Final Year Project Showcase

Batch 2022

Year 2026

Department: Urban and Infrastructure Programme: B.E. (Civil)	
1	**Project Title** Design and construction of ferrocement water tanks using advanced waterproofing techniques
2	**Project Idea** The fundamental idea behind this project stems from the critical need for sustainable, cost-effective, and highly durable water storage solutions in regions facing water scarcity and infrastructural challenges. Traditional water storage tanks made of Reinforced Cement Concrete (RCC) or steel are widely used but suffer from significant drawbacks, including high construction costs, heavy structural weight, susceptibility to cracking, and subsequent leakage or corrosion over time. To address these limitations, this project introduces the concept of utilizing Ferrocement as a structural alternative. Ferrocement, composed of a dense matrix of wire mesh embedded in high-strength cement mortar, offers an exceptional strength-to-weight ratio, superior crack distribution capabilities, and can be easily fabricated using locally available materials. However, since water tanks are continuously subjected to hydrostatic pressure, the core innovative element of this project idea is the integration of Advanced Waterproofing Techniques. By incorporating crystalline waterproofing admixtures (BETOCRETE-C16) directly into the mortar matrix and treating critical joints with specialized swelling tapes (AQUAFIN-CJ6), the project aims to eliminate capillary porosity and joint leakage. Thus, the ultimate concept is to design and construct a low-cost, low-maintenance, and virtually leak-proof ferrocement tank that bridges the gap between traditional structural engineering and modern material technology.

3	**Process** **1. Manual Design** • Designed a circular ferrocement tank according to **ACI 549.1R-93**. • Calculated hydrostatic pressure, hoop tension, hoop stress, reinforcement requirement, and base slab design. **2. Software Verification** • Developed the tank model in **SAP2000**. • Applied hydrostatic loading and compared stresses and deformation with manual calculations. **3. Mould Preparation** • Prepared steel moulds for casting. • Cleaned and applied mould oil. • Fixed welded wire mesh with proper mortar cover. **4. Construction** • Cast the circular tank walls using cement-sand mortar. • Cast the base slab separately with a groove for wall placement. • Positioned the wall inside the groove and sealed the joint. **5. Waterproofing** • Tank 1 was constructed without waterproofing treatment. • Tank 2 was constructed using **BETOCRETE®-C16 crystalline waterproofing admixture** and **AQUAFIN®-CJ6 waterstop tape**. **6. Curing** • Both tanks were water cured for **28 days**. **7. Hydrotesting** • Filled both tanks with water and observed leakage, structural performance, and water-tightness.

4 Outcome

A small-scale ferrocement water tank was successfully designed, analyzed, constructed, and experimentally evaluated using advanced waterproofing techniques. The manual structural design was carried out in accordance with **ACI 549.1R-93** and verified using **SAP2000 finite element analysis**.

Two prototype tanks were fabricated for comparison:

- **Tank 1 (Control):** Conventional ferrocement mortar without waterproofing admixture.
- **Tank 2 (Experimental):** Ferrocement mortar incorporating **BETOCRETE®-C16 crystalline waterproofing admixture** with **AQUAFIN®-CJ6 swellable waterstop tape** at the wall-base joint.

The experimental program included:

- 28-day cylinder compressive strength test
- Wire mesh tensile strength test
- 72-hour hydrostatic leakage test
- Structural performance evaluation

The experimental results showed:

- Tank 1 achieved a compressive strength of **1645 psi**.
- Tank 2 achieved a higher compressive strength of **1824 psi**, indicating that the waterproofing admixture did not reduce the mechanical strength of the mortar.
- The welded wire mesh developed a tensile strength of **36,000 psi**, confirming adequate reinforcement capacity.

Hydrotesting demonstrated a clear improvement in water-tightness:

- **Tank 1** exhibited minor localized dampness caused by moisture migration through the mortar pores.
- **Tank 2** remained completely dry throughout the **72-hour hydrotesting period**, confirming the effectiveness of the waterproofing system.

Structural evaluation showed that the calculated maximum hoop stress (**31.2 psi**) was significantly lower than the allowable structural threshold (10% of compressive strength) for both tanks, confirming adequate structural safety and resistance against hydrostatic loading.

