



Ferro-Cement: An Alternative to Ordinary Concrete in Construction Industry

Aditya D. Karnawat¹, Harsh S. Mehta², Hitesh J. Mistry³, RutujaDhawle⁴

Dept. of Civil Engineering, Thakur College of Engineering and Technology, Mumbai, India¹

Dept. of Civil Engineering, Thakur College of Engineering and Technology, Mumbai, India²

Dept. of Civil Engineering, Thakur College of Engineering and Technology, Mumbai, India³

Dept. of Civil Engineering, Thakur College of Engineering and Technology, Mumbai, India⁴

Abstract: Ferrocement is reinforced composite material which is highly versatile that can be used in construction of different structural components like flooring and roofing elements, boats & water tanks. Ferrocement is used for serving various purposes because of its advantageous properties like light weight, less crack & cost effectiveness. Ferrocement is made with reference to ACI 549, 1997 and ACI 318,2008. Ferrocement has wide range of applications and is widely used in developed countries and its use is also increasing in developing countries like India, China etc. Ferrocement is slightly different due to absence of coarse aggregates while addition of special type of Chicken Mesh as well as polypropylene fibers in certain proportions. When all such components are combined they provide good results as compared to ordinary concrete structures constructed now-a-days. In this paper, strengths of concrete and ferrocement cubes are being studied.

Keywords: Ferro-cement, flooring, roofing, boats, water tanks.

I. INTRODUCTION

Ferro - cement is a thin construction material with its thickness varying anything between 15-40mm. In any case the thickness of the member is not likely to exceed 2 inches (i.e . 50mm) except in certain cases. Ferrocement draws its resemblance from ordinary reinforced concrete whose thickness seldom is less than 100mm. Ferrocement is quite similar to ordinary reinforced concrete with the exception that it does not contain coarse aggregates. Also in place of heavy steel reinforcement light chicken wire mesh (available in varying thickness and opening size) is used. Also, some small proportion of polypropylene fibers are added which serve the purpose of crack arresting. Hence due to this presence of wire mesh and fibers as well as small thickness ferrocement is less likely to develop cracks. Ferrocement uses the tension stiffening effect to control the cracks. Tension stiffening effect is the ability to resist tension and provide stiffness to the member. It is well known that plain mortar may not be able to carry tension if as it is extremely weak in tension, thus this presence of wire mesh and fibers increases its resistance to cracks. As flexural cracks start to develop in plain mortar, the energy stored in the material eventually gets converted to fracture energy. This energy advances existing cracks and causes the mortar to soften at relatively high rates. This behaviour improves the softening response by introducing the tension stiffening effect, which causes the average concrete stress in tension to gradually reduce to zero as the cracking intensifies.

II. CASE STUDY

A. Case Study of Water Tank

Site Address: J.A. Desai, Mahant Road, Near Ruhia High School, Vile Parle East, Mumbai-400057

Type: Water tank for fire fighting purpose using ferrocement beams

Capacity Of Tank: 20000 litres.

Dimensions of Water Tank: 9.6m x 3.4m x 0.7m

Beams required for construction of tank were manufactured as precast units at Chembur facility and transported to the site where all components were attached together by welding. Chicken wire mesh was already attached to beams as per requirement hence the only work at the site was to pour the cement paste mixed with certain fixed proportion of Silica Fume and polypropylene fiber. The walls of the tank were around 2 inches (50mm) thick. Tank was placed on the terrace of the building on small supports. Any form of attachment was not made between the tank and the supports thereby providing the advantage that tank can be easily lifted as a whole structure and shifted as per convenience.



III. CONSTITUENTS OF FERRO – CEMENT

Cement: High and best quality cement shall be used. Generally, 53 grade cement is used. Cement used shall conform IS code 269:1969. Cement used is mostly OPC but in some cases PPC may also be used. It should be stored under dry conditions and for as short duration as possible Sand:-Normally wet sand is the most commonly used in Ferro - cement. It should be free from silt and clay. It should be inert with respect to other materials used and of suitable type with respect to strength, density, shrinkage and durability of the mortar made with it.

Water: Potable water shall be used while manufacturing process i.e. water shall be free from any organic matter. It shall also be noted that saline and chlorinated water is not accepted for ferrocement.

Reinforcing mesh:-This is the most essential component of ferrocement. Various type of wire meshes are available in market with their thickness varying and various type of size and shape of the opening. The only and main requirement of wire mesh is that it shall be easily and cheaply available. It must be quite flexible enough so that can be easily bended at corners if required.

Types:

1. Welded wire mesh
2. Hexagonal wire mesh
3. Woven Wire mesh

Polypropylene Fibers: These prove to be essential component of ferro cement. They are added during the batching process. Thousands of individual fibres are then evenly dispersed throughout the concrete during the mixing process creating a matrix-like structure.

Feature:

1. Increased cohesion of the mix.
2. No requirement for crack control steel mesh.
3. Concrete placement and crack control in ONE operation.
4. Reduced bleeding.
5. Less expensive (per m²) than conventional steel mesh reinforcement.

Rapid Hardening Admixture: Hardening accelerator for concrete which increases the early strength of concrete without reducing the ultimate strength. Increases high early stage strength development at 6–24 hours. Sika 3 admixture was used at the site.

Water Repellent: Increase water repellency and reduce water penetration and absorption in all types of cement-based construction materials. This easily used admixture makes such materials more hydrophobic and resistant to the structural damage or appearance problems caused by excess moisture and sunlight (UV) degradation. Impermo, PWR, etc can be used.

