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Revolutionizing Ferrocement: A Review on Woven Mesh Integration and Fiber-Based Mortar Alternatives

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Abstract: Ferrocement is a versatile and cost-effective composite material widely used in construction because of its excellent strength-to-weight ratio, durability and adaptability. Conventionally, it consists of cement mortar reinforced with welded wire mesh. Recent advances in materials science have introduced woven mesh reinforcement and fiber-based mortar alternatives. This paper presents a review of these developments, focusing on their influence on mechanical performance, durability, crack resistance and sustainability. Woven mesh improves stress distribution and ductility, while fiber-reinforced mortars increase tensile strength and reduce shrinkage and microcracking. The paper compares conventional ferrocement with modified systems, discusses practical applications, challenges and future research needs, and supports the review with a laboratory punching-load comparison of ferrocement panels, in which the panel with steel mesh and fibers reached the highest ultimate load (43.6 kN) with the lowest deflection (9.97 mm). The findings highlight the potential of these technologies for sustainable construction.

Keywords: *Ferrocement; woven mesh; fiber-reinforced mortar; composite materials; structural reinforcement; sustainable construction.*

1. INTRODUCTION

Ferrocement is a versatile composite construction material consisting of a thin layer of cement mortar reinforced with closely spaced, continuous layers of wire mesh or similar materials. Owing to its light weight, high tensile strength, crack resistance and ease of construction, it is widely used in structural and non-structural applications such as roofing panels, water tanks, marine structures, precast elements and low-cost housing. Its ability to be molded into varied shapes makes it an efficient and economical material for modern construction. Recent studies have further highlighted its importance as a sustainable, high-performance construction material [14–16].

Conventional ferrocement uses welded wire mesh as reinforcement. Although this provides adequate strength, it has limitations, including susceptibility to corrosion, limited flexibility and uneven stress distribution. To overcome these drawbacks, recent research has focused on advanced reinforcement techniques and sustainable material modifications.

One significant advancement is the use of woven mesh and multiple mesh layers as reinforcement. Studies have shown that increasing the number of mesh layers improves the load-carrying capacity, flexural strength and ductility of ferrocement panels and slabs [15,17]. Ferrocement strengthening has also been applied successfully to retrofit RC beams, slabs, compression members and masonry structures, significantly improving shear strength, cracking load, ultimate load, ductility and energy dissipation [2,6,7,16].

Another important innovation is the use of fiber-reinforced mortar and sustainable recycled materials. The inclusion of fibers such as PVA and 3D-printed fibers has improved crack resistance, toughness and durability [1,9]. Moreover, recycled materials, industrial by-products and other sustainable alternatives have enhanced mechanical performance while promoting waste reduction [4,5,8,10–13].

The combined use of advanced mesh systems and fiber-reinforced mortar offers improved strength, durability and sustainability. This paper therefore reviews recent developments in woven mesh integration and fiber-based mortar alternatives and evaluates their effectiveness in enhancing the mechanical properties and long-term performance of ferrocement structures. The review is supported by a laboratory comparison of the punching-load behavior of ferrocement panels.

2. LITERATURE REVIEW

Recent studies have shown that ferrocement is an effective and sustainable construction material with a wide range of structural applications. Faraji et al. [1] reported that fiber-reinforced ferrocement composites exhibit excellent chemical resistance and toughness, with PVA fiber proving the most effective. Mukherjee and Kaushik [2] demonstrated that ferrocement significantly improves the shear strength, flexural capacity, ductility and energy absorption of masonry wallettes, making it a cost-effective retrofitting solution.

Madera Sierra et al. [3] confirmed the suitability of ferrocement slabs for lightweight construction with spans below 4 m by verifying that they satisfy vibration serviceability requirements. Similarly, Eltaly et al. [18] and Joyklad et al. [17] showed that ferrocement panels and RC slabs exhibit increased load capacity, ductility and energy dissipation with additional mesh layers and proper anchorage.

Miah et al. [4] used recycled crushed clay bricks as fine aggregate in ferrocement-strengthened RC beams, and Miah et al [19] reported the use of jute fibers and other waste materials in ferrocement composites; both lines of work improved flexural strength, stiffness and sustainability. Mohana and Leela Bharathi [5] further demonstrated that nano fly ash-based geopolymer ferrocement panels with rubber and plastic aggregates enhance impact resistance and environmental performance.

