

FERROCEMENT AN AFFORDABLE HOUSING MATERIAL FOR LOW COST HOUSING

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ABSTRACT

Affordable housing projects are characterized by an increasing demand mainly due to urbanization. The selection of building materials should meet the needs of local conditions to improve quality of life for the most needed ones by building new structures and/or by improving existing structures. Ferro cement as a construction material attracted considerable attention from research workers, field applicators and economists. Its property of improved homogeneity compared to R.C.C. and reduced thickness made it possible to employ the material as substitute to timber, steel and asbestos cement as material. Ferro cement is supposed to be a product of low level technology. Ferro cement is ideally suited for thin wall structures as the uniform distribution and dispersion of reinforcement provide better cracking resistance, higher tensile strength to-weight ratio, ductility and impact resistance. The applications of ferro cement structural elements are highlighted in this paper.

Keywords: ferrocement, sunscreens, Urban, demand, Life, Affordable, building Material

1.Introduction

In the early 1970's, labour intensive ferrocement construction was viewed as particularly suitable for countries, the applications of ferrocement must be viewed from a different perspective due to the competitiveness in the construction industry and the increase in labour cost coupled with

shortage of skilled construction workers. In order to alleviate these problems, mechanised production and proper choice of reinforcements must be pursued to ensure the cost competitiveness and speed of construction. construction technique and to evaluate their performance in service. Ferrocement as a construction material attracted considerable attention from research workers, field applicators and economists. The simplicity of operation involved in the making of fibrocement made it popular, first in the war-affected Europe and later, now in the developing countries. Its property of improved homogeneity compared to R.C.C. and reduced thickness made it possible to employ the material as substitute to timber, steel and asbestos cement as material. Ferro cement is supposed to be a product of *low* level technology. As is true for all such technology, good and bad products can be made from the same set of materials, the difference being in the understanding and skill of the operatives. The salient features of the design, construction and performance of these ferrocement structural elements are discussed briefly in this paper.

2. Technology

Ferro cement is a type of thin reinforced concrete, commonly constructed of cement mortar reinforced with closely spaced layers of continuous and relatively small wire mesh. The mesh may be metallic or of any other suitable material. In reinforced concrete, larger diameter steel bars are placed whereas smaller diameter wire meshes are buried in cement mortar in Ferro cement. As the diameter of the bars are smaller, the bonded area increases considerably and consequently the tensile strength of Ferro cement increases. For example One 6 mm diameter bar in concrete is replaced by four numbers of 3 mm diameter wires for equivalent area in the form of welded mesh in Ferro cement. The same area of steel is replaced by 36 numbers of GOG wires of chicken mesh. These smaller diameter bars increases the area of contact with mortar. The fundamental assumption in loaded concrete member is that at the point of bonding, the strain in steel is equal to the strain in concrete. In Ferro cement, the number of contact points is more as the bars are smaller. Hence, the Ferro cement elements behave better in pre-cracking stage, more as a homogenous material.

Multiple layers of steel welded mesh, wire mesh and small diameter steel bars embedded in a rich cement mortar and thin elements are formed. Ferro cement reinforcement can be assembled into its final desired shape and mortared. The term Ferro cement means the combination of a ferrous Product with cement. The use of non-metallic meshes (natural fabrics, jute bamboo, etc.) is being experimented in different parts of the world. There is a saving in the cost of formwork and material. Ferro cement is especially advantageous because of its lower dead weight and higher strength. Since the reinforcement is finely distributed through the section, only very fine cracks are developed under service loads. This property is utilized to the maximum in the application of Ferro cement water tanks. Ferro cement components are used in housing and this is even cheaper than timber.

The Ferro cement technology is relatively new. The product being more homogenous can replace many of the manufactured metals and natural materials like timber. Ferro cement is more efficient when subjected to direct tensile forces or in zones where tension is predominant. It is also efficient when nearly equal tensile and compressive forces are to be resisted, as in shelves, sheets, etc.

3. Application Of Ferrocement

Ferro cement is generally used in sunshades, cupboards, water tanks, partition walls and roofing elements. Where timber is very expensive, Ferro cement beams or trusses may be used to replace wooden structures. Ferro cement service core-units suit very well to 'sites and service' scheme. Different types of Ferro cement roofing elements have been developed for economically weaker section housing with lower thermal comforts. Ferro cement housing components can be produced as pre-fabricated elements suitable for both rural and urban housing schemes.

3.1. Ferro cement Rafters

Timber is used as rafters in trusses and other roofing elements. Ferro cement can replace these timber products in housing. Fire-resistance of Ferro cement is an excellent property for its use as a substitute for timber. Ferro cement cupboards for storage of goods in residential houses and other buildings have been developed.

3.2. Liquid Storage Structures

The properties of Ferro cement are best suited for liquid storage structures. Impermeability is the prime characteristic of Ferro cement. Small capacity tanks of 500 liters to 10,000 liters are commonly used in residential buildings. As compared to the conventional overhead water tanks made of brick, concrete and steel, Ferro cement water tanks are cheaper in cost. Moreover, it reduces the weight of the structure.

