

Design of Rectangular Ferrocement Water Tank

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Abstract: In rural areas, ensuring reliable and cost-effective water storage solutions is paramount for addressing water scarcity challenges. Traditional tank materials such as Reinforced Concrete Cement (RCC), steel, and PVC present various drawbacks including high costs, susceptibility to cracks, and environmental concerns. This project focuses on exploring the feasibility and advantages of rectangular ferrocement water tanks as an alternative solution. Ferrocement tanks offer a promising alternative due to their enhanced durability, cost-effectiveness, and environmental sustainability. Unlike RCC and steel tanks, ferrocement tanks exhibit resistance to cracks and corrosion, ensuring long-term structural integrity with minimal maintenance requirements. Moreover, ferrocement construction utilizes locally available materials and employs eco-friendly practices, reducing environmental impact and promoting sustainability. Through a comprehensive analysis encompassing construction processes, cost-effectiveness, water quality preservation, and community acceptance, this project highlights the superiority of ferrocement technology over traditional tank materials. The study demonstrates that ferrocement water tanks provide a viable and sustainable solution for rural communities, offering improved access to clean water resources and contributing to socio-economic development.

Keywords: Ferrocement, Sustainability, Cost-effectiveness, Water quality, Community Acceptance, Crack-resistant tanks, Low-maintenance tanks, Durability.

1. Introduction

Water storage and supply challenges persist in many developing countries, particularly in decentralized rural areas, where ensuring a reliable and cost-effective water supply remains a complex endeavor. While urban centers may not directly face water scarcity, extending water supply to remote rural locations poses intricate issues, leading communities to resort to collecting and storing rainwater or alternative sources, often with unhygienic practices exacerbating waterborne diseases. Various non-traditional structures like reinforced concrete, steel, and asbestos cement tanks have been considered, each with drawbacks including high costs, health hazards, and limited durability. In this context, ferrocement water tanks emerge as a promising alternative, offering a more economical yet quality solution. This study aims to explore ferrocement tanks, comparing them to conventional options, to address critical water storage challenges in rural communities. The significance lies in potentially providing a sustainable solution, impacting rural development positively by improving water quality and accessibility. Objectives include investigating conventional and ferrocement tanks, selecting optimal designs, and validating effectiveness through analytical and experimental approaches.



Fig 1 : Ferrocement work

1.1 Importance

Importance of Ferro cement tank is determined as follows:

1. Addressing water scarcity
2. Cost effectiveness
3. Improved durability
4. Environmental sustainability
5. Resilience to natural disasters

1. *Addressing Water Scarcity:* In rural areas, where water is scarce, affordable water storage solutions are crucial for irrigation and domestic use.
2. *Cost-Effectiveness:* Ferrocement tanks offer a significantly cheaper alternative to RCC tanks, reducing the financial burden on villagers for setting up gardens and water storage systems.
3. *Improved Durability:* Unlike RCC tanks prone to cracks, ferrocement tanks are crack-resistant, ensuring a longer lifespan and reduced maintenance costs.
4. *Environmental Sustainability:* With less cement and steel usage, ferrocement construction aligns with eco- friendly practices, minimizing environmental impact.
5. *Resilience to Natural Disasters:* Ferrocement's flexibility and shock resistance make it ideal for areas prone to seismic activity, ensuring water security even during disasters.

1.2 Objective

The following are the objectives:

- a. Demonstrate Construction Process
- b. Compare Performance Against Traditional Tanks
- c. Cost-Effectiveness Analysis
- d. Water Quality Assessment
- e. Environmental Impact Study
- f. Documentation of Best Practices
- g. Promotion of Ferrocement Technology

1.3 Methodology

- a. We consider a rectangular water tank having capacity 0.54 cu.m.

Tank Dimensions: Inner and Outer Measurements.

Dimension	Inner (mm)	Outer (mm)
Length (L)	1424	1524
Width (W)	510	610
Height (H)	560	610

Table 1: Tank Dimension

b. Tank Specification :

Sr.No.	Aspect	Details
1	Dimension	1524mm*610mm*610mm
2	Capacity	0.54 cu.m
3	Materials :	
	i) Steel (M.S)	6mm dia, tor steel
	ii) Weld mesh	4 inch*4 inch*11 gauge
	iii) Chicken mesh (G.I)	26 gauge*1/2 inch
	iv) Cement	Birla super OPC-53 grade
	v) Sand	Wash sand
4	Thickness	50mm (Long wall, short wall, base slab)
5	Reinforcement spacing :	
	i) Horizontal	305mm c/c
	ii) Vertical	305mm c/c
6	Mix proportion	1:3

Table 2: Tank specification

c. Cost analysis :

A) Material					
Sr.No.	Materials	Quantity	Per	Rate (Rs.)	Amount (Rs.)
1	Tor steel 6mm dia M. S. bars	9	Kg	60	540.00
2	Weld mesh	40	Sq ft	8	320.00
3	Chicken mesh	80	Sq ft	3	240.00
4	Binding wire	½	Kg	85	42.50
5	Welding rods			80	80
6	Cement	2½	Bags	370	925.00
7	Sand	20	ghamela	80	1600.00
				Total	3747.50
B) Labour					
1	Welder	1	Days	700	700.00
2	Fitter	1	Days	800	800.00
3	Mason	1	Mandays	1300	1300.00
4	Helpers	1	Mandays	700	700.00
				Total	3500.00

d. Construction procedure :

Total (A) + (B) = 7247.50

Add contingency, overheads 19.48% = 1753.50

Total = Rs.9000.00

a) Constructing the rectangular frame :

- The initial phase involves cutting steel bars to precise measurements: 1524mm length, 610mm width, and 610mm height. These bars are then welded together meticulously, ensuring accurate alignment for a sturdy rectangular framework. Attention to detail during welding, including thorough inspections for defects, guarantees the structural integrity of the skeletal cage.



