ISSN (Online) : 2319 – 8753
ISSN (Print) : 2347 - 6710

International Journal of Innovative Research in Science, Engineering and Technology

An ISO 3297: 2007 Certified Organization Volume 3, Special Issue 4, April 2014

Two days National Conference – VISHWATECH 2014

On 21st & 22nd February, Organized by

Department of CIVIL, CE, ETC, MECHNICAL, MECHNICAL SAND, IT Engg. Of Vishwabharati Academy's College of engineering, Ahmednagar, Maharastra, India

Tensile Strength of Ferrocement with respect to Specific Surface

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Abstract: The study reported herein investigates the increase in tension due to increase in contact area between wire meshes and mortar, i.e. increase in specific surface of ferrocement. For achieving higher values of specific surface, No. of Layers of meshes needs to be increased. Behavior of such ferrocement is studied which includes mechanical properties for determining the relations between the tensile strength of ferrocement with respect to the specific surface using various combination of meshes which is to be used in ferrocement.

Keywords: Composite Material, Ferrocement, Specific Surface, Impregnated.

I. INTRODUCTION

Ferrocement is a composite material which can be describe as steel-and-mortar combined together. It is a form of reinforced concrete but its behavior is so different from conventional reinforced concrete in terms of performance, strength, and application that it must be classed as a completely different material. It differs from conventional reinforced concrete in that its reinforcement consists of well spaced, number of layers of steel mesh completely impregnated with cement mortar. Ferrocement can be made into sections less than 25 mm thick, with only a very little of cover over the outermost mesh layer of mesh. On the other hand conventional concrete is cast into sections several thick with at least 25mm cover over the outermost steel rods. Ferrocement reinforcing can be done over any temporary frame work in any desired shape and mortar can be applied over it in upside downward directions. Conventional concrete must be cast into forms. These simple differences lead to other, more measurable differences. Thin panels of ferrocement can be design with complete structural integrity and water tightness. By use of Fabrication Technology we can have any complicated shape for construction. In this we required only Semi skilled labours like bar bender & welder or they can be trained in a day or two for that purpose.

II. EXPERIMENTAL INVESTIGATION

A) MATERIALS:-

a) Cement: There are several types of cement available commercially of which ordinary Portland Type 1 cement conforming to the specifications laid down by IS 269-1976 is used.
b) Aggregates to be used for the production of high quality mortar for Ferrocement structures must be strong, impermeable and capable of producing a sufficient workable mix with a minimum. Water/cement ratio to achieve proper penetration of mesh. Aggregates normally used are natural sand, it should confirm to the specifications laid down in IS 383-1970 and passing through IS Sieve 2.36 mm.
c) The quality of mixing water for the mixing of mortar has vital importance on the resulting hardened ferrocement. The water should be free from impurities which may affect the rate of hardening, or the strength & durability of mortar. The fresh drinking water should be used in the mortar.
d) One of the essential components of ferrocement is the wire mesh. Different wire meshes are available almost everywhere. The function of wire mesh in the first instance is to act as a lath providing the form and to support

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the mortar in its green state. In hardened state its function is to absorb the tensile stresses on the structure which mortar, on its own, would not be able to withstand.

The cube and cylinder compressive strength, which were tested at 28 days showed 34 N/mm^2 and 31 N/mm^2 respectively, and split tensile strength of 4.7 N/mm^2.

B) CASTING OF TEST SPECIMENS:-

The specimens of size 925 mm X 65 mm X 35 mm (thickness) were cast for conducting the tensile test. Steel mould with open top was fabricated for casting the above specimens, and placed on a levelled surface to avoid the undulations and to get a smooth surface of beam. The contact surfaces of the mould were oiled before casting for easy removal of specimens. The cement mortar was properly mixed in a dry pan of required proportion and with required amount of water. For 35mm thick beam with 0 layers of mesh in it was first casted in three equal layers of mortar with proper compaction. For 1 layer of mesh cement mortar is laid for half of the thickness after that mesh was placed over the finished and compacted mortar, and balance half layer is laid with good compaction, and top surface finished. Similar process of laying for 2 layer mesh was done. The specimens were de moulded after 24 hours and been transferred to the curing where they allowed to cure for 28 days. After curing, specimens were removed from tank, surface dried and taken for the testing.

C) TESTING OF SPECIMENS FOR TENSION :-

All the specimens were tested on computerised Universal Testing Machine the details of the test specimen are shown in Fig. In order to test the specimen, tensile test setup was prepared. Gauge lengths were marked on the each specimen and for proper arrangement rubber grip were used.

