ISSN: 2277-9655
Impact Factor: 4.116
CODEN: IJESS7

IJESRT
INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY

A REVIEW PAPER ON FERROCRETE ROOF TECHNOLOGY

Rahane Akshay Bharat[*1], Dr.Wakchaure M.R.[*2]
[*1]PG Student, Department of Civil Engineering, AVCOE, Sangamner, India.
[*2] Professor, Department of Civil Engineering, AVCOE, Sangamner, India.

ABSTRACT
For roofing system different systems are adopted till yet. In this research study flexural strength of ferrocrete panels is studied. Ferrocrete building elements could be a viable area. Ferrocrete consist of two main components: the matrix and the reinforcement. The Matrix is hydraulic cement binder, which may contain fine aggregates, grit and admixtures to control shrinkage and set time, and increase its corrosion resistance. The beauty of ferrocrete is that it could appear in any shapes. Only imagination could limit the forms and shapes of this beautiful and cheap material. Furthermore, unskilled labour could be employed to construct its structure. Being a precast product, use of ferrocrete panel will increase the speed of construction and also make the construction of buildings feasible in bad weather conditions. The use of ferrocrete panel with higher ductility will make the structure less prone to seismic damage. Increase in number of mesh layers also improves the ductile behavior of ferrocrete slabs. As the material required for the construction of such panel is less, it is environment friendly. Less use of cement and steel for any section compared with RCC, with corresponding reduction in self-weight. This technique does not require any scaffolding, shuttering or a concrete mixer or a vibrator.

KEYWORDS: Ferrocrete Roof, flexural Strength.

INTRODUCTION
Ferrocrete is a highly versatile form of reinforced concrete made up of wire mesh, sand, grit, water and cement, which possesses unique qualities of strength and serviceability. Over the years, applications involving Ferrocrete have increased due to its properties such as strength, toughness, water tightness, lightness, ductility and environmental stability. Ferrocrete also may be cast in various shapes and forms and are aesthetically very appealing. The success of Ferrocrete has been attributed to the ready availability of its component materials, the low level technology needed for its construction and relatively low cost of final products. Due to their thinness, ferrocrete elements can be used as roofing / flooring elements to cover large spans. The slenderness of these elements may adversely affect their performance under working loads. Hence, there is a need to study their
(a) first crack strength, Mcr and
(b) load-deflection behavior.

While (a) and (b) characterize the serviceability behavior of ferrocrete elements, it is equally important to predict their flexural strength Mu one of the ultimate limit states. A number of investigations are available for the flexural analysis and design of ferrocrete members. However Ferrocrete elements do form cracks under certain loads much smaller than the ultimate load and have a durability problem when unmodified cement mortar is used. Durability of a structure is its resistance to weathering action, abrasion, chemical attack, cracking or any other process of destruction. Corrosion of reinforcement is one of the major reasons for deterioration of ferrocrete. The corrosion of reinforcement mainly depends upon the permeability of the cement mortar. So by proper selection of chemical and mineral additives, water cement ratio of ferrocrete can be reduced. This in turn reduces the pore size, there by achieving very high strength levels and durability and the flexural moment capacity of Ferrocrete elements increases with the volume fraction of reinforcement.

ISSN: 2277-9655
Impact Factor: 4.116
CODEN: IJESS7

MATERIALS SPECIFICATIONS

Constituents of Ferrocrete

Ferrocrete is a composite thin element which is constructed of building materials steel reinforcing mesh, cement, fine aggregate (sand), coarse aggregate and water and each of these materials are separately described in this section below.

Steel Reinforcing Mesh

Ferrocrete uses layers of continuous/ small diameter steel wire/ weld mesh netting (metallic or non-metallic) as reinforcement with high volume fraction of reinforcement (2 to 8%) and the specific surface of reinforcement is considerably higher for ferrocrete than for RCC. Also, the reinforcing steel wire mesh has openings large enough for adequate bonding; the closer distribution and uniform dispersion of reinforcement, transform the otherwise brittle mortar into a high performance material distinctly different from reinforced concrete. Skeletal steel rods/wires/strands are used as spacer material and to form the skeleton of the shape of the structure to be built, around which the mesh layers are later attached.

Cement

Portland cement is generally used in ferrocrete. But the type of cement should be selected according to the need or environment in which the structure is built, for example ASTM cement Type I-V mentions the strength characteristics of cement and its specific use / application (ACI 549, IR 93). Mineral admixtures, such as fly ash, silica fumes, or blast furnace slag, may be used to maintain a high volume fraction of fine filler material as well as to enhance the properties at wet and hardened state.

Aggregate

Only fine aggregate is used in ferrocrete. Coarse aggregate is not used in ferrocrete. Normally, the aggregate consists of well graded fine aggregate (sand) that passes a 2.36 mm sieve; and since salt-free source is recommended, sand should preferably be selected from riverbeds and be free from organic or other deleterious matter. Good amount of consistency and compatibility is achieved by using a well-graded, rounded, natural sand having a maximum top size about one-third of the small opening in the reinforcing mesh to ensure proper penetration (ACI Committee 549R-97). The moisture content of the aggregate should be considered in the calculation of required water.

