EXPERIMENTAL INVESTIGATION ON FERROCEMENT WATER TANK

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Abstract: Ferrocement is the oldest form of the reinforced concrete, dating back two centuries. It is composed of mortar and galvanized steel wire mesh. It is used for a wide range of application including construction of boats, water tanks, slabs and roofs, and lining of tunnels. Properties such as high strength/weight ratio and good resistance to cracking and impact loadings are bringing ferrocement under the spotlight again. Ferrocement is a type of thin wall reinforced concrete, commonly constructed of hydraulic cement mortar, reinforced with closely spaced layers of continuous and relatively small size wire mesh. The mesh maybe made of metallic or other suitable materials. One particularly popular use for ferrocement is water tank construction. Ferrocement resists cracking very well and due to its thinness, uses very little cement. The major materials to be used are steel mesh, rebars, Portland cement, fine aggregate, water and suitable admixtures. The tank is then casted for 2 days and plastered for another 2 days and then left dry for another day. So, the time taken to completely cast the tank is 5 days. Curing of tank is then done for about 28 days. Steam curing can also be done incase of shorter duration of curing. The casted tank is then tested by means of pumping water into the tank at very high pressure. Pumping is done until the tank starts vibrating heavily. The value of pressure is measured with an air pressure gauge and is noted in psi. The outcome expected is that water tank constructed using ferrocement is approximately 20 to 30% cheaper than RCC tank with high strength and durability. Keywords: Ferrocement, Rebar, Welded steel mesh, Fine aggregate and Lace ties

Introduction: Ferrocement tanks water have the ability to store water in hygienic condition at cheap rate and more durable. A prototype test is also conducted to ensure structural integrity, assess operational performance, prepare and document detailed drawings, bill of quantities and construction steps. This booklet summarizes the underlying design concept of improved large ferrocement water tanks and presents easy-to-follow construction details with relevant drawings, bill of quantities and necessary guidance.

Literature Survey:
ACI committee 549 (1999) Ferrocement is a type of thin wall reinforced concrete commonly constructed of hydraulic cement mortar reinforced with closely spaced layers of continuous and relatively small size wire mesh. The mesh maybe made of metallic or other suitable materials.

Onet and Magureanu (1946) The effect of loading direction upon the cracking and deformation of ferrocement members subjected to bending. Ferrocement is generally a flexible material and a very flexible one is the sections, which are under reinforced. The long-term deformation factors established by means of strains (or) deflections indicate that the long-term deflections influences the behaviour of beams much more than the instantaneous one.

Hugo Wainshtok Rivas (1994) discussed the use of prefabrication technology in the fabrication of ferrocement precast elements. He made a comparative study on the technical and economical analysis of precast ferrocement elements with other systems. It was observed that ferrocement advanced favourably than other systems. He clearly states that in the prefabrication of ferrocement elements, quality and strength can be achieved by use of metallic moulds, small travelling
cranes for lifting the elements, employment of vibrating table to achieve the right compactness of the mortar in the moulds and curing by immersion in pools. He has suggested that ferrocement construction system can be used for the urbanization of towns and cities combining it correctly with other systems, eradication of slums, emergency houses in case of natural disasters and the development of rural communities.

Al-Rifaie and Trikha (1990) have investigated the efficiency of various arrangements of hexagonal mesh reinforcement of 0.7 mm diameter in 500 mm × 500 mm ferrocement slabs of thickness 20 mm and 30 mm, tested under patch loads on simply supported condition over a span of 450 mm. The specimens were cast using cement sand mortar of 1:2 proportion and a water cement ratio of 0.45. It was found that the arrangement consisting of twin layers with two meshes orthogonally oriented and placed in contact is superior to the other arrangements of meshes unidirectionally oriented or alternative layers equally spaced with orthogonally oriented meshes. The load deflection behaviour was linear upto the first crack load. There was 16.7% increase in first crack load for 20 mm thick models and 11% to 24.4% increase for 30 mm thick models when compared to the other arrangements.