3.3. Ferro cement Core Units

Ferro cement service core units are cloisters used for toilets. They can be cast as bathroom units, toilet units or in combination. This is made up of 3 cm walls, floor and roof and needs very little formal foundation. These are best suited for the sites and services scheme where the water and sewerage distribution is assured before development of housing area.

3.4. Matrix

The mortar matrix used in Ferro cement consists of cement and well-graded sand, passing through 2.36 mm sieve. Water cement ratio in Ferro cement products vary from 0.3 to 0.55 by weight. A workable mix generally is to be achieved such that the mortar penetrates and surrounds the mesh reinforcement and will have only acceptable level of shrinkage and porosity. Standard admixtures may be used to increase plasticity and to reduce water. Such mortar used for Ferro cement is usually of high compressive strength varying from 350 to 600 Kg/cm^2 .

4. Fabrication Procedure

First step in making the Ferro cement is that of making reinforcement skeleton embedded with required fixtures, for application of cement mortar. The determination of the quantity of steel reinforcement is an essential part of design similar to R.C.C. During the application of mortar, reinforcement skeleton will get distorted. Suitable temporary stiffeners are to be placed in position to keep the required profile of the skeleton. These sorts of stiffeners are necessary because there is no shuttering required for Ferro cement products.

Application of mortar needs careful consideration and understanding of the behavior of the structure. When the bottom slab of a tank is cast, care is taken to spread the mortar first on the platform to get the required cover and then the steel skeleton is placed on top of the spread mortar. Then the slab is finished to the required thickness on the first casting itself. Vertical application of mortar alone is on a different method. The first coat of mortar is forced inside the skeleton and just left to be set with a rough surface. On the second day, the mortar is applied to the required thickness and cover and smooth finish is achieved.

5. Problems In Implementation

While the basic principles of design are simple to follow, the freedom exercised in construction of reinforced concrete cannot be taken in Ferro cement. Essentially one is dealing with a thickness of 2 to 4 cm and steel wires of 0.5 to 3 mm diameter. The cement mortar used is of a mix not less than 1:3. Hence, in dealing with a fine material one has to be extremely careful about skill of operation. There have been instances where one could not make reinforcement element in thickness less than 4 cm whereas the specification demand 2 cm or less. This is particularly important when the skill of bar benders, masons, plasterers are not at a level as it should be handling of elements, especially the volumetric precast elements can also present problems. Reversal of stresses on thin elements is to be particularly taken care about.

6. Areas Of Research

Ferro cement is inherently a durable material because of the micro-cracking around cement mortar, the even distribution of steel and the rich cement content. The partial galvanization of the chicken mesh employed in the skeleton may also help in durability. However, concrete structures are found to be increasingly on attack from the increasingly polluted atmosphere. The conditions will be worse in patently corrosive atmosphere of a chloride or supplied bearing environment. Experiences in the past have indicated that:

1. Mix design and fineness of sand in mortar can help durability.
2. A minimum cover of 4 mm is necessary for the outer steel.
3. A cement mortar with maximum size aggregate of 2.38 mm is desirable.

4. Galvanized steel mesh prevents corrosion.
5. Epoxy or chlorinated rubber paints are beneficial as coatings.
6. Workmanship in maintaining uniform cover for steel will help.
7. Delayed loading of the elements reduce cracking.

7. Conclusion

Shelter is a basic human need next only to food and clothing. At the end of the 10th Five Year Plan, the housing shortage is estimated to be 24.7 million. However, urban areas in our country are also characterized by severe shortage of basic services like potable water, well laid out drainage system, sewerage network, sanitation facilities, electricity, roads and appropriate solid waste disposal. The history of Ferro cement goes back to 1848 and many regarded it as the earliest use of reinforced concrete. Its cost is lower than conventional construction materials because one does not need shuttering, scaffolding, vibrator and mixers which cuts down infrastructures costs.

Adaptability to local conditions, unlike conventional building elements like concrete slabs etc. Ferro cement elements can be manufactured by semiskilled laborers. It is cost-efficient and can be easily maintained. It has high resistance to destruction by natural forces (rain, fire, termites) Ferro cement units being thinner than normal concrete products, a properly carried out curing procedure was very important.

Ferro cement is a versatile structural construction material possessing unique property of strength and serviceability It is made with closely- knit wire mesh and mild steel reinforcing bars filled with rich cement mortar. Welded mesh may also be used in place of reinforcing bars. The materials required for making it namely cement, sand, wire mesh and mild steel reinforcing bars.

To over come inconsistent quality and exorbitant cost of timber, an alternative substitute for making doors and window shutters with Ferro cement has been successfully developed. Ferro cement is application of rich cement sand mortar normally 1:3 or 1:2 proportions and can be made to get any shape with mild steel sections/bars and more than layer of chicken/wire mesh/expanded mesh etc. Ferro cement technique can be used for lintels shelves, doors, window

frames, water tanks etc. Building center is already using this technology in manufacturing doors and water tanks in India.

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