HYBRID BUILDING – A COMBINATION OF CONVENTIONAL RCC AND FERROCEMENT TECHNOLOGY

Mr. V. Niranjan[1], Mr. Shameer Ali M.C[2]

[1]Assisstant Professor, Department of Civil Engineering, RVS Technical Campus, Coimbatore-641402, India,
[2]PG student, Department of Civil Engineering, RVS Technical Campus, Coimbatore-641402, India

---

Abstract - *Ferrocement is a system of reinforced concrete that differs from conventional reinforced or prestressed concrete primarily by the manner in which the reinforcing elements are dispersed and arranged. It comprises of closely spaced, multiple layers of mesh or fine rods completely embedded in cement mortar. Ferrocement is a highly versatile form of reinforced concrete made up of wire mesh, sand, water, and cement,which possesses unique qualities of strength and serviceability. It can be constructed with a least of skilled labour and utilizes readily available materials. There are several applications of Ferrocement which include building industry, irrigation sector, water supply and sanitation areas. Studies indicate that it appears to be an excellent composite in the case of seismic resistant structure. It varies from conventional reinforced concrete primarily by the manner in which the reinforcement is arranged within the brittle matrix. Meanwhile its behaviour is quite different from that of conventional reinforced concrete in performance, strength and potential applications, it is classed as a separate material. Light weight ferrocement has great resistance against cracking; also many of its engineering properties such as toughness, fatigue against resistance, and impermeability etc. are improved when compared to reinforced concrete.*

***Key Words*: Ferrocement, Wire-Mesh, Fine aggregate**

1. INTRODUCTION

1.1 General

Ferrocement is a form of reinforced concrete that varies from conventional reinforced or prestressed concrete primarily by the manner in which the reinforcing elements are dispersed and arranged. It consists of closely spaced, multiple layers of mesh or fine rods completely embedded in cement mortar. Ferrocement is a highly versatile form of reinforced concrete made up of wire mesh, sand, water, and cement, which has unique qualities of strength and serviceability. It can be constructed with a least of skilled labor and utilizes readily available materials. There are several applications of Ferro cement which include building industry, irrigation sector, water supply and sanitation areas. Studies indicate that it appears to be an excellent composite in the case of seismic resistant structure. It varies from conventional reinforced concrete primarily by the manner in which the reinforcement is arranged within the brittle matrix. Since its performance is quite different from that of conventional reinforced concrete in performance, strength and potential applications, it is classed as a separate material. Light weight ferrocement has great resistance against cracking; also many of its engineering properties such as toughness, fatigue against resistance, and impermeability etc. are improved when compared to reinforced concrete. In India, light weight ferrocement is used often because the constructions made from it are well resistant against earthquakes. Earthquake-resistance is dependent on worthy construction technique and additional reinforcement of the cement.

2. LITERATURE REVIEW

Desayi P et. al and Naaman A.E (1991) Investigations related to mechanical properties of ferrocement elements under monotonically with increased loading and fatigues have been reported (Balaguru P. et. al., 1951) and some design procedure has been suggested based on the results of such studies. Both first crack and ultimate moment increases with increasing matrix grade (decreasing w/c ratio) (Walkus B.R,1986) and increasing volume fraction of reinforcement have been reported (Suresh G.S et. al., 2007), No information has been available on the response of light weight ferrocement structure subjected to monotonic and repeated loading. In this work matrix grade increase and volume fraction is increasing by taken as 6 layer wire mesh and study the behaviour of light weight ferrocement beam.

Hoe I. Ling, et.al (August 1998) presented a paper on "Tensile Properties of Geogrid Under Cyclic Loadings". The tensile behaviour of three commonly used polymeric geogrids (polypropylene, polyester and high-density polyethylene) under cyclic loading was investigated. The tests were strain controlled and were conducted for 100 cycles at different load ratios. The stiffness and damping ratios of geogrids at all load cycles were compared with primary loading curve. The stiffness increased while the damping ratio decreased with more loading cycles at any load ratios.

M. A. Saleem and M. Ashraf (2008) says The greatest humanitarian challenge faced even today after one year of Kashmir Hazara earthquake is that of providing shelter. Currently on the globe one in seven people live in a slum or refugee camp. The earthquake of October 2005 resulted in a great loss of life and property. This research work is mainly focused on developing a design of small size, low cost and earthquake resistant house. Ferrocement panels are recommended as the main structural elements with

lightweight truss roofing system. Earthquake resistance is ensured by analyzing the structure on ETABS for a seismic activity of zone 4. The behavior of structure is found satisfactory under the earthquake loading. An estimate of cost is also presented which shows that it is an economical solution.

