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Flexural Strength Of Ferrocement Panels Using Low Cost Steel Fibers

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Abstract

Ferro-cement is a type of thin wall reinforced concrete commonly constructed of hydraulic cement mortar reinforced with closely spaced layers of continuous and relatively small wire mesh. The mesh may be made of metallic or other suitable materials. Ferro-cement has a very high tensile strength-to-weight ratio and superior cracking behavior in comparison to conventional reinforced concrete. The aim is to study the flexural test on ferro- cement of the suitable panel for model making. Casting of ferro-cement panel with steel fibers using proportions of 2% and 4% with cement.

Keywords: Ferrocement panels , Flexural strength , mix design , low cost steel fibers.

I. INTRODUCTION

Ferrocement:

Cement and concrete are used interchangeably but there are technical distinctions and the meaning of cement has changed since the mid-nineteenth century when ferrocement originated. Ferro- means iron although metal commonly used in ferrocement is the iron alloy steel. Cement in the nineteenth century and earlier meant mortar or broken stone or tile mixed with lime and water to form a strong mortar. Today cement usually means Portland cement, Mortar is a paste of a binder (usually Portland cement), sand and water; and concrete is a fluid mixture of Portland cement, sand, water and crushed stone aggregate which is poured into formwork (shuttering). Ferro- concrete is the original name of reinforced concrete (armored concrete) known at least since the 1890s and in 1903 it was well described in London's Society of Engineer's Journal but is now widely confused with ferrocement. The advantages of a well builtferro concrete construction are the low weight, maintenance costs and long lifetime in comparison with purely steel constructions. However, meticulous building precision is considered crucial here. Especially with respect to the cementitious composition and the way in which it is applied in and on the framework, and how or if the framework has been treated to resist corrosion.

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Ferrocement Technology:
Shelter is one of the basic needs of human being. But more than 80 developing countries in the world suffer from housing shortages resulting from population growth, internal migration, war, natural disaster, to mention a few. Most dwellings in rural areas are made of cheap local materials including low quality wood (which is easily attacked by termites), scrap metal, thatch and/or earth products (like clay, mud, sand, rock/ stone) which are temporary and unsafe. There is an urgent need to explore a building material that is structurally efficient but at the same time, should be lightweight, eco-friendly, cost effective and especially the ones that can perform the desired functions (Akhtar et al. 2009). Ferrocement is such a material that is slim and slender but at the same time strong and elegant (PushyamitraDivekar, 2011) which provides a potential solution to roofing problems (Abdullah and Takiguchi, 2003), with an history of ancient and universal method of building huts by using reeds to reinforce dried mud (wattle and daub) (ACI Committee 549-R97).

II. PROPERTIES OF FERROCEMENT

Ferrocement has a high tensile strength and stiffness and a better impact and punching shear resistance than reinforced concrete, because of two-dimensional reinforcement of the mesh system on a per volume basis (Naaman, 2000); and undergo large deformations before cracking or high deflections before collapse (Naaman, 2000; Moita et al., 2003; Memon&Sumadi, 2006; Patil and Prakash, 2009). High surface area imparts ductile characteristics to ferrocement even though mortar is weak in ductility; hence meshes of both square and hexagonal apertures are adopted (Doshi et al., 2011). Specific surface (which is the contact area of reinforcement per unit volume of matrix) of ferrocement of 25 mm (1 in.) thick is 62,795 mm^2 /sq.m (9 sq.in./sq.ft) as compared to RCC slab of 100 mm (4 in.) thick whose specific surface is 3,375 mm^2 /sq.m (0.5 sq.in./sq.ft) The modulus of elasticity of ferrocement with CM 1:2 is comparable with M40 grade concrete and CM 1:3 is of M35 grade concrete, and the compressive strength of cement mortar 1:3 (cement: sand) is about 20 MPa (2900 psi) (Doshi et al., 2011).

III. OBJECTIVES OF EXPERIMENTAL STUDY

- Study the flexural tests experiments performed on ferrocement.
- Selection a suitable panel for our experiment and model making.
- Study the properties of low cost steel fibers.
- Prepare a fabrication mould for casting of the slab panels.
- Casting the ferrocement panel with varying mesh layers and steel fibers.
- Proportions used will be 5%, 10%, 15% of steel fibers with cement.

