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A REVIEW PAPER ON FERROCEMENT ROOFING SYSTEM

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ABSTRACT

The present study describes the results of testing flat Ferro cement slab panels reinforced with 2 layers of chicken wire mesh. The main objective of this work is to study the effect of using 2 layers of chicken wire mesh on the flexural strength of flat Ferro cement slab panels and to compare the effect of varying the number of wire mesh layers and use of steel reinforcement the ultimate strength and ductility of Ferro cement slab panels. The no of layers used are two, three and four. Slab panels of size (1m X 1m) with thickness 30 mm are reinforced with chicken wire mesh with varying no of layers of mesh. Panels were casted with mortar of mix proportion (1:1.75) and water cement ratio (0.4) including admixtures with dosage of 1. 1% of total weight of cement. Panels were tested under two point loading system in UTM machine after curing period of 28 days. Test result shows that panels with more number of layers exhibits greater flexural strength and less deflection as that compared with panels having less number of layers of mesh.

Keywords- *Ferro cement; Wire Mesh, effect, Flexural Strength, Ductility, Ultimate Strength, Layers, panels, admixtures and steel reinforcement*

I. INTRODUCTION

"Ferro cement is a type of thin wall made up from reinforced concrete commonly constructed of hydronic cement mortar reinforced with layer of continuous small size of mesh." Mesh is made up suitable materials and the metallic materials. Its gives greater elasticity and resist to cracking given to cement mortar by extreme subdivisions and distribution of the reinforcement. A large number of civil infrastructure in the word are in a state of serious deterioration today due to carbonation, chloride attack, etc. It is a very durable, cheap and versatile material. In 1940 Pier Luigi Nervy, an Italian engineer, architect and contractor, used Ferro cement first for the construction of aircraft hangars, boats and buildings and a variety of other structures. Ferro cement is a highly versatile form of reinforced concrete made up of wire mesh, sand, aggregate, water and the cement, which possesses unique qualities of strength and serviceability. Over the years, applications involving Ferro cements have increased due to its property strength, toughness, water tight, lightness, durability, and most important stability.

II. LITERATURE REVIEW

S. DeepaShri and R.-They carried out an experimental work on Ferro cement panels for studying their flexural behavior by using polypropylene fibers. Fume is added to reduce the dosage .Chemical admixture needed to get required slump result. It is well known that addition of steel or glass fibers will generally improve the ductility, toughness, flexural strength and reduce the deflection of cementations materials. In the present study, polypropylene fibers are added to the matrix and the dosage of fibers is taken as 0.4% by weight of the cementations materials. Weld mesh is arranged in the different layers in Ferro cement slab instead of reinforcement also. Weld mesh of size 590 mm X 290 mm with grid size 20 mm X 20 mm and 1.2 mm dia. skeleton reinforcement is used for casting of Ferro cement slabs panel. The slab panel size was 750mm X 300mm X 25mm and 30mm. The authors conclude that the load carrying capacity of Ferro cement slab panel with 0.3% fibers is larger compared to without fibers, delayed the first crack load, yield load and ultimate load compared to without and there is an increase in strength with the increase of slab thickness. Hybrid reinforced Ferro cement specimens sustain the larger deflections at both yield and ultimate loads compared to the SCC Ferro cement specimens. Micro cracks are formed before failure of the specimens in many form, indicating more energy absorption and ductility, the stiffness of the specimens with 2-layers bundled weld mesh is lower than that of the specimens with 3 layers bundled or wounded.

Mohamad N. Mahmoud Sura A. Majeed.-Carried out an experimental work on flat and Ferro cement slab panels for studying their flexural behavior. The panels tested for flexure are of size 1m X 1m with 30mm thickness for both flat as well as plain slab panels. The wire mesh used was mild steel galvanized chicken wire mesh of 0.5 to 0.65 mm diameter and 12.5 mm grid size. From his experimental work the author concludes that the cracking load was not significantly affected by the number of the wire mesh.Mesh particularly use for the panels. The also concludes that the flexural strength of the panel increased by 40 to75% for panels having 2 and 3 wire mesh layers compared with that of single layer; while for the folded panel the percentage increase in the flexural strength using 2 and 3 layers folded panel 60 to 80% compared with that of plain mortar panel.

M.N.Soutsos, T.T. Le, A.P. Lampropoulos- carried out an experimental project involved casting and testing of slab panels using UTM(Universal Testing machine) panels were tested for flexural strength with maximum capacity of 4.5 to 5.0 KN. Concrete was mixed in batch. 3 panels for testing at 3-days, 7-days and 28-days of size 1m × 1m.The experimental program includes preparing and testing of flat Ferro cement slab panels under two-point loading.

