IOSR Journal of Engineering (IOSR JEN) **www.iosrjen.org**
ISSN (e): 2250-3021, ISSN (p): 2278-8719
PP 50-55

An Experimental Study on Ferrocement

Asadullah[1] , Ansari Abu Usama[2,] Vajed Shaikh[3]
[1,2,3]*(Department of Civil Engineering, Maulana Mukhtar Ahmad Nadavi Technical Campus, Malegaon, India)*

Abstract : *The development of a low-cost energy-saving structural concrete sandwich panel for housing and other building applications is reported. This paper represent experimental program is carried out to investigate the durability of natural fiber mortar using co-co nut hair and jute as a long fiber. Both co-co nut hair and jute are replaced by 1% by total weight. Overall unit weight of the sandwich composite elements falls in the range of the light weight structural element. Ferro cement wall panel with different infill materials of size 55mm x 150mm x 40mm were cast and tested under uniaxial load. Experimental studies and research must determine the result in terms of ultimate load carrying capacity, compressive strength, load vs deflection graph analysis and stress vs strain graph. The experimental result emphasized that better cracking resistance, high serviceability and ultimate load carrying capacity.*

Keywords: *coco-nut fibre, ferrocement, flexural strength ,natural fibre*

I. Introduction

The word "concrete" has its origin from the Latin word "concretes", which means to grow together. The first modern concrete was made in 1756. Concrete consist of mixer of corse aggregate, fine aggregate and cementitious material mixed with water. The cementitious material and water form a paste or gel which coats the sand and aggregate. When the cementitious material has chemically reacted with the water (hydrated), it hardens and binds the whole mix together. Usually within a few hours the initial hardening reaction takes place. Some weeks required for concrete to reach full hardness and strength. Concrete can continue to harden and gain strength over many years. Many invention done in concrete research, out them ferrocement is, wherein the cement mortar is dashed against a cage of welded mesh and chicken mesh. Ferrocement is characterized by its thickness and crack free surface area. This has made ferrocement an ideal material for water tanks. The ferrocement has also found many applications in civil engineering field. The researchers have shown that as the percentage of steel in ferrocement increases, the strength properties also increase. But, the steel area cannot be increased beyond certain limit because of the difficulties in dashing the cement mortar to the ferrocement cage. In developing countries when it used, provide better resistance to fire, earthquake hazard and corrosion to material. Developed countries like United States starts use of ferrocement in construction in year 1930 through 1950. It became popular due to reduction in labor cast and novelty architecture. The constituent materials of ferrocement are wire mesh reinforcement, skeletal reinforcement, cement mortar and admixtures. The wire mesh reinforcement imparts to the member tensile strength and resistance to cracking. In addition, for members cast without mould, the wire mesh helps to hold the mortar together in the wet state. While it is possible to use any fibrous element to reinforce mortar, it is economically and structurally efficient to use steel wires as reinforcement, because of high modulus of elasticity compared to organic and other metal fibers. The wire mesh generally consists of thin wires either woven or welded into a square or rectangular grid. The main consideration in the choice of the wire mesh is the requirement to bend it into the required shape.

The principal types of wire mesh reinforcement used in construction are as follows:
• Hexagonal mesh
• Woven mesh
• Watson mesh
• Welded mesh
• Expanded metal

The cement mortar used for ferrocement is consist of Portland cement, sand and water, with or without admixtures. The proportion of the constituents are so adjusted that the mortar gives the required strength, workability, water-tightness and finish. The properties and specifications for the individual constituents of cement mortar are cement, aggregate and water. Portland cement mixed with water reacts to form cementitious gel which in the green stage binds the sand particles to form a compact mass. Aggregate, more specifically fine aggregate, is the inert material which occupies 60 to 75 percent of the volume of mortar. The I.S specifications give four different grading for fine aggregate suitable for concrete. Of these, grading II and III, with the particles greater than 2.36mm and smaller than 150 microns removed are suitable for ferrocement.