Loading was applied gradually through a hydraulic system and mid span displacements were recorded. The loading was continued till the failure of specimen occurred. The initial and final crack width is recorded. The behaviour of other combination has been studied for tensile strength and ultimate load at failure, and reported in Table I

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Figure 1: Typical Setup for Tensile test

III RESULTS AND DISCUSSION

A Total of 24 specimens were tested in this investigation on UTM (averaging three test specimens per category of Size 1, 2 and 3, layer 0,1 and 2) and the results of experimental tests carried out are analysed.

A. Tensile Loads

The tensile strength of ferrocement is related to the volume of reinforcement used in the structure. Apart from the volume of reinforcement, its direction of loading and direction of tensile stress is also important. A ferrocement member subjected to tensile stress as mentioned will behaves like an elastic material until the first crack occurs. Further to this the specimen goes into multiple crack stage and gradually continuing to a point where the mesh starts to experience yielding. Once at this stage the number of cracks will continue to grow with the increase in the tensile force or stress. The specific surface area of the ferrocement member or element has been found to influence the first crack in tension, as well as the width of the cracks. The maximum stress at first crack for ferrocement matrix increases in proportion to the specific area of the element.

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TABLE I
ULTIMATE LOAD AT FAILURE AND EXTENSION

Mesh Size	Specific Surface per Layer	Layer of Meshes	Load At Failure (kN)	Extension (mm)
1" X 1" 12 Gauge	64.32	Single Layer of square Weld Mesh	5.50	9.01
		Double Layer of square Weld Mesh	8.95	13.7
0.75" X 0.75" 16 Gauge	53.78	Single Layer of square Weld Mesh	4.25	10.5
		Double Layer of square Weld Mesh	6.20	18.5
0.5" X 0.5" 18 Gauge	61.62	Single Layer of square Weld Mesh	5.10	14.0
		Double Layer of square Weld Mesh	9.05	17.6

From the Table I it can be seen that load carrying capacity of ferrocement composite is depends upon the specific surface when mesh layers were increased from 1 to 2, we found increment in load carrying capacity by 62.73% for steel square welded mesh of 12 gauge having specific surface of 64.32 mm^2/mm^3 . For next specimen, 0.75" X 0.75" 16 gauge mesh specific surface has decreased by 19.6% so there is decrement in load carrying capacity by 29.4 %, and further for 2 layers of such mesh it is increased by 45.8%. Also similar results were found out for the third type of mesh, in this specimen specific surface with comparing to first mesh has decreased and for second mesh it has increased by 14.57%, and there is increment in load carrying capacity by 20%.