III. MATERIAL SPECIFICATION

Materials

Ordinary Portland Cement (Grade 53), Sand -:Passing through 2.36 mm I. S. Sieve, Admixture (Parma) Water – Ordinary Drinking Water or potable water , Mesh Used – chicken Mesh of 0.5 to 1.5 mm Diameter

Mix Proportion

Cement sand ratio (1:1.75).Water cement ratio (0.4). A total of 3 panel (1m×1m) of above proportion were casted with and without steel.

Constituents of Ferro cement include the hydraulic cement mortar which should be designed according to the standard mix design procedures for mortar and concrete which includes Ordinary Portland cement(O.P.C), water(potable), sand , wire mesh and admixtures.

Cement:

The cement should be fresh. It should be uniform consistency and free of lumps and foreign matter. The type or grade depending on the application or use.

Water

Potable or drinking water is good for use as mixing water as well as for curing Ferro cement.

Fine Aggregates

Normal weight fine aggregate with properties clean, hard, and strong free of organic impurities and deleterious substances and relatively free of silt and clay are used.

Wire mesh

Steel meshes for Ferro cement includes square woven or square welded mesh and chicken wire mesh of hexagonal shape and expanded metal mesh. Some mesh are galvanized. Properties of the resulting Ferro cement product can be expected to be affected by mesh size, ductility, manufacturing process and treatment due to handling.

Admixtures

There are many type of admixtures available, chemical admixtures is best suitable for ferrocement because it reduces the reaction between matrix and galvanized reinforcement. Chemical admixtures used in Ferro cement serve one of the following purposes like water reduction, improve in impenetrability, air entrainment, which increases resistance to freezing and thawing action.

IV. HISTORY OF FERROCEMENT

Joseph Louis Lambot a horticulturist experimented with plant pots, seats and tubs made of meshes and plastered with sand and cement mortar replaced his rotting rowing boat. He called this material as “Ferciment” in a patent which he took in 1852. There was very little application of true Ferro cement construction between 1888

&1942 when Pier Luigi Nervi began a series of experiments on Ferro cement. He observed that reinforcing concrete with layers of wire mesh produced a material possessing the mechanical characteristics of an approximately homogeneous material capable of resisting high impact. In 1945 Nervi built the 165ton Motor Yatch "Prune" on a supporting frame of 6.35mm diameter rods spaced 106mm apart with 4 layers of wire mesh on each side of rods with total thickness of 35mm.It weighed 5% less than a comparable wooden hull &cost 40% less at that time.

In 1948 Nervi used Ferro cement in first public structure the Tutrin Exhibition building, the central hall of the building which spans 91.4m was built of prefabricated elements connected by reinforced concrete arches at the top &bottom of the undulations. In1974 the American Concrete Institute formed committee 549 on Ferro cement. ACI Committee 549 first codified the definition of Ferro cement in 1980 which was subsequently revised in 1988,1993 and 1997(AE Naaman2000) of Portland cement, 805 kg/m3 of sand, 1190 kg/m3 of gravel and 189 kg/m3 of water. The total water–cement ratio was 0.71. It appears that the incorporation of steel fibres increased the compressive strength by about 4 and 5 N/mm for fibre dosage rates of 30 kg/m3 and 50 kg/m3. The increases in the compressive strength of synthetic fibres is lower, about 2–3 N/mm2 for dosage rates of 4.5–5.3 kg/m3. Incorporation of steel fibres also appeared to increase only slightly the flexural strength, i.e. by about 0.4–0.6 N/mm2 for the plain concrete value of 4.2 N/mm2. The most important parameters for the design of ground supported slabs are the flexural toughness and the equivalent flexural strength ratio. The flexural toughness of concrete increases considerably when steel and synthetic fibres are used.

Properties of Ferro cement Composites

- Mesh wire diameter 0.5 to 1.5 millimeters
- Size of mesh opening 6 to 35 millimeters
- Maximum use of 12 layers of mesh per inch of thickness of specimens.
- Maximum 8% volume fraction in both directions
- Maximum 10 square inches per cubic inch in both directions.
- Thickness 10 to 50 millimeters
- Steel cover 2 to 5 millimeters
- Ultimate tensile strength up to 35 MPa
- Allowable tensile stress up to 15 MPa
- Modulus of rupture up to 65 MPa
- Compressive strength up to 30 to 79 MPa