In retrofitting applications, Abdallah et al. [6], Sen et al. [7] and Amala et al. [20] reported significant improvements in the cracking load, ultimate strength and ductility of RC beams, slabs and masonry structures strengthened with ferrocement.

In addition, Minde et al. [21] and Raj et al. [14] emphasized ferrocement as a sustainable and economical material for low-cost housing, roofing and water tanks. Overall, the literature indicates that ferrocement offers superior structural performance, durability and sustainability, making it highly suitable for modern construction and strengthening applications.

3. REVIEW OF WOVEN MESH AND FIBER-BASED MORTAR DEVELOPMENTS

3.1 Woven Mesh Integration

Recent research indicates that woven mesh can significantly improve the mechanical properties of ferrocement. Compared with welded mesh, woven mesh provides a more uniform distribution of stress and enhances the ductility of the composite. Common mesh geometries used in ferrocement are shown in Fig. 1.

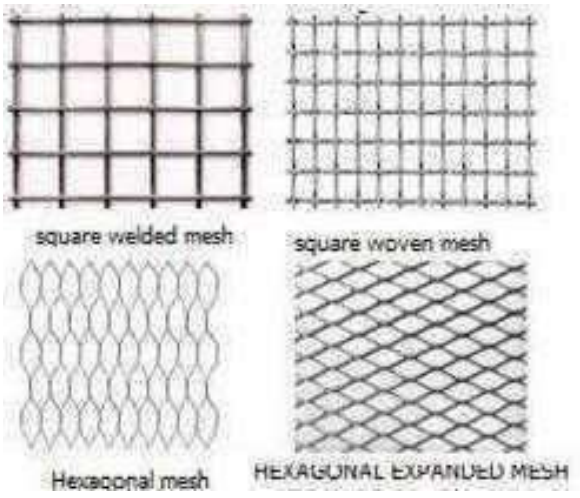


Fig. 1. Types of reinforcing mesh: square welded mesh, square woven mesh, hexagonal mesh and hexagonal expanded mesh.

3.2 Fiber-Based Mortar Alternatives

The incorporation of fibers in the mortar matrix is another area of innovation in ferrocement technology. Fibers such as polypropylene, glass and steel have been shown to enhance the mechanical properties of cementitious materials. Shah et al. [22] reported that fiber-reinforced mortars exhibit improved tensile strength, reduced shrinkage and enhanced durability. Fibers not only improve the performance of the mortar but also contribute to the overall resilience of the ferrocement element.

3.3 Comparative Studies

Comparative studies between conventional ferrocement and ferrocement incorporating woven mesh and fiber-based mortars have yielded promising results. For instance, Ahmed et al. [23] found that ferrocement panels with woven mesh and fiber-reinforced mortar showed a 30% increase in load-bearing capacity compared with conventional ferrocement panels. These findings suggest that integrating woven mesh with fiber-based mortar can lead to more efficient and durable construction solutions. Overall, ferrocement that combines woven mesh with fiber-reinforced mortar offers a load capacity of up to 30% higher than that of conventional systems, together with improved crack resistance, better long-term durability and lower maintenance demands.

3.4 Key Findings of the Review

The reviewed literature points to several key findings regarding the combined use of woven mesh and fiber-based mortars in ferrocement. Woven mesh markedly enhances tensile strength and ductility, whereas fiber-reinforced mortar contributes to durability and crack resistance. When the two are used together, the resulting structural performance is superior, and the improved bonding between the constituents lowers the likelihood of failure.

Experimental studies in the literature additionally report increased ultimate load capacity, reduced deflection and better resistance to environmental effects. Woven mesh improves macro-level performance, whereas fibers enhance micro-level behavior; this dual reinforcement results in a highly efficient composite suitable for modern construction needs.

4. RESEARCH GAP

4.1 Durability and Long-Term Performance

The long-term durability of ferrocement elements that combine woven mesh with fiber-reinforced mortar, including resistance to corrosion, shrinkage and environmental degradation, is scarcely addressed. The effects of fiber type, dosage and distribution within the mortar, in combination with woven mesh, remain underexplored.

4.2 Optimized Mix Design and Processing Techniques

Research on optimal fiber proportions, fiber types (synthetic, natural, steel) and mortar mix designs tailored to enhance bonding and performance with woven meshes is limited.

Methods for effectively integrating woven mesh with fiber-reinforced mortar during casting and curing need refinement.