IV. LITERATURE REVIEW

Flexural behaviour of flat and folded ferrocement panels by Mohammad Mahmood Civil Engineering department Mosul University Iraq-

The paper describes the results of testing folded and flat ferrocement panels reinforced with different number of wire mesh layers. The main objective of these experimental tests is to study the effect of using different numbers of wire mesh layers on the flexural strength of folded and flat ferrocement panels and to compare the effect of varying the number of wire mesh layers on the ductility and the ultimate strength of these types of ferrocement structure. Seven ferrocement elements were constructed and tested each having (600x380mm) horizontal projection and

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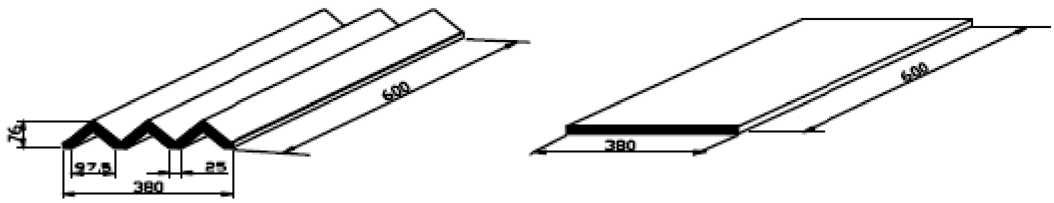
20mm thick, consisting of four flat panels and three folded panels. The used number of wire mesh layers is one, two and three layers. The experimental results show that flexural strength of the folded panels increased by 37% and 90% for panels having 2 and 3 wire mesh layers respectively, compared with that having single layer, while for flat panel the increase in flexural strength compared with panel of plan mortar is 4.5%, 65% and 68% for panels having 1, 2 and 3 wire mesh layers respectively. The strength capacity of the folded panels, having the particular geometry used in the present study, is in the order of 3.5 to 5 times that of the corresponding flat panels having the same number of wire mesh layers.

Experimental Program Geometry of the specimens: The tested ferrocement elements consist of three folded panels and four flat panels. The dimensions of the folded and flat panels are shown in Fig. (1) which depicts that the horizontal projection of the folded panel is equal to (380x600mm) which is equal to the dimensions of the flat panel. The thickness of all the elements is equal to 20mm. The number and designation of the tested elements are given in Table (1). In handling the folded panel without wire mesh, it failed along the longitudinal folds after removing it from the mold so it has been excluded for the test results. The panels are constructed using the conventional ferrocement materials, which is composed of cement mortar and square wire meshes.



(a)Folded panel **(b)Flat Panel**

Fig 1 Folded and flat panels

V. TEST RESULTS

Abbreviation :

E1:- Panel of plain mortar
E2:-Panel using 2% steel fiber
E3:- Panel using 4% steel fiber

Table 1: Test results for sample E1, Thickness of panels=20mm ;Number of Mesh layers=2

Load(kg)	**Deflection(mm)**		
	E11	**E12**	**E13**
0	00	00	00
20	0.04	0.05	0.05
40	0.10	0.12	0.12
60	0.15	0.22	0.23

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80	0.29	0.31	0.37
100	0.40	0.41	0.38
	First cracking Load = 80kg	First cracking Load = 80kg	First cracking Load = 60kg

Table 2: Test results for sample E2, Thickness of panels=20mm ;Number of Mesh layers=2 Steel fiber2%

Load(Kg)	Deflection(mm)		
	E21	**E22**	**E23**
0	00	00	00
20	0.02	0.05	0.01
40	0.08	0.10	0.09
60	0.12	0.15	0.13
80	0.21	0.23	0.22
100	0.27	0.26	0.28
120	0.35	0.34	0.33
140	0.38	0.39	
	First cracking load = 120kg	First cracking load = 100kg	First cracking load = 100kg

Table3: Test result for sample E3, Thickness of panels=20mm, Number of mesh layers=2 Steel fiber 4%

Load(Kg)	Deflection(mm)		
	E31	**E32**	**E33**
0	00	00	00
20	0.03	0.05	0.04
40	0.07	0.06	0.09
60	0.09	0.10	0.13
80	0.15	0.13	017
100	0.21	0.20	0.19
120	0.27	0.25	0.26
140	0.29	0.30	0.32
160	0.32	0.36	0.34
	First cracking load = 120kg	First cracking load = 140kg	First cracking load = 120kg

Table 4: Flexural Strength of ferrocement panels of 700*200*20*mm dimension

Specimen and size	Panel Number	Cracking load(N)	Ultimate load(N)	Flexural strength at cracking load(N/mm2)	Flexural strength at ultimate load (N/mm2)

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E1	E11	800	1000	7	8.75
	E12	800	1000	7	8.75
	E13	600	1000	5.25	8.75
E2(2%)	E21	1200	1400	10.5	12.25
	E22	1000	1400	8.75	10.5
	E23	1000	1200	8.75	10.5
E3(4%)	E31	1200	1600	10.5	14
	E32	1400	1600	12.25	14
	E33	1200	1600	10.5	14

VI. CONCLUSION

- Load carrying capacity and flexural strength of ferrocement panels increases as the percentage offibres increases.
- Flexural strength of panels tested with steel fibre is greater than plain mortor panel.
- Increase in flexural strength of panels with increase in percentage of steel fibres upto certain limit.
- Flexural strength of panels using 4% steel fibre panel is more than 2%steel fibre panels.

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