Overall, the project proved that advanced waterproofing techniques significantly improve the durability, impermeability, and long-term performance of ferrocement water tanks

5 Evidence (Theoretical Basis)

Water storage is an essential requirement for domestic, agricultural, and industrial applications. Conventional reinforced concrete water tanks are durable but often involve higher construction costs, greater material consumption, and longer construction time. Ferrocement offers a lightweight and economical alternative due to its thin cement mortar sections reinforced with closely spaced wire mesh. However, one of the major challenges associated with ferrocement water tanks is water leakage through capillary pores in the mortar and construction joints, which can reduce durability and service life.

This project addresses these challenges by investigating the use of **advanced waterproofing materials**, namely **BETOCRETE®-C16 crystalline waterproofing admixture** and **AQUAFIN®-CJ6 thermoplastic swellable waterstop tape**, to improve the water-tightness and durability of ferrocement water tanks. The tank was manually designed according to **ACI 549.1R-93** using thin-wall cylinder theory.
Design calculations included hydrostatic pressure, hoop tension, hoop stress, reinforcement requirements, and base slab design. The manual calculations were further verified through **SAP2000 finite element analysis**.

The project followed a systematic methodology comprising literature review, manual structural design, software verification, mould preparation, construction of two ferrocement tanks, curing, and experimental testing. Two prototype tanks were fabricated: **Tank 1** without waterproofing treatment (control) and **Tank 2** incorporating crystalline waterproofing admixture and water stop tape. Experimental evaluation included **28-day compressive strength testing**, **wire mesh tensile strength testing**, and a **72-hour hydrostatic leakage test**.

The results showed that the waterproofed mortar achieved a higher compressive strength (**1824 psi**) compared to the conventional mortar (**1645 psi**). The welded wire mesh exhibited a tensile strength of **36,000 psi**, confirming adequate reinforcement capacity. During hydrotesting, Tank 1 exhibited minor localized dampness due to moisture migration through mortar pores, whereas Tank 2 remained completely dry throughout the 72-hour test, demonstrating the effectiveness of the waterproofing system.

The comparison between manual calculations, SAP2000 analysis, and experimental results confirmed that the developed ferrocement tank safely resisted hydrostatic pressure while providing excellent crack control and water-tightness. The study demonstrates that incorporating advanced waterproofing materials significantly enhances the durability, impermeability, and long-term performance of ferrocement water tanks, making them a practical and economical solution for sustainable water storage applications.

6	**Impact on Sustainability of Urban Regions or SDG-11 "Sustainable Cities and Communities"** The developed ferrocement water tank contributes to sustainable urban development by providing a lightweight, economical, and durable solution for water storage. Compared to conventional reinforced concrete tanks, ferrocement requires less cement, steel, and construction material, reducing the overall consumption of natural resources and lowering the environmental impact of construction. The use of advanced waterproofing materials significantly improves the water-tightness and durability of the tank, minimizing water leakage and reducing maintenance requirements throughout its service life. This helps conserve water resources, which is essential for sustainable communities facing increasing water demand. The thin-wall ferrocement construction also reduces the self-weight of the structure, making transportation, handling, and installation easier while lowering construction costs. Its simple construction technique makes it suitable for rural and urban areas where affordable and reliable water storage systems are needed. The project supports sustainable infrastructure by promoting long-lasting, low-maintenance, and cost-effective water storage facilities. The successful use of crystalline waterproofing technology further enhances the durability of the structure, extending its service life and reducing future repair costs.
7	**Competitive Advantage or Unique Selling Proposition (USP)** (Cost Reduction, Process improvement, Attainment of any SDG (Sustainable Development Goal), increase of market share or capturing new marketer having superior performance over a competitor. In summary, any striking aspect of the project that compels the industry to invest in FYP or purchase it. Some detailed description is required in terms of how, why when what. You can select one or more from the following dropdown and delete the rest of them). Please keep relevant options, delete the rest of them, and correct the sequence. The developed **ferrocement water tank using advanced waterproofing techniques** provides a lightweight, economical, and durable alternative to conventional reinforced concrete water tanks. The integration of **BETOCRETE®-C16 crystalline waterproofing admixture** and **AQUAFIN®-CJ6 waterstop tape** significantly improves the water-tightness and long-term durability of the tank. Experimental hydrotesting confirmed that the waterproofed tank remained completely leak-free under continuous hydrostatic pressure, making it a reliable solution for water storage applications.