4.3 Material Compatibility and Bonding Characteristics

Traditional ferrocement primarily uses welded wire mesh with cement mortar. The interaction mechanisms between woven meshes, which differ in surface texture, flexibility and mechanical properties, and fiber-based mortars are not fully understood. Little research exists on the bond strength and durability of fiber-reinforced mortars combined with woven meshes, especially under varying environmental conditions.

4.4 Mechanical Performance and Structural Behavior

Experimental data on the flexural, punching and impact behavior of ferrocement elements that combine woven mesh with fiber-reinforced mortar are still limited. In particular, the influence of the number of mesh layers and fiber content on load–deflection response, crack pattern and failure mode has not been systematically established for such hybrid systems.

5. MATERIALS AND METHODS

5.1 Cement

Ordinary Portland Cement (OPC) of 43 and 53 grade, conforming to IS 8112:2013 and IS 12269:2013 respectively, was selected as the primary binder. Cement is the most critical constituent of the mortar because it governs strength development, setting characteristics and durability. OPC 43 grade is generally suitable for normal strength requirements, whereas OPC 53 grade is preferred where higher early strength and a dense microstructure are desired. The cement used was fresh, free from lumps and stored in airtight bags to avoid moisture absorption. The choice of OPC ensures reliable hydration, adequate bonding with fine aggregate and compatibility with supplementary cementitious materials (SCMs) and admixtures.



Fig. 3. Ordinary Portland Cement (OPC).

5.2 Fine Aggregate

Natural river sand conforming to IS 383:2016 was used as the fine aggregate. Sand reduces shrinkage, improves workability and provides bulk to the mortar. Zone II sand with a fineness modulus (FM) of 2.6 and a maximum particle size of 2.36 mm was selected, which lies within the ideal grading range for ferrocement. Coarser particles were avoided because ferrocement requires a thin mortar cover over meshes and fibers. The sand was washed and sieved to remove organic impurities, clay and oversized particles, ensuring a clean and uniform aggregate surface that promotes bonding with the cement paste and improves the mechanical performance of the composite.

5.3 Supplementary Cementitious Materials (SCMs)

SCMs were incorporated to partially replace OPC and to improve the performance of the ferrocement mortar. They also contribute to sustainability by utilizing industrial by-products.

5.3.1 Fly ash (Class F)

A by-product of coal combustion, fly ash has a high silica and alumina content. It enhances workability, reduces the heat of hydration and refines the pore structure. Its pozzolanic reaction with calcium hydroxide improves long-term strength and durability.

5.3.2 Ground granulated blast furnace slag (GGBS)

Obtained by quenching molten iron slag, GGBS improves sulphate resistance, chloride penetration resistance and chemical durability. Its latent hydraulic properties contribute to a dense microstructure, making ferrocement composites more durable in aggressive environments.

5.3.3 Silica fume

An ultrafine by-product of silicon and ferrosilicon production, silica fume is extremely rich in amorphous silica. Owing to its high specific surface area, it significantly enhances compressive strength, reduces permeability and improves the interfacial bond between mortar and reinforcement. It also helps control microcracking by filling voids within the cement matrix.



Fig. 4. Silica fume.

5.4 Water

Clean potable water, free from organic matter, oils, acids and salts, was used for both mixing and curing. Water quality directly influences hydration, workability and strength development; unsuitable water can delay setting, corrode

reinforcement and reduce durability. Water conforming to IS 456:2000 was therefore used to ensure reliable and consistent mortar properties.

5.5 Chemical Admixtures

Three chemical admixtures were employed to improve the performance of the ferrocement mortar. A polycarboxylate ether (PCE)-based superplasticizer provided high workability at low water–binder ratios; because it increases flowability without additional water, strength is retained and porosity is reduced. A shrinkage-reducing admixture (SRA) was added to control the autogenous and drying shrinkage typical of thin ferrocement sections, thereby limiting early-age cracking and enhancing durability. For the steel-mesh-reinforced panels, a corrosion inhibitor was also incorporated; it forms a protective film on the steel surface, postpones the initiation of rusting and prolongs service life, particularly in marine or otherwise aggressive environments.