II. Methodology

In this work various tests carried out on materials. Also various test were performed on different ingredients of concrete as explain below.

2. 1. Material Properties

2.1.1 **Cement:-** Portland cement is generally used in ferrocement. However the type of cement to be used 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. The initial setting time of cement paste should be sufficiency more, which permits sufficient period available for proper transportation to finishing of concrete The setting time decreases with rise in temperature. For OPC minimum initial setting time of 30 min is recommended by IS specification. the final setting time is determined. Maximum final setting time for OPC is limited to 600 minutes is considered.

2.1.2 Soundness Test

In this test a specimen of hardened cement paste is boiled for a fixed time so that any tendency to expand is speeded up and can be detected. Soundness means the ability to resist volume expansion.

Table No.1: Physical Properties Of Cement Used

SR.NO	CHARACTERISTICS	EXPERIMENTAL VALUE	VALUE SPECIFIED BY BIS
1)	Setting Time I-Initial II-Final	 55 Min 310 Min	 >30 min <10 hours
2)	Soundness Test By (Le-Chatelier Method)	5.2	<10 (Fresh Cement) <5 (Old Cement)

2.1.3 Fine Aggregate:-

Only fine aggregate is used in ferrocement. Normally, the aggregate consists of well graded fine aggregate (sand) that passes a 2.34 mm sieve; and since salt-free source is recommended, sand should preferably be selected from river-beds and be free from organic or other deleterious matter.

Fineness Modulus

Fineness Modulus is generally used to get an idea of how coarse or fine aggregate is. More fineness modulus value indicates that the aggregate is coarser and small value of fineness modulus indicates that the aggregate is finer.

Table No.2: Fineness Modulus Of Fine Aggregate

IS Sieve Size	Weight of Fine Aggregate (gm)	Percentage (%) Retained	Cumulative Percentage (%)	Percentage (%) Passing	Cumulative Passing Percentage (%)
2.36 (mm)	100	10.52	10.52	89.48	89.48
1.18 (mm)	220	23.15	33.67	66.33	155.81
600 (µ)	190	20	53.67	46.33	202.14
300 (µ)	330	34.73	88.4	11.60	213.74
150 (µ)	30	3.15	91.55	8.45	222.19
75 (µ)	30	3.15	94.7	5.30	227.49
Pan	50	5.26	99.96	0.04	227.53

Table No.3: Classification of Sand Based On Fineness Modulus

TYPE OF SAND	FINENESS MODULUS RANGE
Fine	2.2 – 2.6
Medium	2.6 – 2.9
Coarse	2.9 – 3.2

Table No.4: Physical Properties of Fine Aggregate (Sand)

SR.NO	CHARACTERISTICS	VALUE
1)	Specific Gravity	2.46
2)	Bulk Density	1.5 kg/lit
3)	Fineness Modulus	2.27

2.1.4 Steel Wire Mesh

Figure No.1 steel mesh reinforcement

Ferrocement 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 ferrocement than for RCC.

A hexagonal chicken wire mesh is used in ferrocement panel. It consists of with the dimension of 540mm*140mm. The mesh is placed in the middle of each panel. The cover for the mesh is taken as 100mm from all side of panel. Some panel have one or two layer of wire mesh.

2.1.5 Coconut Fiber

Natural fiber such as coconut fiber has certain physical and mechanical characteristics that can be utilized effectively in the development of reinforced concrete material. Coconut hair is used as a fibre in ferrocement panel. The strength of coconut hair is very high hence it provides more tensile strength to ferrocement. 1% of coconut hair is used to increase the strength of ferrocement. For good binding with mortar, it is added during mixing of cement and sand.

Figure No.2 Coconut hair

2.1.6 Jute Fiber

India is one of the large jute producing country. Jute is an important fibre with a number of advantages. Jute has high specific properties, low density, less abrasive behavior to the processing equipment, good dimensional stability and harmlessness. We used jute as a mesh in ferrocement. It is also taken as 1% of total weight of ingredient. It is added in the form of layer within the layer for binding with the cement mortar. The thickness of jute is 1.5mm and its size is same as wire mesh. It is also laid with the covering of 100mm from all sides of panel. The location of jute is above the mesh in between the mortar is placed.