Mohamad N. Mahmood Sura A.Majeed carried out an experimental work on flat and folded ferrocement panels for studying their flexural behaviour. The panels tested for flexure are of size 380mm X 600mm with 20mm thickness for both flat as well as folded slab panels. The wire mesh used was mild steel galvanized welded wire mesh of 0.65 mm diameter and 12.5 mm square grid size. From his experimental work the author concludes that the cracking load was not significantly affected by the number of the wire mesh particularly for the folded panels.

Naveen G.M, Suresh G.S (2012) Light weight ferrocement is a composite material consisting of cement-sand mortar (matrix) along with light weight fine aggregate (In this work foamed blast furnace slag is employed as light weight fine aggregate) as a replacement of sand in some quantity reinforced with layers of small diameter wire meshes The present work is concentrated on two major aspects, Effect of blast furnace slag on first crack and ultimate strength and Behavior of light weight ferrocement element under monotonic & repeated flexural loading. The first part of the present study has been focused on the effect of blast furnace slag (BFS) on ultimate strength with replacement of slag by 0%, 10%, 20% and 30% and second part of the work focusing the behavior of Light weight ferrocement beam under monotonic load and repeated load with increased load. The results obtained from this work is expected to be useful in determining the strength and ductility of light weight ferrocement beam subjected to similar types of forces and thus will help toward designing ferrocement elements to withstand monotonic and repeated flexural loading. Keywords: Light weight ferrocement, blast furnace slag (BFS), wire mesh.

Randhir J. Phalke, Darshan G. Gaidhankar (2014) The present study describes the results of testing flat ferrocement panels reinforced with different number of wire mesh layers**.** The main objective of this work is to study the effect of using different no of wire mesh layers on the flexural strength of flat ferrocement panels and to compare the effect of varying the no of wire mesh layers and use of steel fibers on the ultimate strength and ductility of ferrocement slab panels. The no of layers used are two, three and four. Slab panels of size (550*200) with thickness 25 mm are reinforced with welded square mesh with varying no of layers of mesh.

Panels were casted with mortar of mix proportion (1:1.75) and water cement ratio (0.38) including super plasticizer (Perma PC-202) with dosage of 1% of total weight of cement. Some panels were casted with steel fibers (0.5%) of total volume of composite and aspect ratio (l/d) =57. Panels were tested under two point loading system in UTM machine after curing period of 28 days. Test result shows that panels with more no of layers exhibits greater flexural strength and less deflection as that compared with panels having less no of layers of mesh.

S.Jaganathan, P.Sudharsanamurthy (2016) says Ferrocement is a form of reinforced concrete using closely spaced multiple layers of mesh and /or small diameter rods completely encapsulated in mortar. The most common type of mesh used is steel mesh. Other materials such as selected organic, natural or synthetic fibers may be combined with metallic mesh." Quarry dust being inexpensive and ecofriendly is been proposed for partially replacing sand. Steel mesh provided in the ferrocement construction has a serious disadvantage whenever the corrosion property is concerned. So in order to compensate the strength and durability of ferrocement panels, present study has been made to replace steel mesh with HDPE–geogrid mesh for different proportions of cement and flyash and partial replacement of sand with quarry dust. An optimum proportion has been arrived taking into account the social responsibility to bring out the product that could be economic, efficient and ecofriendly.

S. U. Khan, T. Ayub, S. F. A. Rafeeqi (2013) says the compressive strength of plain concrete confined with Ferrocement was estimated using mathematical models and compared with 55 experimental results. In this paper, predictive model of compressive strength for plain concrete confined with Ferrocement has been developed by using MATLAB Artificial Neural Network (ANN) simulation. Out of 55, 19 experimental results are selected for training of multilayer feed forward neural network. Comparative analysis of the results showed that compressive strength estimated by ANN predictive model are very close to the experimental results than existing theoretical models.

S.F.A. Rafeeqi and T. Ayub (2011) The paper presents a short investigation of theoretical prediction models for plain concrete confined with Ferrocement. Although to date scant experimental data is available for a conclusive recommendation, however, ample evidence of the versatility of the model proposed by Waliuddin and Rafeeqi [36] has been provided in this paper. The proposed model possess the capability of predicting strength of plain concrete, confined with Ferrocement for almost all the possible and practical methods of confinement by way of; integrally cast mesh layer, mesh layers in precast shell and wrapped mesh layer on precast core.