Fig 2: Rectangular Skeletal

b) Securing welded wire mesh layer :

- A welded wire mesh layer is meticulously applied to enhance reinforcement. The mesh, tailored to match the cage's dimensions precisely, is carefully positioned and securely tied to the steel bars using binding wire. Ensuring complete coverage and tight ties prevents any compromise in structural integrity, crucial for the tank's stability.

c) Reinforcing with G.I Chicken Wire Mesh :

- applying galvanized iron (G.I.) chicken wire mesh to both the tank's exterior and interior surfaces for added reinforcement, crucial in preventing cracking. Precision cutting ensures seamless coverage, followed by careful positioning and securing of the mesh with binding wire to the skeletal cage. This process is repeated for both exterior and interior layers to enhance structural integrity and durability, with excess wire trimmed for a neat finish.



Fig 3: Applying G.I Chicken Mesh

d) Preparing Mortar Mix (No Use of Any Admixture) :

- We prepare the mortar mix using cement and sand without any admixtures. We choose Birla Super OPC-53 grade cement for its strong bonding properties and wash sand, free from impurities, to ensure a robust mixture. Maintaining the correct 1:3 ratio of cement to sand is crucial for the mix's strength and workability. We carefully measure and mix the dry ingredients before gradually adding water to achieve the desired thick, paste-like consistency.

- In the fifth step, we clear the construction site to create a safe and tidy work environment. This involves removing debris, rocks, vegetation, and any obstacles that could hinder construction or pose safety hazards. A clean site not only enhances safety but also facilitates efficient work by allowing free movement and accurate placement of materials. Site clearance is especially important for precise projects like tank construction, ensuring smooth progress and minimizing errors during the build.

e) Preparing Base Slab Foundation :

- Preparing the base slab involves several key steps. First, lay down a cover to prevent the mortar from sticking to the ground, ensuring smooth movement and efficiency during construction. Next, spread a thin, even layer of mortar on top of the cover, serving as a bedding layer for the skeletal framework. Carefully level the surface using tools like a straightedge to ensure consistency and stability. Finally, accurately position the steel formwork on the leveled surface, ensuring proper alignment for stability. Adjustments may be necessary to achieve perfect alignment, guaranteeing the integrity of the base slab.



Fig 4: Base slab preparation

f) Applying Mortar To Walls :

- Applying interior wall mortar involves preparing a mix of cement and sand in a 1:3 ratio to the right consistency. Then, using a trowel, start from the bottom and work up, ensuring even coverage on the tank walls. Embed reinforcement elements like steel bars and wire mesh within the mortar for a strong structure. Check thickness periodically to maintain the specified 50mm, and smooth the surface for a polished finish, enhancing water resistance and durability.



Fig 5: Exterior side



Fig 6: Interior Side

- To apply mortar to the tank's exterior, use a trowel, starting from the bottom and working up to cover steel bars and wire mesh evenly. Maintaining a consistent 50mm thickness for structural stability, adding more mortar where needed. Using a spirit level to ensure a straight, even surface, smoothing it continuously with the trowel for a polished finish. Repeat this process across the entire exterior for robustness and a pleasing appearance.

g) Levelling Surfaces :

- After applying mortar to both interior and exterior tank walls, removing excess material is crucial to maintain quality. Use a trowel or scraper to carefully scrape away surplus mortar, ensuring even thickness. Level the surface to distribute mortar evenly and smooth out any imperfections, using a spirit level to maintain alignment. Pay close attention to corners and edges for uniformity and strength.



Fig 7: Smoothing



Fig 8: Levelling

h) Final Finishing :

- Begin by inspecting all sides of the tank for defects like uneven surfaces or cracks. Address any issues promptly to maintain structural integrity, using appropriate tools to fix them. After finalizing finishing touches for a smooth appearance, properly cure and seal the mortar to enhance strength and durability. Follow manufacturer guidelines for drying time before commissioning the tank for use.



Fig 9: Final finishing

i) Curing :

- After finishing all work on the tank, the curing process begins by allowing the materials to dry properly. On the second day, the tank is partially filled and water is applied to hydrate all surfaces, aiding in the curing process, especially for concrete. By the third day, the tank is

fully filled with water, subjecting it to maximum hydrostatic pressure to identify any weaknesses or leaks, while also assisting in material curing for maximum strength.



Fig 10 : Curing

2. Result

The ferrocement tank project had great outcomes in different areas. It was eco-friendly because it used fewer materials like cement and steel, which helped the environment. It had a low environmental impact compared to steel tanks. The water in the tank stayed clean and cool, good for drinking and irrigation. Even though bad weather caused some small delays, the project finished on time, showing good time management. The tank was well-built with no cracks or weaknesses, showing it will last a long time. Overall, the project showed that ferrocement technology can make durable, eco-friendly water tanks.

3. Conclusion

The successful construction of the ferrocement water tank demonstrated the material's superiority in terms of durability, cost-efficiency, and environmental sustainability. The project meet all its objectives, staying within budget and on schedule while providing a high-quality water storage solution. The involvement of the local community not only facilitated the construction process but also empowered community members with valuable skills and knowledge. Comparative analysis with other materials like RCC, steel, and PVC showed that ferrocement offers significant advantages, particularly in terms of durability, resistance to corrosion, and lower initial and long-term costs. These findings support the use of ferrocement as a preferred material for water tanks and similar infrastructure projects. Future projects can benefit from the lessons learned and recommendations provided, further enhancing cost efficiency, sustainability, and community involvement. Overall, the ferrocement water tank project serves as a model for sustainable and community-centric infrastructure development.

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