5.6 Reinforcing Mesh

Mesh is the primary reinforcement in ferrocement, controlling crack width and enhancing tensile strength. Four woven mesh types are considered in this study. Galvanized steel woven mesh is widely available, economical and offers good tensile resistance, but it is vulnerable to corrosion under aggressive exposure. Stainless steel woven mesh provides superior corrosion resistance, excellent bond with the mortar and long-term durability; despite its higher cost relative to galvanized mesh, it is well suited to marine and industrial settings. Basalt FRP woven mesh, manufactured from basalt fibers, is lightweight, corrosion-resistant and environmentally friendly, and its good tensile strength and chemical stability in alkaline cementitious media make it a promising alternative to steel mesh. Glass fiber reinforced polymer (GFRP) woven mesh is likewise a non-metallic, corrosion-proof and lightweight option with good tensile strength and durability, although it performs less well than basalt FRP at elevated temperatures.

5.7 Fibers

Fibers were added to the mortar as secondary reinforcement to enhance toughness, ductility and crack resistance, and four fiber types were compared. Steel fibers bridge cracks and retard their propagation, thereby improving impact resistance, tensile strength, post-cracking behavior and load-carrying capacity. Polypropylene fibers are lightweight, economical and chemically inert synthetic fibers whose main contributions are the suppression of plastic shrinkage cracking and better resistance to water penetration (Fig. 5). Basalt fibers are naturally derived, eco-friendly fibers with high tensile strength, thermal stability and alkali resistance that improve the toughness and durability of the mortar. Carbon fibers deliver very high stiffness and tensile strength even at low dosages and are non-corrosive and lightweight, although relatively expensive; they markedly improve ductility and crack resistance.



Fig. 5. Polypropylene fibers.

5.8 Specimen Preparation

Ferrocement panels of size 100 × 100 × 8 cm were prepared. The mesh was cut to the required size (Fig. 6), placed in the molds, and the mortar was then placed and finished over it (Figs. 7 and 8).



Fig. 6. Cutting of mesh.



Fig. 7. Placing of mortar.



Fig. 8. Preparation of ferrocement panels.

6. RESULTS AND DISCUSSION

6.1 Ultimate Punching Load and Deflection

The results demonstrate that ferrocement panels with steel mesh and fibers exhibit superior structural performance because of enhanced composite action. As shown in Table 1, the panel with steel mesh and fibers achieved the highest ultimate punching load (43.6 kN) with the lowest deflection (9.97 mm), followed by the single-layer steel mesh panel (35.1 kN; 12.27 mm). The control panel without steel mesh showed the lowest strength (23.22 kN) and the highest deflection (20 mm). Relative to the single-layer steel mesh panel, the addition of fibers increased the ultimate load by about 24%, and relative to the control panel the increase was about 88%.

Table 1. Ultimate punching load and deflection of ferrocement panels

Sample	Panel size (cm)	Deflection, d (mm)	Ultimate punching load (kN)
Panel without steel mesh	100 × 100 × 8	20	23.22
Panel with steel mesh (single layer)	100 × 100 × 8	12.27	35.10
Panel with steel mesh and fibers	100 × 100 × 8	9.97	43.60

6.2 Load–Deflection Behavior

The load–deflection data are given in Table 2 and plotted in Fig. 2. The reinforced panels show higher stiffness and better crack control, whereas the panel without steel mesh deflects far more at every load level. The improved performance is attributed to the combined action of the mesh, which provides primary reinforcement, and the fibers, which enhance crack resistance and energy absorption.

Table 2. Load–deflection results of the panels

Load (kN)	Deflection (mm): steel mesh and fibers	Deflection (mm): steel mesh (single layer)	Deflection (mm): without steel mesh
0	0	0	0
5	0.13	0.5	3.54
10	0.28	1.39	7.24
15	1.06	2.25	12.89
20	1.7	4.78	17.25
23.22	2.65	7.27	20
25	3.11	8.66	22
30	5.39	10.11	24
35	5.94	12.27	25
35.1	5.98	13.25	26.15
40	7.98	14.11	28.11
43.6	9.92	16.05	29.09

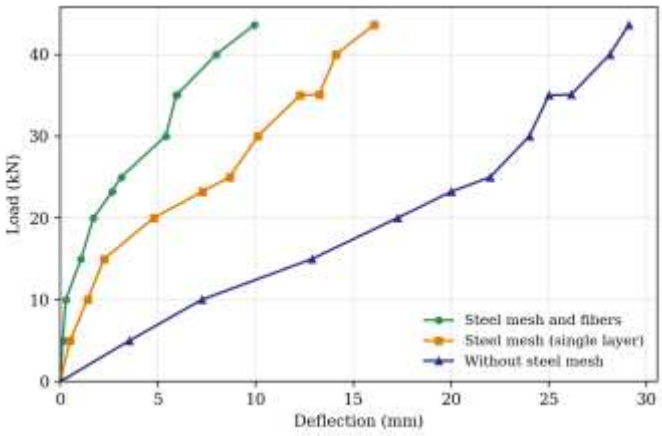


Fig. 2. Load versus deflection of the tested ferrocement panels.

