Construction of Ferro Cement Water Tank by using Chicken Mesh wire

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Abstract - *'Water tank', basically it is a small or large size of container which store the water for various purposes such as drinking, domestic use, industrial etc , here; In This project design a cylindrical Ferro cement water tank for domestic use. It is a cylindrical cross section of which is the combination of chicken wire mesh and steel rods and cement with roof top. It is a 8000-10000 lit capacity water tank. Cost analysis of water tank has been done. In this water tank we use chicken mesh wire which is flexible hence easily mould in cylindrical shape. Because of chicken mesh wire load distribution of tank is good , hence it is uniformly distributed.; because of this risk of cracking in tank wall can reduce. We can build tank with uniform or without formwork (which is temporary), hence ease of construction increase. Ferro cement is a cheaper construction method with durable structure. Cost of construction is less than RCC construction and the method is more convenient than other traditional methods.*

Key Words: **Ferrocement, Water tank, Analysis, Cylindrical tank, Chicken mesh wire.**

1. INTRODUCTION

Ferro cement water tank is the more convenient method in construction industries. Construction of ferro cement water tank are made up of chicken wire mesh& steel rods, they are coverd with layer of cement – sand mortar. These tanks are suitable to construct where there is less water sources, or in emergency areas such as camps of armed forces, or in draught prone area. For drinking, domestic, gardening purpose. These water tanks are simple to construct & their cost is cheap. Ferro cement water tanks are maintenance free, it can save maintenance cost. In highrise buildings, steel tanks are commonly used to store water for domestic use and this may be due to the availability of steel tanks in the prefabricated form. However, the use of such steel tanks has many disadvantages like high cost, rusting and consequent deterioration of the quality of stored water, frequent maintenance and limited life-span due to corrosion. A study is conducted to investigate the performance and practical application of ferro cement as an alternative to steel in the construction of prototype water tanks.(1). Tanks resist corrosion effect due to salty water. These kind of tanks can be constructed for large capacity storage , they are light in weight structure. This study has brought out that ferro cement 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 interms of construction.(2).We constructed tank in cylindrical shape to eliminate bending forces , & to store more water . Ferro cement is proposed to construct of water tanks with high strength, crack resistance, high ductility, impact resistance and energy absorption properties suitable for rise buildings. This paper presents the results of an analytical study of proposed ferro cement water tanks. The cement sand matrix of the ferro cement composite was designed to achieve high compressive, tensile and flexural strengths for the produced ferro cement tanks.(3). Roof top is provided as covered for water tank, hence it protect from contamination of water ; vents are provided for ventilation to circulate air in tank, it also helps for cleaning

2. MATERIAL REQUIRED OF CONSTRUCTION PROCESS OF TANK.

1. Cement
2. Sand
3. Water
4. Chicken Wire Mesh.

- **Cement:** Ordinary Portland cement of grade 43 conforming to IS: 8112-1989 which was stored in a cool and dry place before used Physicalproperties of cement, is found compressive strength at 28 days is 44.10 N/mm square.
- **Sand:** Fine aggregate used in the light weight Ferro cement is taken from river bed. This river sand is mostly free from all impurity and organic matters.
- **Water:** Ordinary potable drinking water free from organic matter, silt, oil, sugar, chloride and acidic material was used for mixing.
- **Chicken mesh wire:** The mesh wire holds the cement mortar placed and helps to make the ferro cement construction more durable. The ideal mesh is a 13 x 13 mm, 19 gauge will prove to be the best from a practical point of view.(4).