a) Application in Domestic, Agricultural, and Community Water Storage
The developed ferrocement water tank can be used for residential houses, rural communities, agricultural irrigation, schools, hospitals, and public infrastructure projects. Its lightweight construction and excellent water-tightness make it suitable for areas requiring affordable and durable water storage systems.

b) Use in Low-Cost and Affordable Water Storage Projects
The tank requires less cement, steel, and formwork than conventional RCC tanks due to its thin-wall ferrocement construction. This reduces construction cost while maintaining adequate structural strength, making it suitable for low-cost housing schemes, rural development projects, and community water supply systems.

c) Implementation in Public Infrastructure and Government Projects
The developed tank can be adopted for government water supply schemes, schools, hospitals, parks, and disaster relief projects. Its durability, ease of construction, and leak-resistant performance make it suitable for sustainable public infrastructure.

d) Integration into Sustainable Construction Practices
The project promotes sustainable construction by reducing material consumption through thin-wall ferrocement technology. The use of advanced waterproofing materials increases service life, reduces maintenance requirements, and conserves water by preventing leakage, making it an environmentally responsible construction solution.

e) Superior Waterproofing and Structural Performance
Unlike conventional ferrocement tanks, the developed tank incorporates crystalline waterproofing admixture and waterstop tape that seal capillary pores and construction joints. During the **72-hour hydrostatic test**, the waterproofed tank remained completely dry, while the conventional tank exhibited minor dampness. This demonstrates improved durability, crack resistance, and long-term performance.

f) Association with the United Nations Sustainable Development Goals (SDGs) The project directly contributes to the following Sustainable Development Goals:

- **SDG 6 – Clean Water and Sanitation:** Provides leak-proof water storage, reduces water loss, and improves safe water management.
- **SDG 9 – Industry, Innovation and Infrastructure:** Introduces innovative ferrocement construction combined with advanced waterproofing technology for durable infrastructure.
- **SDG 11 – Sustainable Cities and Communities:** Supports affordable, durable, and sustainable water storage systems for urban and rural communities.

a	**Attainment of Sustainable Development Goals (SDGs)** Goal 6 – Clean Water and Sanitation The developed ferrocement tank minimizes water leakage through advanced waterproofing technology, ensuring safe and efficient water storage while reducing water wastage. Goal 9 – Industry, Innovation and Infrastructure The project introduces an innovative combination of ferrocement construction and crystalline waterproofing materials to develop durable, lightweight, and economical water storage infrastructure. Goal 11 – Sustainable Cities and Communities The lightweight, cost-effective, and durable ferrocement tank provides a sustainable solution for domestic, agricultural, and community water storage, supporting resilient infrastructure and sustainable urban development.
b	**Environmental Aspect** The project promotes environmentally friendly construction by reducing the consumption of concrete and steel through thin-wall ferrocement technology. The advanced waterproofing system extends the service life of the tank, reduces maintenance, minimizes water wastage due to leakage, and lowers the environmental impact associated with repair and reconstruction.
e	**Expanding Market Share** The developed ferrocement water tank has the potential to expand its market by targeting: • Residential and commercial buildings. • Rural water supply projects. • Agricultural irrigation systems. • Government water storage schemes.

	• Schools, hospitals, and public infrastructure. • NGOs and humanitarian organizations involved in water supply projects. Its affordability, durability, and leak-proof performance make it attractive for sustainable construction and water management projects.
f	**Capture New Market** The project can capture new market segments by offering an economical and durable alternative to conventional water tanks. Potential users include: • Low-cost housing developers. • Sustainable construction companies. • Government and municipal water authorities. • Rural development programs. • Agricultural sector. • Disaster relief and emergency water storage projects. The experimentally verified leak-proof performance, lightweight construction, and long service life make the developed ferrocement tank a practical and commercially viable solution for future water storage applications.
g	**Any Other Aspect (Please tag it like above options)**

8 **Target Market** (Industries, Groups, Individuals, Families, Students, etc) Please provide some detail about the end-user of the product, process, or service

The target market for the developed **ferrocement water tank with advanced waterproofing techniques** includes:

Industries

- Construction companies involved in residential, commercial, and industrial infrastructure projects.
- Manufacturers and contractors specializing in ferrocement products and prefabricated water storage systems.
- Water management and infrastructure development companies seeking durable and cost-effective water storage solutions.