Basunbul et al. (1991) The parameters considered in the experimental investigation were number of mesh layers, the skeletal steel, and the web mesh reinforcement. It was observed that the number of ribs and the presence of web mesh reinforcement play an important role in developing full moment capacities. Increasing the number of wire mesh layers improves stiffness and rigidity in the cracked region and not in the uncracked region.

Mansur and Paramasivam (1982) proposed a method to predicate the ultimate strength of the ferrocement in flexure based on the concept of the plastic analysis, where ferrocement is considered as a homogenous and a perfectly elastic-plastic material. Simple equations were derived for the direct design of a cross-section. Experimental investigation were also conducted to study the behaviour and strength of ferrocement in flexure. It was found that the ultimate moment increase with increasing matrix grade (w/c ratio) and increasing volume fraction of reinforcement and that the method developed can give satisfactory prediction of the ultimate moment capacity of ferrocement.

Austriaco and Pama (1952) have discussed the various factors, which affect the durability of ferrocement namely mortar composition, permeability, corrosion of reinforcement and construction practices. Each of the above factors was well discussed and field studies were also presented. Finally they have concluded that field studies must be undertaken to verify the predictions in practice.

Vijay Raj (1960) conducted studies on utilization of lime for improving durability of ferrocement. For the experimental investigations CM 1:3 was prepared using w/c ratio 0.45 and fresh hydrated lime powder 15% (by weight of cement) was added and finally mixed in a concrete mixer. This mix was utilized for conducting slump test to find the workability. Reference mix was kept without lime dosage. The durability characteristic was determined by exposing ferrocement with lime in varying concentration of sulphuric acid for 30 days. Specimens for the above study were prepared by fabricating 3 mm M.S rod skeletal grid over the 20 SWG chicken mesh and plastered. It is found that there is an improvement in durability by reducing the permeability and addition of lime has improved the workability of the mortar.

**Experimental methodology**

**Volume Calculation:**
- Tank height: 0.5 m
- Inner diameter: 0.28 m
- Outer diameter: 0.30 m
- Tank wall thickness: 0.1 m
- Reinforcement bars: 6 mm
- Mesh type: Welded square mesh
- Mesh size: 8*24*3
- Grade of cement: 53 grade
- Grade of concrete: M25

**Water capacity**

\[
\text{Volume} = \pi r^2 h
= 3.14 \times 0.14 \times 0.14 \times 0.5
= 0.030 \text{ m}^3
\]

So, the capacity of the tank = 0.030 m³
Testing
Water pressure can be measured in three common units, bar, psi and Head (m).
1 bar = 10 metres Head = 100 psi.
0.1 Bar (100 psi) is equal to approx one metre of height between the bottom of the water tank and the outlet of the tap or shower.
So according to this method, 0.5 meter height of water sustains 50 psi of pressure.

Conclusion
The goal of the current research is studying the feasibility of ferrocement water tank in design and construction of structures. Previously tanks constructed by ferrocement were of capacity ranging from 5 cubic meters to a maximum capacity of about 10 cubic meters. The most common capacity would range about 7 cubic meters. There was always a doubt that ferrocement construction cannot hold on more than 10 cubic meters. But we have proved here that definitely it is capable of holding capacity of about 60 cubic meters. Also tanks constructed of ferrocement is much stronger when it is constructed with 6mm bars and closely knit welded square mesh rather than any other meshes because welded square meshes have the tendency to hold onto the reinforcement more rigid owing to its even distribution of steel thereby making the entire structural skeletal frame more stronger than ever.
This study has brought out that ferrocement construction of water storage tank is extremely economical and at the same time with no compromise in strength, rigidity and workability. At the time of theoretical design we thought that it can be approximately 10 to 20% economical than the conventional RCC tank and could be just about slightly easier with less labour internas of construction. But from the results presented above and our test experiences have proved that it is atleast 40% economical than the conventional RCC tanks if not 50% or more and also it is extremely easier internas of construction since it does not require formwork or shuttering by any means.

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