6.3 Practical Implications

The findings confirm that combining fibers with mesh reinforcement markedly improves the strength and stiffness (reduced deflection) of ferrocement panels. Three practical benefits are anticipated. First, structural performance is enhanced, since woven mesh improves tensile strength and crack resistance while fiber-based mortars increase durability and service life. Second, materials can be optimized by developing fiber–mortar composites that balance workability, strength and flexibility, and by identifying suitable fiber types, mesh configurations and mix proportions. Third, sustainability is promoted through the use of fiber reinforcement, possibly

derived from recycled or natural sources, and through lower material consumption made possible by the improved mortar performance.

7. CHALLENGES AND FUTURE SCOPE

Challenges remain in terms of cost, standardization and large-scale implementation. Further research is needed to optimize mix design, to clarify the bond behavior between woven mesh and fiber-reinforced mortar, and to evaluate long-term durability and environmental impact in various applications (Section 4).

8. CONCLUSIONS

The integration of woven mesh and fiber-based mortar alternatives represents a significant advancement in ferrocement technology. These innovations enhance the mechanical properties of ferrocement and address several limitations of conventional systems, such as corrosion susceptibility, uneven stress distribution, shrinkage and microcracking.

In the present laboratory comparison, the panel with steel mesh and fibers achieved the highest ultimate punching load (43.6 kN) with the lowest deflection (9.97 mm), outperforming the single-layer steel mesh panel (35.1 kN) and the control panel (23.22 kN).

Adopting these materials can lead to more sustainable and resilient construction practices. However, further work on long-term performance, optimized mix design, bonding behavior and environmental impact is required before widespread adoption.

REFERENCES

[1] Faraji, M. F., Işık, M. A. M., Bodur, B., Üçdemir, G., Bayraktar, O. Y., Kaplan, G., … & Ozbakkaloglu, T. (2025). Chemical resistance and toughness of fiber-reinforced ferrocement composites in H_2SO_4 and Na_2SO_4 environments: Enhancing the flexibility of structural foam concrete. *Construction and Building Materials*, *481*, 141593.

[2] Mukherjee, A., & Kaushik, H. B. (2025). Effectiveness of ferrocement composites in enhancing the shear and flexural behavior of masonry wallettes: Experimental and analytical study. *Engineering Structures*, *343*, 121072.

[3] Sierra, I. E. M., Salinas, J. C., Manzano, M. A. R., & Zúñiga, A. P. G. (2025). Evaluation of human-induced vibration of ferrocement in lightweight constructive systems. *Results in Engineering*, *26*, 105376.

[4] Miah, M. J., Miah, M. S., Hasan, N. M. S., Sobuz, M. H. R., & Li, Y. (2025). Role of recycled crushed clay bricks as fine aggregates in enhancing the performance of ferrocement-strengthened RC beams. *Construction and Building Materials*, *478*, 141412.

[5] Mohana, R., & Bharathi, S. L. (2024). Assessment on the mesh and mortar effect of the impact resistant nano fly ash based geopolymer ferrocement panels using rubber and plastic aggregates. *Structures*, *68*, 107147. Elsevier.

[6] Abdallah, A. M., Badawi, M., Elsamak, G., Hu, J. W., Mlybari, E. A., & Ghalla, M. (2024). Strengthening of RC beams with inadequate lap splice length using cast-in-situ and anchored precast ECC ferrocement layers mitigating construction failure risk. *Case Studies in Construction Materials*, *20*, e02747.

[7] Sen, D., Alwashali, H., Islam, M. S., Seki, M., & Maeda, M. (2023). Lateral strength evaluation of ferrocement strengthened masonry infilled RC frame based on experimentally observed failure mechanisms. *Structures*, *58*, 105428. Elsevier.

[8] Barbhuiya, S., Adak, D., Marthong, C., & Forth, J. (2025). Sustainable solutions for low-cost building: Material innovations for Assam-type house in North-East India. *Case Studies in Construction Materials*, *22*, e04461.