Groups

- Government departments involved in rural water supply, public infrastructure, and community development projects.
- Non-governmental organizations (NGOs) working on clean water, sanitation, and disaster relief programs.
- Municipal authorities responsible for public water storage and distribution.
- Architects, civil engineers, and consultants promoting sustainable construction practices.

Individuals

- Homeowners requiring reliable domestic water storage.
- Builders and contractors seeking economical and durable water tanks.
- Farmers requiring water storage for irrigation and livestock purposes.

Families

- Families living in rural, remote, or water-scarce areas requiring affordable and leak-proof water storage systems.
- Households looking for low-maintenance and long-lasting water tanks.

Educational and Research Institutions

- Universities and research organizations working in civil engineering, construction materials, and sustainable infrastructure.
- Students and researchers studying ferrocement technology, waterproofing materials, and structural engineering.

Public Sector and Community Applications

- Schools, hospitals, community centers, parks, and public buildings requiring dependable water storage facilities.

	• Emergency response and humanitarian organizations requiring portable and durable water storage solutions during disasters. The developed ferrocement water tank provides a lightweight, economical, and durable alternative to conventional water storage systems, making it suitable for a wide range of domestic, agricultural, institutional, and public infrastructure applications.	
9	**Team Members** (Names along with email address	Isha Saeed(ishasaeed32@gmail.com) Neha Imran(nehaimran327@gmail.com) Syeda Talbia (syedatalbiakhurshid@gmail.com) Fatima Zahra (sheikhfatima699@gmail.com) Umm-e-Hani (umm.e.hani821@gmail.com)
10	**Supervisor Name** (along with email address)	Dr. Syed Salman Mobeen (ssalman@cloud.neduet.edu.pk)

11	**Video (If any)**	You may please provide the link of the video to be accessible

Pictures (If any)