Water

In ferrocrete, the water used for mixing cement mortar should be fresh, clean and fit for construction purposes; the water of pH equal or greater than 7 and free from organic matter such as silt, oil, sugar, chloride and acidic material (ACI Committee 549R-97).

Coarse Aggregate

Proper size of coarse aggregate is used for ferrocrete preparation. In this study, grit of size 3/8th of mm is used. The following table gives detailed specification to be used in ferrocrete roof system.

Table No.1 Material Specification

Materials		Range
A) Wire mesh		
i.	Diameter of wire	0.5-1.5 mm
ii.	Type of mesh	Chicken wire or square woven or welded galvanized mesh
iii.	Size of mesh opening (S)	6 - 25 mm
iv.	Volume fraction (VR) of reinforcement in both directions	2% VR 8%
v.	Specific surface (SR) of in both directions	reinforcement 0.1 SR 0.4 mm2 /mm3
vi.	Elastic Modulus (ER)	140 - 200 N/mm^2
vii.	Yield strength (Ry)	250 - 460 N/mm^2
viii.	Ultimate tensile strength (Ru)	400 - 600 N/mm^2
B) Skeletal Steel:		

ISSN: 2277-9655
Impact Factor: 4.116
CODEN: IJESS7

i.	Type	Welded mesh, steel bars, strands
ii.	Diameter (d)	3 mm to 10 mm
iii.	Grid size (G)	50 mm to 200 mm
iv.	Yield strength	250 - 460 N/mm^2
v.	Ultimate tensile strength	400 - 600 N/mm^2
C) Mortar Composition:		
i.	Cement	Any type of Portland cement (depending on application)
ii.	Sand to cement ratio (s/c)	1 s/c 3 by weight
iii.	Water cement ratio (w/c)	0.3 w/c 0.5 by weight
iv.	Gradation of sand	5 mm to dust with not more than 10%* passing 150 m BS test sieve

PREPARATION OF MOULD

Mould made up of steel, concrete or wood can be used. Considering the economical condition concrete mould and wooden mould are used. Wooden mould of dimension 1m x 1m x 0.030 m is constructed to obtain a wall panel of required size for the construction of the precast ferrocrete panel. Concrete mould of required dimension is constructed to obtain precast ferrocrete roof for the testing. After the ferrocrete gets hardened the precast panels are demoulded from the concrete mould and are undergone for curing.

PREPARATION OF MESH

Weld mesh and wire mesh were cut according to the required dimensions for test specimen of size 1000 x 1000 x 30 mm. The meshes were wooden hammers. Then they were used in the ferrocrete slab over which the mortar mix was poured.

PREPARATION OF MIX

Cement and fine aggregate with the ratio of 1:3 is measured taken and undergone to normal hand mixing. Initially dry mix preparation on water and super plasticizer together to give flow ability to the mix.

CONSTRUCTION METHOD

i) The first step is to prepare the skeletal framework onto which the wire mesh is fixed with a thin tie wire (or in some cases, by welding). A minimum of two layers of wire mesh is required, and depending on the design, up to 12 layers have been used (with a maximum of 5 layers per cm of thickness).

ii) The sand, cement and additives are carefully proportioned by weighing, mixed dry and then with water. Hand mixing is usually satisfactory, but mechanical mixing produces more uniform mixes, reduces manual effort and saves time. The mix must be workable, but as dry as possible, for greater final strength and to ensure that it retains its form and position between application and hardening.

iii) After checking the stability of the framework and wire mesh reinforcement, the mortar is applied either by hand or with a trowel, and thoroughly worked into the mesh to close all voids. This can be done in a single application, that is, finishing both sides before initial set takes place. For this two people are needed to work simultaneously on both sides.

iv) Thicker structures can be done in two stages, that is, plastering to half thickness from one side, allowing it to cure for two weeks, after which the other surface is completed.

v) Compaction is achieved by beating the mortar with a trowel or flat piece of wood.

vi) Care must be taken not to leave any reinforcement exposed on the surface, the minimum mortar cover is 1.5 mm.

vii) Each stage of plastering should be done without interruption, preferably in dry weather or under cover, and protected from the sun and wind. As in concrete construction, ferrocement should be moist cured for at least 14 days.

TESTING ON FERROCRETE SLAB

The slab panels are to be removed from curing period of 28 days. Panels are to be tested for flexural strength under loading testing machine. Dial gauge will be placed below the panel to record the deflection in mm each stage of loading. Cracks will then marked during each loading and corresponding central deflection is also noted down.