IV. PROCEDURE OF CASTING

Initially they bind the chicken mesh on either side of steel grill of appropriate size using binding wire. Mortar is been prepared of required quantity. The wire mesh which has been prepared earlier is been kept on the vibrator machine and the mortar is been poured or filled in the wire mesh of steel grill and is been stabilized by using hand trowel.

After completing the process of filling and stabilizing the mortar, the vibration is done. This allows the escape of entrapped air and reduces the voids which remained unfilled by hand trowel. In a similar manner numbers of structural members are casted. These casted members are then allowed to set and harden for 24 hours. Spraying curing is done to gain the required strength.

1. Fine sand (2.5 ghamelah)
2. Cement (1 ghamelah)
3. Admixture (corniche chemical powder 500 grams)
4. Fiber (1 gram per sq.m).

V. OBJECTIVES

To evaluate tension stiffening effect of Ferro - cement with polypropylene fibers. To evaluate tension stiffening effect of Ferro - cement with polypropylene having double layers of hexagonal mesh at top and bottom with polypropylene fiber having varying percentage of fiber (0.00%, 0.10%, 0.15%, and 0.20%). To evaluate tension stiffening effect of Ferro - cement with polypropylene 28 days curing. To establish correlation between different fiber percentage in Ferro-cement and ultimate failure of specimens.



VI. ADVANTAGES & DISADVANTAGES

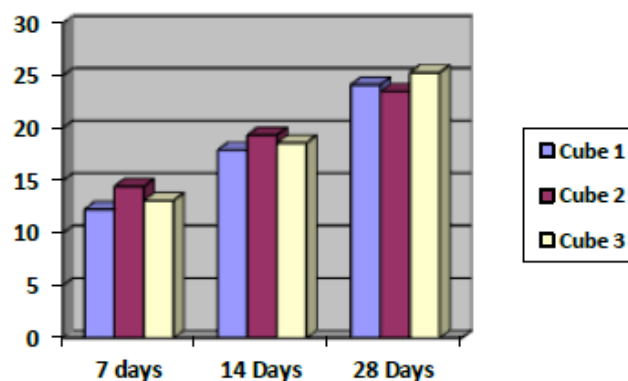
Advantages: One of the major advantage of ferrocement is that it is light in weight due to absence of heavy coarse aggregates and steel reinforcement. Also, being very thin it reduces the dead load of the structure thereby helping in achieving economy. Ferrocement possesses extreme temperature resistance hence does not undergo unequal expansion and contraction due to varying temperature. Being precast and light weight, it can be easily transported to any site required without any problem. It is durable and chemically inert and can better resist against environmental factors as compared to ordinary concrete. Also, in case some portion of the structure is damaged due to some circumstances it can be easily and cheaply replaced which is not possible in ordinary reinforced structures. Additional advantages provided by ferrocement are that it is sound and vibration proof. It does not require any form of periodic maintenance and also the maintenance cost is restricted.

Disadvantages: Waterproofing to R.C.C. structure is carried out with modern material known as Ferro - cement. It is carried out generally in two layers of about 8 mm thickness each layer. It consists of wire mesh reinforced cement matrix layers which are vibrated in situ. The top surface also vibrated finished smooth with non-metallic fibres impregnation. The cement matrix and wire mesh layers are laid alternately. Each cement matrix layer is laid on a bond coat for assured integrity. Each wire mesh layer is fixed with u-clips to the base. The performance of the treatment is most excellent. Because in situ low water cement ratio cement matrix is vibrated and become dense with nil/negligible pores. The wire mesh layers generally two nos. prevent crack formation, if at all due to shrinkage, temperature or structural relative movements. Therefore the treatment is durable and permanent. It takes care and care efficiently due to certain admixtures. The wire mesh layers add strength to the main structure in addition to crack formation prevention. It is laid on insulated foundation layer of about average thickness of 40 mm. There will be dead load reduction to conventional brickbat coba treatment. It adds strength to base structure.

VII. TESTING OF CONCRETE

Concrete cubes of size 150mmx150mmx150mm were prepared and tested after 7, 14 & 28 days. Concrete of grade M20 was prepared to be compared with ferrocement cubes. The strength of cubes after respective days was as follows: -

Sr. No.	Weight of Specimen (kg)	Age in days	Total load (KN)	Ultimate Comp Strength (MPa)	Avg of 3 Specimen (MPa)
1	8.676	7	276	12.27	13.25
2	8.526	7	325	14.45	
3	8.450	7	294	13.10	
1	8.500	14	403	17.92	18.63
2	8.452	14	435	19.34	
3	8.350	14	420	18.60	
1	8.650	28	543	24.13	24.31
2	8.560	28	529	23.51	
3	8.520	28	569	25.29	





VIII. CONCLUSION

Thereby it is concluded that using ferro-cement over conventional cement gives various benefits: -

Since ferro-cement is made using some proportion of polypropylene fibers it acts as better crack arrester. Due to the presence of the fibers prolongation of cracks is restricted ultimately increasing the durability structure. Ferro-cement provides better abrasion resistance as compared to ordinary concrete. Having improved thermal resistance ferro-cement does not undergo unequal expansion or contraction due to variation of temperature thereby further increasing the durability. Ferro-cement also does not absorb any water or dirt and is also inert thereby does not react with chemicals. In case of ferro-cement construction cost is reduced due to use of less quantity of materials. Furthermore, ferro-cement does not require frequent maintenance. Also due to absence of reinforcement steel and use of chicken wire mesh ferro-cement acts as much lighter thereby reducing the dead load of the structure. Structure constructed using ferro-cement can be constructed at much faster pace as compared to ordinary structure.

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