Figure No 3 jute fiber

III. Result And Discussion

On the basis of study and system development, following are the result obtained.

3.1 Ferrocement Panels With Chicken Mesh Only

Ferrocement panels are made with chicken mesh only as reinforcement. The material used in these panels is cement, sand and chicken mesh. Initially cement mortar is prepared with mix proportion of 1:3 and water cement ratio of 0.45. Then this mortar is placed in panels size of 550mm*150mm*40mm.Chicken mesh is laid in the form of layer at the bottom and top of the panel. The size of the mesh is 540mm*140mm.The ultimate load result are as under

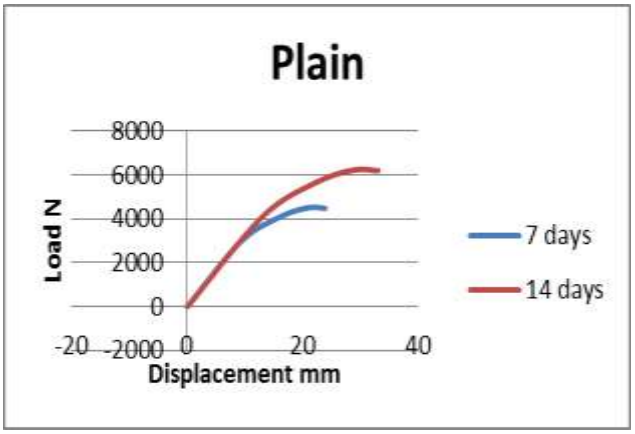

Figure: 4 Load Vs Displacement

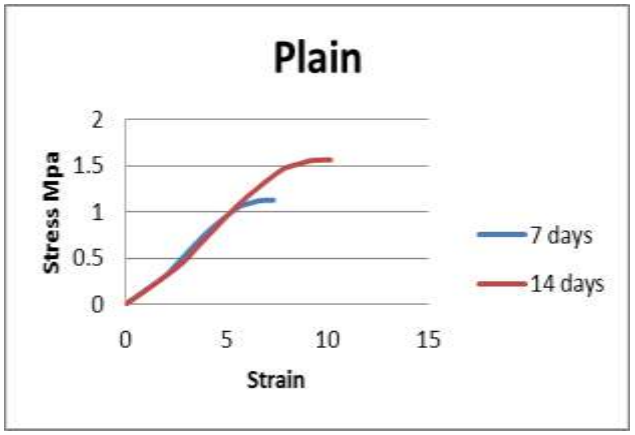

Figure No 5 Stress Vs Strain

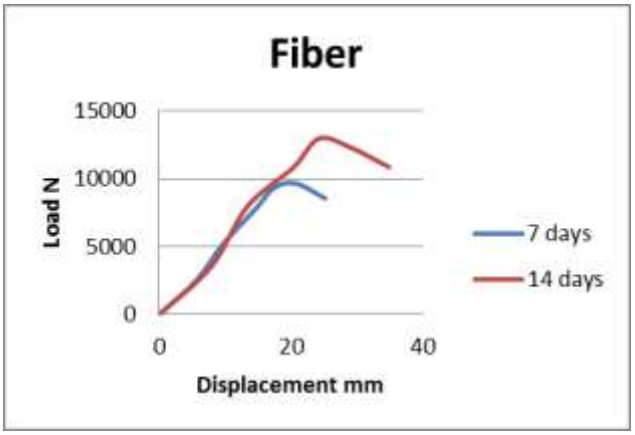

Figure No 6 Load Vs Displacement

3.2 Ferrocement Panel With Coconut Hair As A Fibre

Ferrocement panels are made up of chicken mesh as a reinforcement and coconut hair is used as fiber with 0.5% by weight.The material in these panels are cement, sand, chicken mesh and coconut Hair. Initially the cement mortar is prepared with mix proportion of 1:3 and water cement ratio of 0.45. Then this mortar is placed in panels size of 550mm*150mm*40mm.Chicken mesh is used in the form of two layers in the panel. The size of the mesh is 540mm*140mm.The coconut Hair is mixed with cement mortar at the time of mixing of cement and sand. The ultimate load of each panel showed in figure.

