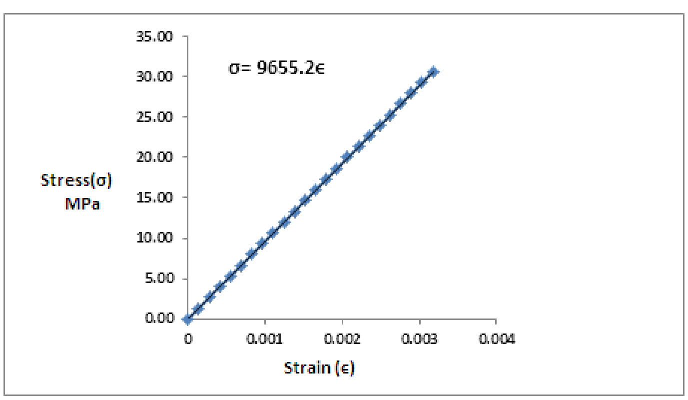
Figure 4.3 Connection with non-epoxy (NE) and connection with epoxy (E)

4.2.2 Ferrocement LGS composite specimen under uniaxial compression

Ferrocement-LGS composite specimen with different slenderness ratio such as 200x300mm, 200x450mm and 200x900mm are tested under uniaxial compression monotonically.

Figure 4.3 Arrangement of compression specimen on UTM

Monotonic uniaxial compression loading of ferrocement-LGS composite E300mm and NE-300mm



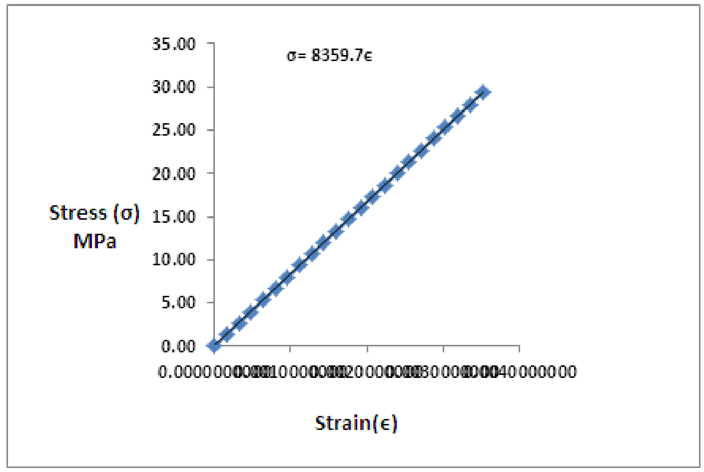


Figure 4.4 Stress strain graph for specimen E -300and NE300mm

Monotonic uniaxial compression loading of ferrocement-LGS composite E450mm and NE-450mm

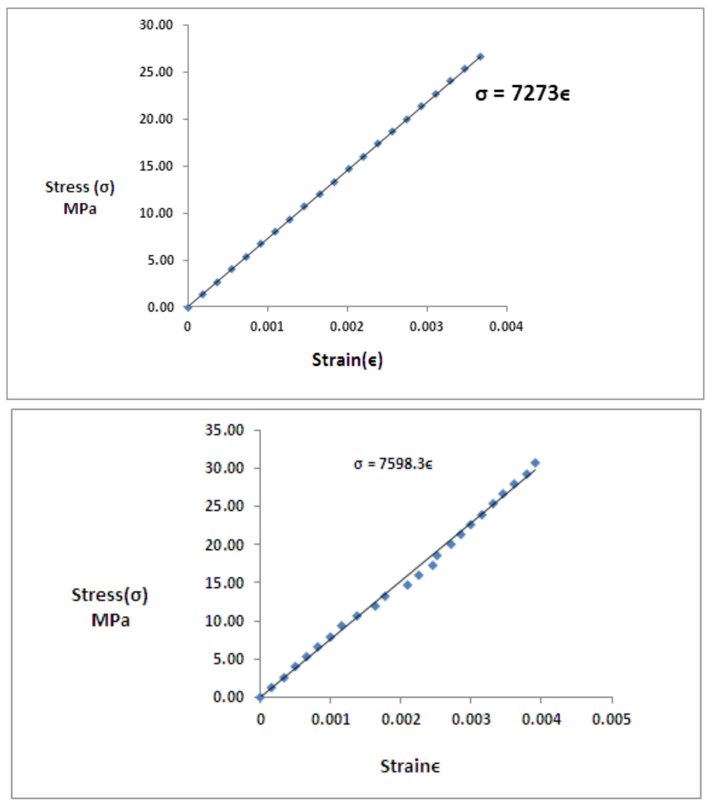


Figure 4.5 Stress strain graph for E-450 and NE-450mm

Monotonic uniaxial compression loading of ferrocement-LGS composite NE-990mm

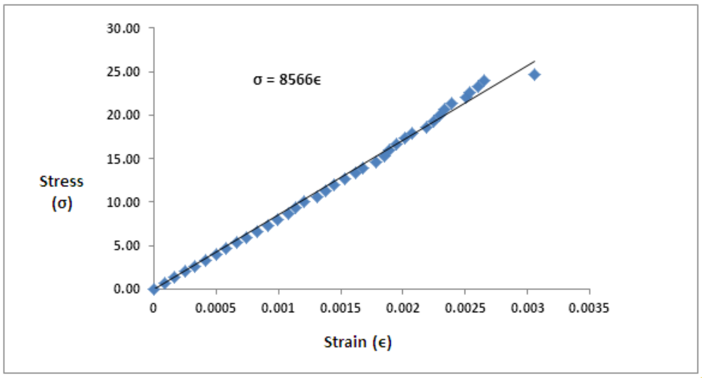


Figure 4.6 Stress strain graph for NE-900mm

5 Results and Discussion

Load carrying capacity and uniaxial compressive strength were tested under monotonic loading. Behaviour of each specimen and its failure pattern was a noted.

Table 5.1

Parameters	Specimen No				
	1. Epoxy 300 mm- M	2. Non Epoxy 300mm- M	3. Epoxy 45o mm- M	4. Non Epoxy 450 mm- M	5. Non Epoxy 900 mm-M
Failure Stress Mpa	30.65	29.32	26.66	31	24.66
Ultimate Strain mm/mm	0.017307692	0.016453	0.00833	0.00534	0.00353
Modulus of Elasticity (best fit) Mpa	9655.2	8359.7	7266.2	7598.3	8566
30% Secant Modulus of elasticity Mpa	840.13	840.7	1387.2	3620.45	6951.2
Secant Modulus of elasticity at Failure Mpa	1771.12	1782.19	3199.1	5738.42	6979.74
Modulus of Resiliance Mpa	0.003174862	0.00351	0.003665	0.003914	0.0276
Area under modulus of resiliance	0.048660994	0.051425217	0.048859439	0.058064143	0.03961965

From above table 5.1, Compressive strength of ferrocement LGS composite members decreases with increasing the length of specimen.

6 CONCLUSION

1. The individual channel of 300 mm length, in absence of flange restraining by ferrocement panels carries load 24.3 KN .
2. The individual ferrocement panel of 300 mm length, in absence of LGS channel carries loads 189.3 KN.
3. The LGS channel with ferrocement panels attached to both flanges having length of 300mm can carries load 215.8 KN without epoxy and 225.6 KN with epoxy.
4. Addition of ferrocement panels with epoxy enhances compressive load carrying capacity of LGS channels significantly.
5. The study suggests while designing LGS-ferrocement composite walls, considering compression capacity of ferrocement panels provides multifold increase in overall compression carrying capacity and hence would result in economical and light weight structure.

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