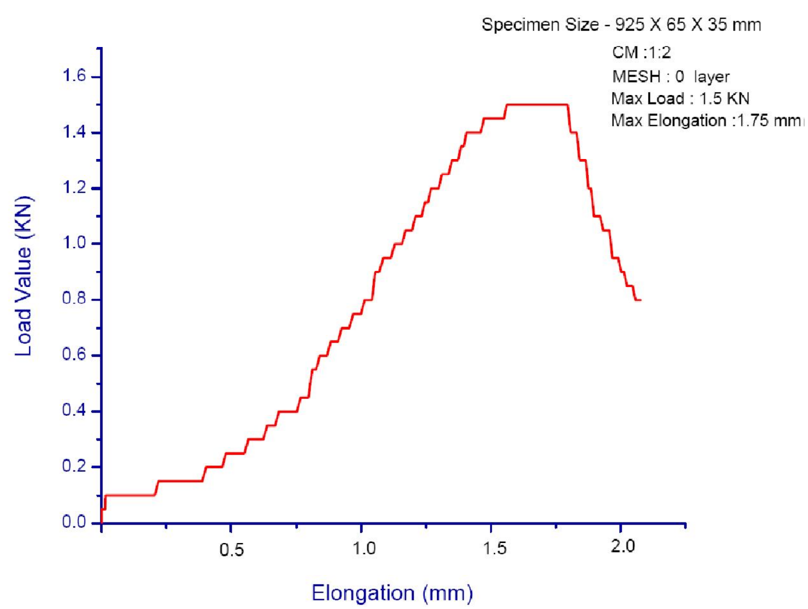

Figure 2 : Showing Graph for Mesh Layer 0

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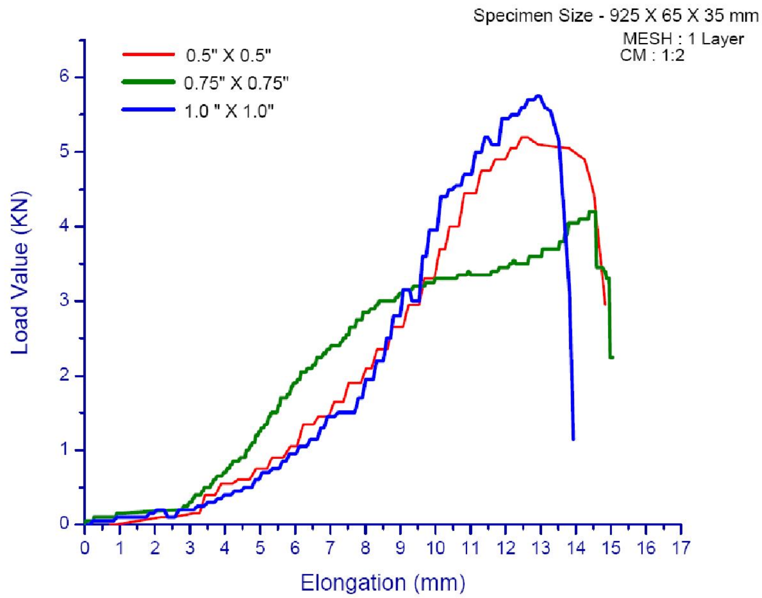

Figure 4: Showing Graph for Mesh Layer 1

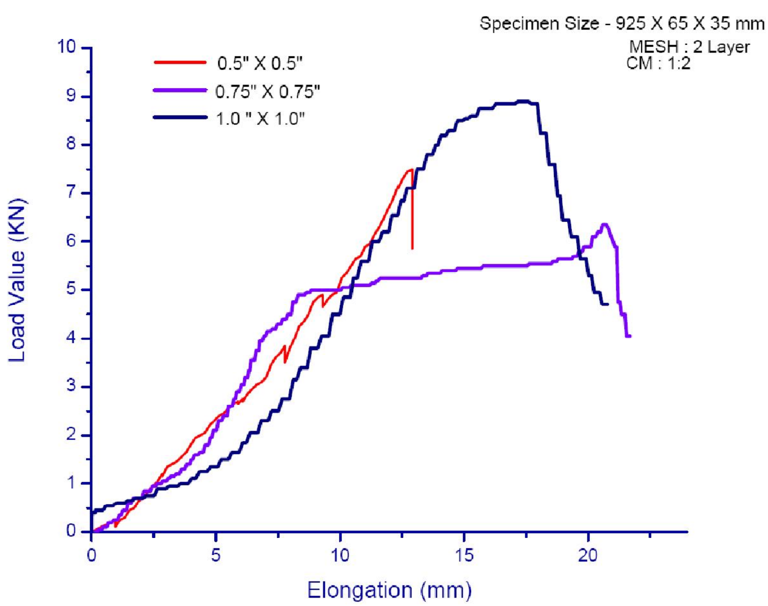

Figure 5: Showing Graph for Mesh Layer 2

B. Load Displacement response

On tensile test loading elongation of ferrocement specimen were also recorded. After analysing the results it was found that elongation of specimen with double mesh has increased by 18.75% for 1” X 1” mesh. For 0.75” X 0.75” it is further increased by 21% for single layer and 27.6% for double layer.

Load vs Elongation curve for ferrocement specimen for all the combinations of meshes and layers have shown some typical behaviour it is linear for initial stage, and found parabolic in non-linear zone. Linearity of curve can be seen upto the loads 3 to 4 kN beyond this load curve takes a shape of flat parabola and reached to the ultimate load point. After reaching the at ultimate load point curve moves in downward direction and reached the breaking point.

IV CONCLUSION

The following conclusions are drawn from the above study:

1. The load taken by the ferrocement is depends upon the number of reinforcing mesh layers used in ferrocement.
2. Increase in number of mesh layers also improves ductility of ferrocement.
3. As the specific surface increases there is increase in the tensile strength of ferrocement.
4. Orientation of mesh its thickness and spacing of mesh are the main factors that responsible for the specific surface.
5. This study suggests that in order to increase the load carrying capacity and ductility, as well as decrease the crack width of ferrocement, discontinuous fibers may be use as additional reinforcement; and this can be experimented for tensile behavior in the future. Also different combination of mortar, meshes and layer thickness can be tested and compared with this study.

ACKNOWLEDGMENT

The authors, Swayambhu Bhalsing and Sayyed Shoaib like to thank our project guide Asst.Prof.Pankaj Autade for their constant encouragement, help and support. We are also thanking Dr. B.N. Divekar, President of Ferrocement Society, for providing valuable guidance. All Management and Staff of Dr.PDVVP COE Ahmednagar for providing facilities for conducting the experimental investigation in institute.

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