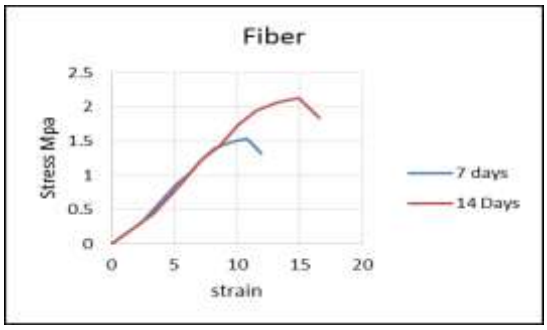

Figure No 7 Stress Vs Strain

3.3 Ferrocement Panel With Coconut Hair And Jute

Ferrocement panels are made up of chicken mesh as a reinforcement and coconut hair is used as fiber with 0.5% and jute 1% by weight. The material in these panels are cement, sand, chicken mesh, coconut Hair and Jute. Initially the mortar is prepared with mix proportion of 1:3 and water cement ratio of 0.45. Then this mortar is placed in panels size of 550mm*150mm*40mm.Chicken mesh is used in the form of two layers of the panel and jute is placed in between these two layer with cement mortar which having the same size as mesh. The size of the mesh is 540mm*140mm.The coconut hair is mixed with cement mortar at the time of mixing of cement and sand. The ultimate load result as shown

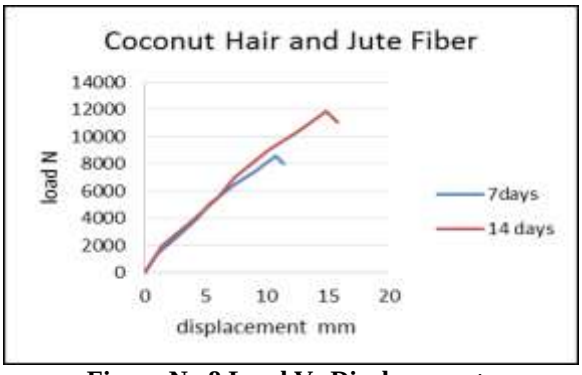

Figure No 8 Load Vs Displacements

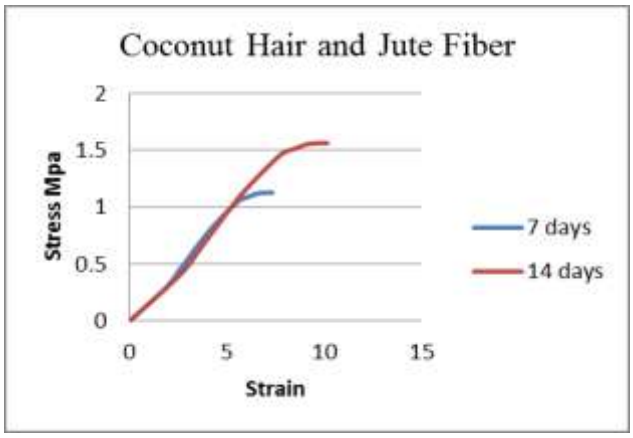

Figure No 9 Stress Vs Strain

IV. Conclusion

The whole study describes the development of light weight sandwich panels which could be used as wall element in all type of low and medium rise buildings. After considering low water cement ratio the durability is enhanced. The panels are rein-forced with to maximize ductility and energy absorption properties. Such panels can be used to great advantage in both developing and developed countries. The outcome of this study shows that the fiber layer resulted in a significantly improved flexural behavior. The ultimate load of panel with fiber is higher than that of plain panel and also panel with fiber and jute is higher than plain panel as well as panel with fiber. These result open up new promising areas for the repair and strengthening of existing structure due to previous deterioration or, e.g, new requirements regarding actual or specified load.