V. CASTING OF SPECIMEN

In this section we provide the numerical example to illustrate the models developed in the previous section. The The above specimens, and placed on thick plywood plank , after demoulding. The contact surfaces of the mould to the plywood bottom and sides were oiled before casting for easy dismental of specimens. The cement mortar was property mixed in a dry pan by adding required amount of water. For 30mm thick cementitious slabs with 2 layer mesh, the cement mortar is laid for 7 mm on the bottom of mould and well-compacted, and then single layer mesh is placed (at centre of slab) over the finished mortar, and the balance 7 mm mortar is laid with good compaction, and top surface finished. For 2 layer mesh, the cement mortar was laid for 3 mm cover area , and the first layer of mesh was placed on the finished compacted cover mortar; and then, above the first mesh layer, 7 mm mortar was laid and property finished; and next, second layer mesh has been placed, and finally the top cover area of 3 mm was spread above this second layer and top slab surface well-finished using straight edge. Similar process of laying for 3 layer mesh was done,e expect that the additional mesh layer has been placed in the centre of the slab. The specimens were demoulded after 24 hours and been transferred to the curing tank where they were allowed to cure for 28 days. After sufficient curing, ferrocement were removed from the water tank, surface dried and white washed at the top surface so as to have a clear picture and propagation of cracks during flexure test.

VI. TESTING OF SPECIMEN

A special flexure loading frame was exclusively fabricated for testing the slab panels and the details of the test set up. In order to test the slabs on a two point loading, over an effective span of 1 m, the centre line of the panel, and the roller supports were marked and ferrocement panel was seated on the bottom rollers. Then these two roller

supports were slowly raised by means of hydraulic jack till the panel touched the top roller support. Loading was applied manually through a hydraulic jacking arrangement to cause upward deflection in order to facilitate easy measurement of deflection and crack width and also to study the crack pattern. The load was given through the jack in small increments and the mid-span deflection of the centre of the slab was recorded up to failure using an external LVDT. The proving ring readings and displacement values were observed simultaneously. The proving ring readings have been taken at every 5 division interval and the corresponding deformation values were observed in the displacement indicator. The loading was continued till the ultimate failure of the slab panels is reached, and the above measurements were taken at different load levels until final failure. The initial and final crack width was measured using a crack detection microscopic. offerrocement composites using different reinforcing mesh types.

Advantages of ferrocement

There are many advantages of ferrocement. Some of the common and major advantages are listed below.

- Raw materials are available in most of the countries.
- It can be constructed in any shape.
- Labor is not required to be very experienced.
- Construction work is easy, less weight and durable.
- Cost of the construction materials is low.
- Provide resistance to fire, corrosion and earthquake.

Disadvantage of ferrocement

There are also some disadvantages of ferrocement which needs to be in consideration before using it. The disadvantages are as below.

- Number of labor will be higher.
- Rust can be developed on reinforcement if not covered properly by mortar.
- It is hard to do welding etc properly.
- Binding rod and mesh along can be time consuming.

Application of ferrocement

- Residential and public buildings
- Industrial structure
- Agriculture structure
- Transportation structure

VII. CONCLUSION

Based on experimental test results the following conclusion scan be made.

- The flexural loads at first crack and ultimate loads dependon number of reinforce mesh layers used in the Ferro cementpanel
- Increasing the number of layers of wire mesh from 2 to 4layers significantly increases the ductility.
- Presence of steel fibers also increases the flexural strength of panels.

REFERENCES

1. *Koshelev, F. F., A. E. Kornev, and N. S. Klimov. Obshchaiatekhnologiiareziny. Moscow, 1968.*
2. *Dogadkin, B. A. Khimiiaelastomerov. Moscow, 1972.*
3. *F R Eirich. (Ed.) Science and Technology of Rubber. Academic Press. New York, 1978.*
4. *Hofmann, W. Vulkanizatsiiaagenty. Moscow, 1968.*
5. *J A Brydson. Rubber Chemistry. Applied Science Publishers Ltd. London, 1978.*
6. *James E. Mark, BurakErman (eds.) Science and technology of rubber. p. 768, 2005.*
7. *Conesa, J.A., Galvez, A., Mateos, F., Ignacio Martín- Gullón, I., Font, R., Organic and inorganic pollutants from cement kiln `stack feeding alternative fuels. Jounal of Hazardous Materials 158, 585–592, 2008.*

ISSN 2277 – 5528
Impact Factor- 4.015

8. *Corti, A., Lombardi, L., End life tyres: alternative final disposal processes compared by LCA. Energy 29, 2089–2108, 2004.*
9. *Courtemanche, B., Levendis, Y.A., A laboratory study on the NO, NO2, SO 2, CO and CO2 emissions from the combustion of pulverized coal, municipal waste plastics and tires. Fuel 77 (3), 183–196, 1998.*
10. *De, S.K., Isayev, A., Khait, K., Rubber Recycling. CRC Press Taylor & Francis Group, 2005.*