3. CONSTRUCTION PROCEDURE OF FERRO CEMENTWATER TANK:

- **PREPARATION OF FOUNDATION** : FOR THE PROTOTYPE, THE FOUNDATION CONSISTS OF COMPACTED SOIL AND SAND UP TO 0.5 M ABOVE THE EXISTING GROUND LEVEL.
  - ➢ concrete hollow blocks with vertical bars along the circumference at about 20-30 cm center to center can be used.
  - ➢ Mark the location of the foundation perimeter (circular ring).
  - ➢ Lay the blocks.
  - ➢ Insert the vertical bars (dia. 6 or 9mm, 20-30 cm c/c); fill the holes with cement mortar. Large Ferro-Cement Water Tank – UNHCR, July 2006 - 10.
  - ➢ Fill the space with soil/sand. At least top 10 cm should be filled with sand.
  - ➢ Compact the soil using a compacting hammer or other devices.
  - ➢ Wet the sand with water and compact.
- **Preparation of Lean Concrete Base**: This layer should be laid over the foundation. Generally, 5-6 cm thick lean concrete (typically a mix of 1: 3: 5 by weight) is used.
- **Preparation of Base Slab Reinforcement** : In this prototype, two layers were prepared outside the tank area and transferred by lifting. Generally 4 to 6 persons are required for moving and placing the reinforcement.
- **Laying Base Slab Reinforcement** : The two layers of slab reinforcement were placed in their final position. The distance between the layers can be controlled using small separators made up of crushed concrete pebbles or pre-cast pieces.
- **Erecting L-bars Along the Wall-Base Junctio**n: L-shaped bars are used both for strength and to improve constructability. It is difficult to fix the long vertical bars (1 to 2.5 m) to the base slab reinforcement at this stage. at least two (the top and bottom) circular rings and then fix the L-shaped bars as anchor bars.
- Placing Vertical Dowel/Fixing Plate/Bars for Central Column: placed along the perimeter, 4-8 bars can be placed at the location where the central column is to be erected.
- **Casting the Base Slab**: : After fixing therebarfor slab, the central column and the peripheral L-shaped bars, the slab can be concreted. The concrete (1:2:4 by weight) can be mixed at the site or can be ordered from the ready-mix supplier.
- **Erecting Vertical Reinforcement and Stiffeners for the Wall**: These should be read in conjunction with the Sections on Material Specifications and Drawings, as that is where dimensions and quantities are provided.
- **Keeping Openings for Construction and Pipe Works:** A temporary access opening should be provided for the movement of theworkers inand out of the tank during construction. The size of the opening should be large enough for one person to enter the tank. This opening will be plastered at the end. Large Ferro Cement Water Tank(4).
- **Fixing the Wire (Chicken) Mesh (WM1 and WM2) :** The mesh is wrapped around the wall reinforcement and fixed with tie wire at a few locations. It is convenient to start from the bottom and move upward. About 10 cm of overlapping is recommended at discontinuous ends. Both inner and outer layers should be placed before starting the plastering.
- **Preparation and Fixing of the Central Column:** The mortar filling of the pipe or tube may or may not contain the reinforcement. There are two methods for preparation: either the column can be prepared completely outside and fixed at its final position or alternatively, all the work, including placement of rebar and fixing of the top plate, can be performed when it is erected. Large Ferro Cement Water Tank (4).
- **Plastering the Wall:** The first step for plastering is the preparation of the mortar (sand and cement only, ratio 1:2) with a workable consistency (limiting water cement ratio in the range of 0.35 to 0.45 by weight gives the optimum results.
- **Preparation of Roof Shallow Truss:** Eight roof trusses of about 10 cm depth made up of 9mm (top and bottom) and 6 mm (vertical and diagonal) welded bars are used to stiffen the roof.
- **Fixing Roof Trusses Roof Stiffeners**: The roof stiffening trusses are welded with the top of C-channels in the wall at the lower end and with the column top base plate at the other end. These trusses are braced laterally by similar trusses at their mid length, forming an octagon.