[9] Hematibahar, M., Nikolai, V., Petrů, J., Bashir, M. N., Hasanzadeh, A., Tesfaldet, G., … & Bakhtiyari, A. (2025). Experimental evaluation of mechanical strength of silica fume-cemented sand reinforced with 3D-printed fibers. *Journal of Materials Research and Technology*.

[10] Xu, H., Gao, C., Wang, L., Jin, H., Lin, J., Chen, L., … & Ngo, T. (2026). Exploring sustainable alternatives: Limestone waste powder and silica fume in designing low-carbon shotcrete for enhanced mechanical, microstructural and sustainable properties. *Construction and Building Materials*, *507*, 145087.

[11] Zhao, B., Fu, Y., Zhong, Y., Cui, M., Yang, H., Zhang, W., … & He, X. (2025). Enhancing fire resistance through the synergy of gypsum and fumed silica composites: Mechanisms and performance. *Case Studies in Construction Materials*, *22*, e04797.

[12] de Souza, E. A., Borges, P. H., Stengel, T., Nematollahi, B., & Bos, F. P. (2024). 3D printed sustainable low-cost materials for construction of affordable social housing in Brazil: Potential, challenges, and research needs. *Journal of Building Engineering*, *87*, 108985.

[13] Ribeiro, G. D., Hiranobe, C. T., da Silva Araújo, S., da Silva Filgueira, M., Rocha, J. A., Mukuno, J. S., … & dos Santos, R. J. (2024). Sustainable construction materials for low-cost housing: Thermal insulation potential of expanded SBR composites with leather waste. *Journal of Materials Research and Technology*, *30*, 5590–5604.

[14] Raj, P. V., Teja, P. S., Siddhartha, K. S., & Rama, J. K. (2021). Housing with low-cost materials and techniques for a sustainable construction in India – A review. *Materials Today: Proceedings*, *43*, 1850–1855.

[15] Hago, A. W., Al-Jabri, K. S., Alnuaimi, A. S., Al-Moqbali, H., & Al-Kubaisy, M. A. (2005). Ultimate and service behavior of ferrocement roof slab panels. *Construction and Building Materials*, *19*(1), 31–37.

[16] Mahmood, A., Kaish, A. B. M. A., Mohammed Ali, T. K., Al Zand, A. W., Jamil, M., & Hamid, R. (2023).

Prefabricated ferrocement jacket for repairing and strengthening axially loaded square sub-standard concrete stub columns. *Buildings*, *13*(10), 2484.

[17] Joyklad, P., Gadagamma, C. K., Maneengamlert, B., Nawaz, A., Ejaz, A., Hussain, Q., & Saingam, P. (2024). Structural behavior of RC one-way slabs strengthened with ferrocement and FRP composites. *Engineering Failure Analysis*, *161*, 108328.

[18] Eltaly, B. A., Shaheen, Y. B., EL-boridy, A. T., & Fayed, S. (2023). Ferrocement composite columns incorporating hollow core filled with lightweight concrete. *Engineering Structures*, *280*, 115672.

[19] Miah, M. J., Miah, M. S., Hasan, N. M. S., Sobuz, M. H. R., & Li, Y. (2025). Role of recycled crushed clay bricks as fine aggregates in enhancing the performance of ferrocement-strengthened RC beams. *Construction and Building Materials*, *478*, 141412.

[20] Amala, M., & Umarani, C. (2024). Experimental investigation on mechanical and microstructural properties of self-compacting geopolymer concrete with different mineral admixtures. *Materials Research Express*, *11*(9), 095305.

[21] Minde, P., Bhagat, D., Patil, M., & Kulkarni, M. (2023). A state-of-the-art review of ferrocement as a sustainable construction material in the Indian context. *Materials Today: Proceedings*.

[22] Shah, T., & Gupta, A. (2025). A comparative analysis of current and emerging construction materials and techniques. *Ecology, Environment & Conservation (0971765X)*, *31*, S78.

[23] Ahmad, S. S., Elshirbeny, A. M., Elshami, A. A., Aboubakr, A., El-Sadany, R. A., & Elmahdy, M. A. (2026). Evaluation of the Mechanical Performance and Carbon Sequestration in Ferro-Rock Sustainable Concrete Through Partial Cement Replacement and Controlled CO2 Curing. *Sustainability*, *18*(11), 5676.