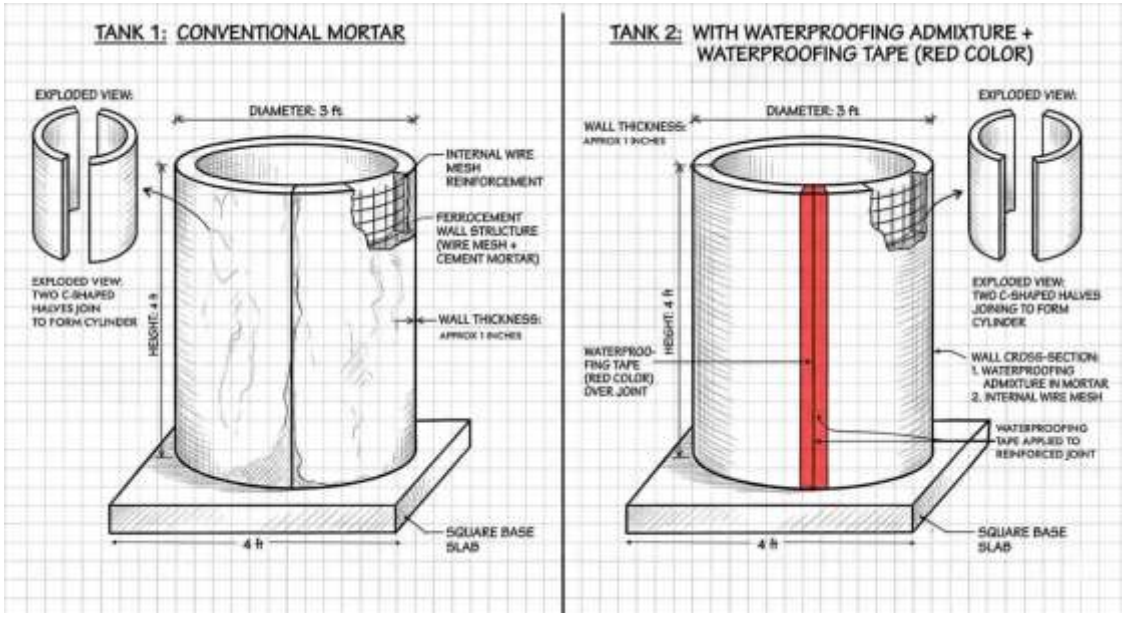

Figure 1. Experimental Matrix

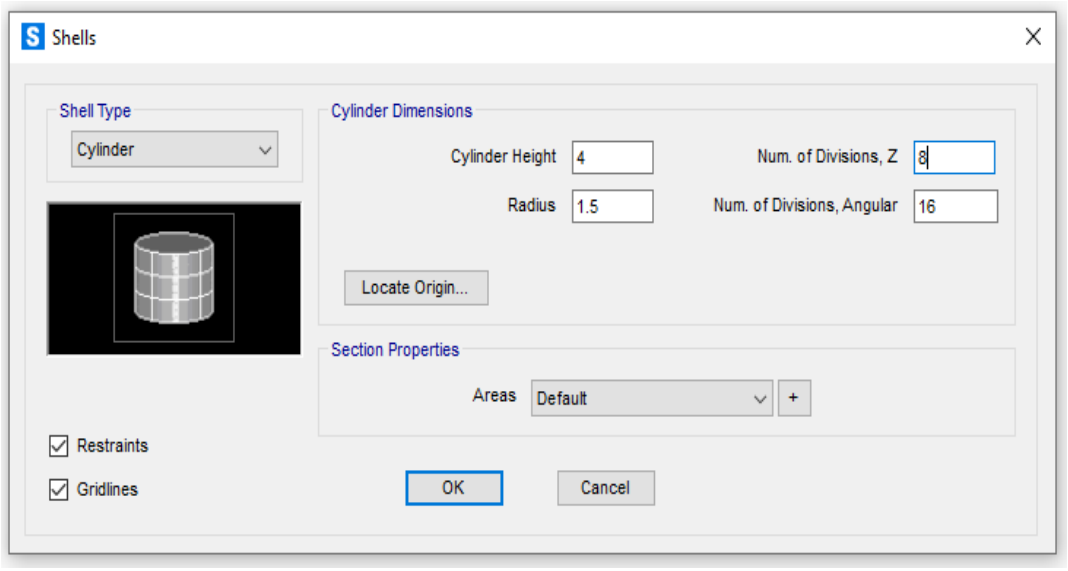

Figure 2. Tank parameters

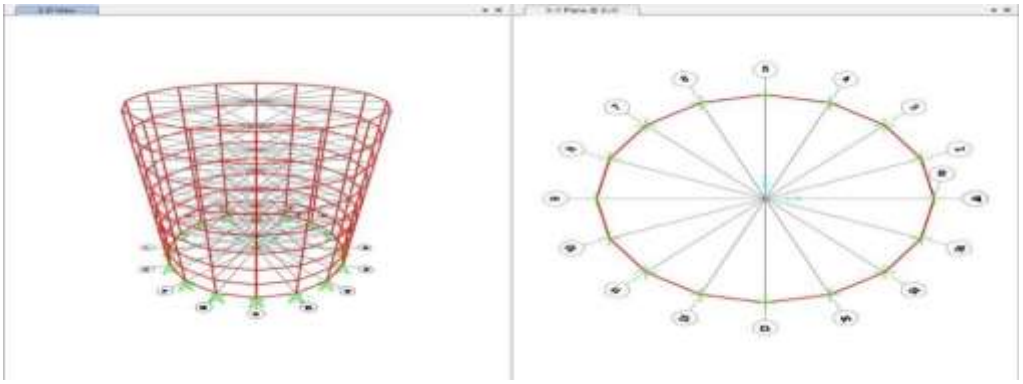

Figure 3. Sap view of tank

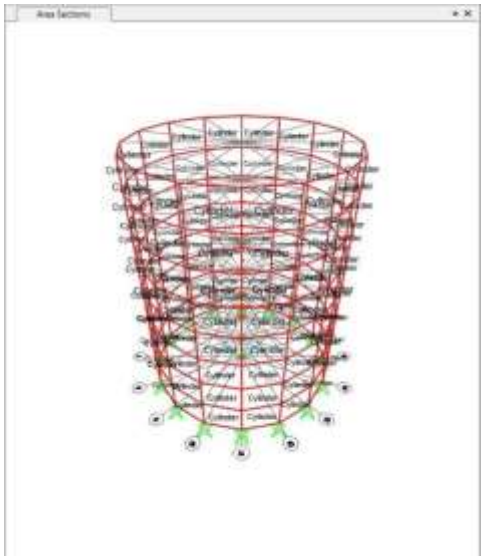

Figure 4. Cylindrical wall

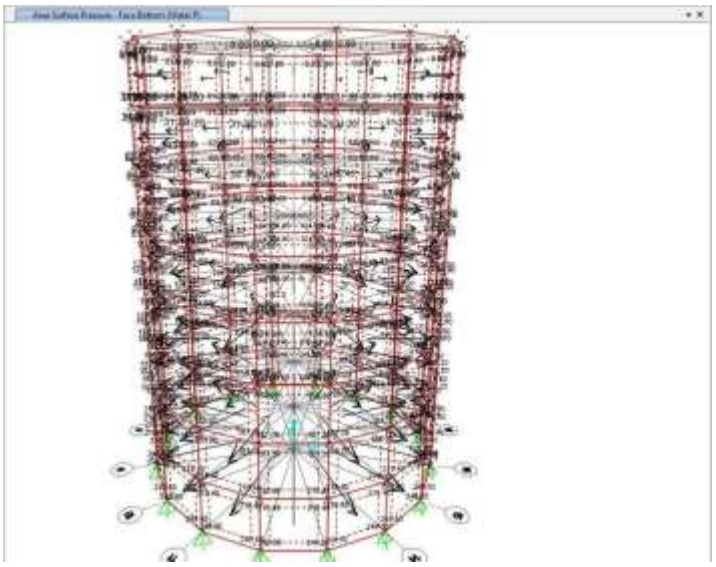

Figure 5. Hydrostatic pressure distribution

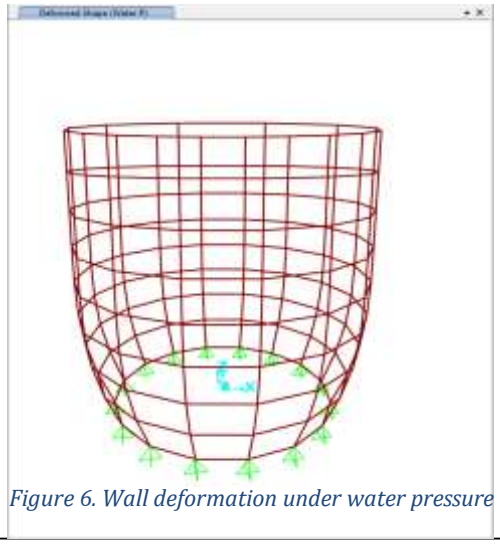

Figure 6. Wall deformation under water pressure

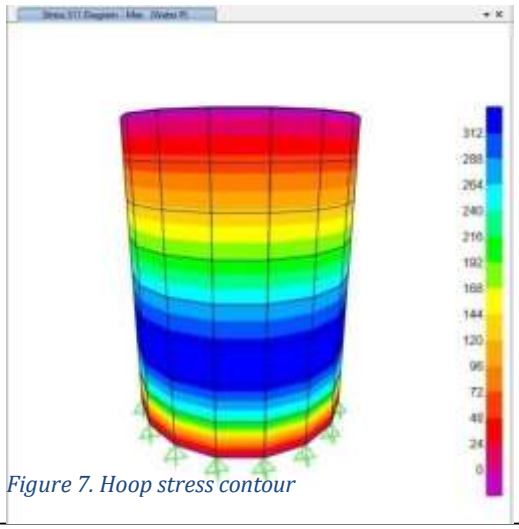

Figure 7. Hoop stress contour

Figure 8. Sand preparation for mortar

Figure 9. Bottom slab casting

Figure 10. Wire mesh (2"x2") layout

Figure 11. Wire mesh roll

Figure 12. Admixture added to mortar

Figure 13. Betocrete admixture container

Figure 14. AQUAFIN CJ-6 waterproofing tape.

Figure 15. Application of waterproofing tape

Figure 16. Mould surface oiled for demoulding

Figure 17. Wire mesh framework

Figure 18. Tank after mortar application

Figure 19. Semicircular half

Figure 20. Hydro test of tank 1

Figure 21. Hydro test tank 2