- **Placement of Roof Reinforcements**: radial bars can be curtailed at mid length along the roof surface. The portions of the vertical bars extending above the height of the wall are bent into the roof.
- **Providing Openings in the Roof:** At least one manhole should be constructed as access to the tank's interior for inspection, cleaningand repair purposes. An additional bar of 9mm can be placed along the perimeter of the opening.
- **Plastering of Roof Trusses:** The process of plastering these trusses is similar to that for walls.
- **Temporary Formwork for Plastering Roof Surface :** This requires a temporary formwork for supporting the wooden plank/plywood. A plank/plywood may be supported by 2-3 props.
- **Plastering the Temporary** Openings : These areas should be the last items to be plastered. Now the roof opening should be used an access.
- **Finishing the Surface** : The excess mortar and uneven surfaces should be brushed off to finish the surface. The exterior of the tank should be painted with a cement coat of a preferred shade, and the periphery of the plinth should be back filled with a layer of grass-turf on the top and drainage developed to avoid accumulation of rainwater.

4. SUITABLE CONDITIONS FOR CONSTRUCTION OF TANK.

- Avoid construction where big trees are planted, because of their roots they may crack the wall of tank.
- Avoid construction , where there is heavy vehicle or continues flowing traffic around tank.
- Avoid construction , where there is high accessibility of water , hence they can damage the tank during flood situation ; tanks have to construct in drought prone areas. (5).been defined in the abstract. Abbreviations such as IEEE, SI, MKS, CGS, sc, dc, and rms do not have to be defined. Do not use abbreviations in the title or heads unless they are unavoidable.

5. Design of Tank

- **Step I : Fixing of dimensions**

If we have to select a suitable size for a circular water tank to store 10,000 liters of water, it is to be noted that the dimensions of tank should be calculatedbased on its capacity. (IS 13356 : 1992)

For Cylindrical tanks, generally, the ratio of Height to diameter of tank is taken as 1.0

... Capacity of tank = 10,000 liters =10,000/1000 = 10m3

... Capacity of tank = 10m3

Also, a freeboard of atleast 75mm shall be provided. (IS 13356 : 1992)

So assume Freeboard (f) = 0.3m =300mm

Assume height of tank (h) = 2.3m =2,300mm

Now, Height (depth) of tank (H) =height of tank + freeboard

H = h + f

... H = 2.3m

+ 0.3m

... H = 2.6m

Now, Tank Volume = Base Area xeffective depth of tank (He)

Where, effective depth = 2.30 – 0.30 =2m.

$$10m3 = (\pi D^2)/4 \times He$$

…….. [where D = Diameter of tank]

$$10m3 = (\pi D^2)/4 \times 2$$

By solving, we get, D = 2.52m ≈ 2.6m

... (height of tank)/(diameter of tank)=2.6/2.6=1.0

... ratio of height / diameter = 1.0Hence, Okay.

- **Step II: Design Constants**

Now, the minimum compressive strength of cement mortar shall be of 25N/mm2.

So, here let us use M25 grade ofconcrete.

For HYSD bars, σst = 230 N/mm2 σcbc = 8.5 N/mm2

Modular ratio (M) = $280/3\sigma cbc=280/(3 \times 8.5)=10.98$

Neutral axis depth factor (k) = m

.σcbc/(m .σcbc+ σst)

8.5)/(10.98 ×8.5+230)

= (10.98 ×

= 0.288 mm

Lever arm (J) = 1 - k/3 = 0.90

Moment of Resistance (Q) = ½ x σcbc

x k x J

= ½ x 8.5 x

0.288 x 0.90

= 1.1016

- **Step III : Thickness of Wall (t)**

Now,

t = 30H + 50

= 30 x 2.6 + 50

=128mm≈130mm

As per IS 13356 : 1992, the minimum wall thickness for ferrocement water tank of larger capacity i.e. more than 1,000 to 2,000 liters shall be atleast 20mm to 40mm depending upon the capacity.

Hence, Okay.

- **Step IV : Design for cantilever action**

... h = H/3=2.6/3=0.86 ≈1m

- **Step V: Design of Tank Wall**

Maximum hoop tension at base = wHD/(2)=(9800 ×2.3 × 2.6)/(2) = 29302 N/m

Using 12mm bars, Area (A) = (π)/(4

×100) x diameter2 = (π ×12 ×12)/(4

×100) = 113mm2

Spacing of hoop bars = 1000 x 113/64 = 1775 mm = say 1770mm

Hence, provide 12mm Ø bar @ 1770mm c/c in both direction.