CONCLUSION

The growing housing needs, especially in developing countries, makes the search for cheap and adequate building units attractive. Ferrocrete building elements could be a viable area. Ferrocrete consist of two main components: the matrix and the reinforcement. The matrix is hydraulic cement binder, which may contain fine aggregates, coarse aggregates and admixtures to control shrinkage and set time, and increase its corrosion resistance. The beauty of ferrocrete is that it could appear in any shapes. Only imagination could limit the forms and shapes of this beautiful and cheap material. Furthermore, unskilled labour could be employed to construct its structure. Being a precast product, use of ferrocrete panel will increase the speed of construction and also make the construction of buildings feasible in bad weather conditions. The use of ferrocement panel with higher ductility will make the structure less prone to seismic damage. Increase in number of mesh layers also improves the ductile behavior of ferrocement slabs. As the material required for the construction of such panel is less, it is environment friendly. Less use of cement and steel for any section compared with RCC, with corresponding reduction in self weight. This technique does not required any scaffolding, shuttering or a concrete mixer or a vibrator. Thus, ferrocrete roof system is more beneficial to be used as a roof member.So, flexural strength is to be found by testing different slab panels resting over beams to study their feasibility property to be used as a roofing element.

ACKNOWLEDGEMENTS

I take this august opportunity to sincerely show panegyrics and thanks to my guide **Dr.Wakchaure M.R.** whose timely suggestions and valuable inputs helped me a lot throughout the duration of my efforts on this seminar. I feel a deep sense of gratitude towards him for being so patient and attentive whenever any problem came up, especially during the selection of my topic.

I am also grateful to all support staff of our department for providing laboratory, library and internet facilities. Last but not the least; I am thankful to my parents, friends, my classmates and colleagues who helped to sustain my determination to accomplish this work in spite of many hurdles.

REFERENCES

[1] Nagesh M. Kulkarni, D.G.Gaidhankar, ISSN: 2319–9598, Volume-1, Issue-5, April 2013, Analysis and Design of Ferrocement Panels an Experimental Study, International Journal of Inventive Engineering and Sciences (IJIES).

[2] S. PriyaVadhana, M. Neelamegam, S. LavanyaPraba, Vol.4, No.6, June 2016, E-ISSN: 2321-9637, Design, Analysis and Construction of Precast Ferrocement Store Room, International Journal of Research in Advent Technology.

[3] Prem Pal Bansal, Dr. Maneek Kumar, Dr. S.K. Kaushik, Volume (2) : Issue (1), Effect Of Wire Mesh Orientation On Strength Of Beams Retrofitted Using Ferrocement Jackets, International Journal of Engineering.

[4] Vincent PrabakarRajaiah, S.Dharmar, Dr.S.Nagan, ISSN: 2319-8753, Vol. 3, Issue 7, July 2014, Experimental Investigation on Flexural Behaviour of Folded Ferrocement Panels, International Journal of Innovative Research in Science, Engineering and Technology.

[5] M.Amala, Dr.M.Neelamegam, e-ISSN: 2278-1684, p-ISSN: 2320-334X,PP 62-66, Experimental Study of Flexure and Impact on Ferrocement Slabs, IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE).

[6] Wail N. Al-Rifaie andMuyasser M. Joma'ah, ISSN 1999-8716, First Engineering Scientific Conference College of Engineering –University of Diyala, 22-23 December 2010, pp. 237-248, Structural Behaviour Of Ferrocement System For Roofing, Diyala Journal of Engineering Sciences.

[7] Dr.T.Ch.Madhavi, ShanmukhaKavya V., Siddhartha Das, Sri Prashanth V., Vetrivel V, Issn 0976 – 6316(Online) Volume 4, Issue 3, May - June (2013), Pp. 57-62, Composite Action Of Ferrocement Slabs Under Static And Cyclic Loading, International Journal Of Civil Engineering And Technology.

[8] A. S. Alnuaimi, A. Hago& K. S. Al-Jabri, Issn 1743-3509, Iii 93, Flexural Behaviour Of Ferrocement Roof Panels, High Performance Structures And Materials.

[9] ObamOgahp, Fagbohun I. Akinlabip, Volume-2, Issue-6,June 2016, Issn: 2395-3470, Impact Energy And Flexural Strength Characteristics Of Wire-Mesh And Steel Fibres Ferrocement Roof Panels, International Journal Of Scientific Engineering And Applied Science.

[10] MungaseSagar , SahaneOnkar, KadlagShrikant, Nawale Vishal, Issn 2348 – 8034, Application Of Ferrocement To Rural Sanitation, Global Journal Of Engineering Science And Researches.

[11] Shubham R. Dakhane, Kaustubh P. Gatlewar, Akshay G. Bahale, Alhad D. Raut, Review On Analysis Of Ferrocement – Construction Material, International Conference On Science And Technology For Sustainable Development (Icstsd)- 2016.

[12] VatwongGreepala *, PichaiNimityongskul, Cement & Concrete Composites 30 (2008) 419–430, Structural Integrity Of Ferrocement Panels Exposed To Fire,Science Directory.

[13] LakhanMurari,And Elson John, Issn 2319-5991,Special Issue, Vol. 3, No. 1, April 2016, Study On Performance Of Prefabricated Ferrocement Columns And Wall Panels, International Journals Of Enggineering Research & Science & Technology,2016.

[14] A.W. Hago, K.S. Al-Jabri, A.S. Alnuaimi, H. Al-Moqbali, M.A. Al-Kubaisy, Construction And Building Materials 19 (2005) 31–37,Sciencedirect.