References

[1]. Febrin A Ismail, M Sofian Asmirza, *Abdul Hakam and Fauzan," ferrocement - brick sandwich wall applied to non-engineered houses", *International Journal of GEOMATE, April, 2018 Vol.14, Issue 44, pp.47-51, 2018.*

[2]. Yousry B. I. Shaheen,Zeinab A. Etman,Ahmed G. Ramadan*," Characteristics of Ferrocement Lightweight Wall", Iran University of Science and Technology 2016.*

[3]. S. Grija, P. Sivakumar, K. N. Lakshmikandhan, R. Ravichandran, B. Karthikeyan, *International Journal of Applied Engineering Research ISSN 973-4562 Volume 9, Number 18 (2014) pp. 4645-4657.*

[4]. R. Alavez-Ramirez a, F. Chiñas-Castillo b,⇑, V.J. Morales-Dominguez a, M.O Guzman, *Thermal conductivity of coconut fibre filled ferrocement sandwich Panels a Research Center for Interdisciplinary Regional Development (CIIDIR-IPN) Unidad Oaxaca, Oaxaca, Oax., C.P. 71230, Mexico.*

[5]. V.BHIKSHMA1, RAVANDEKISHORE and R.SRINIVAS, Durability of Polymer and Modified Ferro Cement Elements, Department of Civil Engineering, *University College of Engineering Osmania University Hyderabad, India.*

[6]. Hassan M.H. Ibrahim, Shear capacity of ferrocement plates in flexure, Civil Engineering Department, *Faculty of Engineering, Port-Said University ,Egypt.*

[7]. A.W. Hago a,*, K.S. Al-Jabri a, A.S. Alnuaimi a, H. Al-Moqbali a, M.A. Al-Ultimate and service behavior of ferrocement roof slab panels, a *Department of Civil and Architectural Engineering, Sultan Qaboos University, P.O. Box 33 Al-Khodh 123, Sultanate of Oman.*

[8]. Hani H. Nassif *, Husam Najm, Experimental and analytical investigation of ferrocement–concrete composite beams, Department of Civil and Environmental Engineering, Rutgers, *The State University of New Jersey, 98 Brett Road, Piscataway, NJ 08854, USA.*

[9]. Masood, M. Arif *, S. Akhtar, M. Haquie Performance of ferrocement panels in different environments *Civil Engineering Department, Aligarh Muslim University, Aligarh 202 002, India.*

[10]. M.A. Al-Kubaisy a,U, Mohd Zamin Jumaatb Flexural behaviour of reinforced concrete slabs with ferrocement tension zone cover a Engineering Faculty, Muscat College of Management Science and Technology, P.O. Box 2910, Ruwi, *Oman civil Engineering Department, University Malaya, Kuala Lumpur, Malaysia.*

[11]. G. Singh & G. J. Xiong Ultimate Moment Capacity of Ferrocement Reinforced with Weldmesh *Department of Civil Engineering, University of Leeds, Leeds, UK, LS2 9JT.*

[12]. P. Paramasivam, K. C. G. Ong & C. T. E. Lim Ferrocement Laminates for Strengthening RC T-Beams *Department of Civil Engineering, National University of Singapore, Kent Ridge Crescent, 0511 Singapore.*

[13]. P. Paramasivam," C. T. E. Lim & K. C. G. Ong Strengthening of RC Beams with *Ferrocement Laminates Department of Civil Engineering, National University of Singapore, 10 Kent Ridge Crescent.119260 Singapore, Singapore.*

[14]. S.P. Shah Theoretical Models for Predicting the Performance of *Fiber Reinforced Concrete Journel of Ferrocement Vol 18. No. J. July 1988.*