Swayambhu Bhalsing, Sayyed Shoaib, Pankaj Autade (2014) 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.

3. PROPERTIES AND MATERIAL USED

3.1 Water

Water is the main constituent in the construction of ferroccement. It helps to increase the workability of the mixture. The water used here should be as inert and also should be free from inorganic matter. Also the water used for the construction should be portable.

3.2 Fine aggregate

Fine aggregate are mainly sands won from the land or the marine environment. Fine aggregates generally consist of natural sand or crushed stone with most particles passing through a 9.5mm sieve. As with coarse aggregates these can be from Primary, Secondary or Recycled sources. Normal weight fine aggregate clean, hard and strong free of organic impurities and relatively free of slit and clay**.**

3.3 Cement

Ordinary portland cement is the basic form of **cement** with 95% of it being the clinker and 5% being gypsum which is added as an additive to increase the setting time of the **cement** to a workable 30 minutes odd or so. The cement should be fresh of uniform consistency and free of lumps.

3.4 Wire mesh

A mesh is a barrier made of connected elements of metal, fiber, or other flexible/ductile materials. A mesh is similar to a web or a net in that it has many attached or woven strands. The meshes in ferrocement includes square welded mesh and hexagonal mesh. Other wire known as chicken mesh. Some meshes are galvanized, that means zinc coated to prevent corosssion.

4. MIX DESIGN

Our recommended mix proportion is 1:3 for casting a single cube. Take 1.75 kg of Portland cement and 5.26 kg of sand. The sand taken should be well sieved using an IS sieve of 1.18mm. Then take the cement and sand in a mixing panel and mix it thoroughly until it appears in uniform color. And taking the quantity of water shall be (1/4+3)% of combined weight of cement and sand is 790 ml for a single cube size of 150X150mm.

5. CONCLUSION

Ferrocement is a form of reinforced concrete. It consists of closely spaced, several layers of mesh or fine rods completely embedded in cement mortar. Since from the limitation of ferrocement along with structure of not able to do multiple storied buildings. From the above studies testes we concluded that hybrid buildings are practical. Hybrid buildings are the combination of ferrocement and reinforced concrete.

REFERENCES

[1] Desayi P and Jacob K.R, "Strength and behavior of Ferrocement in tension and flexure", Proceedings of the symposium, Modern trend in civil engineering, Roorkee, India, pp 274-279.

[2] Hoe I. Ling, et.al (August 1998) "Tensile Properties of Geogrid Under Cyclic Loadings" Journal of Geotechnical and Geoenvironmental Engineering/Volume 124 Issue 8 - August 1998.

[3] M. A. Saleem and M. Ashraf (2008)" Low Cost Earthquake Resistant Ferrocement Small House" Pak. J. Engg. & Appl. Sci. Vol. 2 Jan 2008.

[4] Mohamad N. Mahmood, Sura A.Majeed "Flexural behavior of flat and folded ferrocement panels"Al Rafidain Engineering, Vol 17 No.4 (Aug.2009).

[5] Naveen G.M, Suresh G.S. (2012)."Experimental study on light weight ferrocement beam under monotonic and repeated flexural loading."ISSN:0976-4399,Volume 3, No 2.

[6] Randhir J.Phalke, Darshan G. Gaidhankar. (2014). "Flexural behavior of ferrocement slab panels using welded square mesh by incorporating steel fibers." ISSN:2319-1163.Volume: 03 Issue: 05.

[7] S.Jaganathan, P.Sudharsanamurthy (2016) "An Experimental Study of Geogrid in Ferrocement Panels" IJETST-Vol.||03||Issue||03||Pages 3744-3758||March||ISSN 2348-9480.

[8] S. U. Khan, T. Ayub, S. F. A. Rafeeqi (2013) "Prediction of Compressive Strength of Plain Concrete Confined with Ferrocement using Artificial Neural Network (ANN) and Comparison with Existing Mathematical Models" American Journal of Civil Engineering and Architecture, 2013, Vol. 1, No. 1, 7-14.

[9] S.F.A. Rafeeqi and T. Ayub (2011) "investigation of versatility of theoretical prediction models "for plain concrete confined with ferrocement - Asian journal of civil engineering (building and housing) vol. 12, no. 3.

[10] Swayambhu Bhalsing, Sayyed Shoaib, Pankaj Autade. (2014)."Tensile Strength of Ferrocement with respect to Specific Surface."ISSN:2319-8753,ISSN:2347-6710. Volume 3, Special Issue 4.