Actual Ast = 2 x (1000 ×113)/1770= 128mm2

The spacing of ring may be increased towards the top, since pressure varies lineearly

Using a tensile stress of 1.2N/mm2 for the the combined section,

Thickness T is given by, T = 29302/(1000 T+ (11-1) ×128)=1.2

From which T = 23mm.

Minimum thickness = 3xD +5

Distribution reinforcement,

Asd = 0.3 – 0.1 ((119-100)/(450-100)) = 0.2945714 %

Distribution reinforcement area = 0.29/100 ×119 ×1000=351mm2

Provide half the reinforcement near each face, Asd = 175.27 mm2

Using 8mm Ø bars, A = (π × ×8 × 8)/(4 ×100)=50mm2

The spacing of 8mm Ø bars = 1000 x 50/175.27=280mm c/c

Therefore, provide 8mm Ø bar @ 280mm c/c.

- **Step VI : Design of Slab Base**

Meridional thrust per metre lengthof dome at its base. = 116116 x 1 x 0.1 = 11612

Horizontal component T per metre length .=

11612 cos 81 =

11612 x 0.045801527 = 532

Alternatively, p2 = F2 Cot f2 = 11541 x 0.046 = 532.6615385

hoop tension = 532 x 2.60 = 692 steel required = 692 / 230 = 3mm2

using 12 mm bars, Area (A) = (3.14xdia2) / (4 x 100)= (3.14 x 12 x

12) / (4 x100) = 113mm2

No.of hoop Bars = 3 / 113 = 1 No. ≈ say 2 No.

Hence Provided 2No. 12 mm F Ring bar, for symetry.

Actual, Ast = 2 x 113 = 226mm2 Equivelent area of composite section of beam of area of cross section

A is = A + (m-1)Ash = A + (10.98 – 1

) x 226 = A + 2256.2784

Allowing a stress of 1.2 N/mm2 in composite section we have,

= 692/(A+2256.2784)=1.2

... Provide 8mm Ø strirrups @ 100 mm c/c to tie ring beam.

6. MAINTENANACE OF WATER TANK :

Ferro cement water tank design is a simple design, no complication in opening & closing wall; hence they are easy to maintain. They are very low maintenance tank. Vents are provided for ventilation & for cleaning of tank in while. We need to keep clean surrounding area of tank with brushes, screen must be provided in tank for draining out off water without clogging, taps of tank have to be check in three or six months . If contamination of water take place we need to clean the water as soon as possible by chlorination process. If any type of leakage form we have to repair it properly & immediately. These kind of tanks doesn't create major problems , little care & proper design tank is important , hence it achieve long life of tank .

7. ADAVANTAGES OF FERRO CEMENT TANK:

i.) Raw materials are available in most of the countries.
ii.)It can be constructed in any shape.
iii.)Labour is not required to be very experienced or skilled.
iv.) Construction work is easy, light weight and durable.
v.) Provide resistance to fire, corrosion and earthquake.
vi.) The total cost of construction is very less as compared to traditional construction methods.

8. DIADVANTAGES OF FERRO CEMENT TANK:

i.) It is hard to do welding and binding works properly.

ii.) Binding of mesh wire and steel rods can be time consuming.

9. CONCLUSION OF CONSTRUCTION OF FERRO CEMENT WATER TANK :

On this project basis, when we compared between RCC constructed tanks and ferro cement tanks , it conclude that, ferro cement tanks are more convenient , flexible to construct, they are light in weight , because of mesh wire, no heavy concrete layers . hence it ultimately impact on expenditure of project. Chicken wire mesh are mould in any shape, hence no complex construction needed. Hence ferro cement tank are good in all aspects.

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