Journal of Smart Infrastructure and Environmental Sustainability

Journal of Smart Infrastructure and Environmental Sustainability, ISSN 3107-7358, Vol. 3, No. 3, 2026 (pp.1-7)

RESEARCH ARTICLE AASRRESEARCH.COM

Experimental Investigation on the Flexural Behaviour of Precast Ferrocement Panels Reinforced With Galvanized Welded Wire Mesh for Low-Cost Housing Applications

Donthula Sarika[1], Mukkala Priyankaa[2]

[1,2]*Malla Reddy Engineering College and Management Sciences*

KEYWORDS:

Ferrocement;
Precast Ferrocement Panels;
Galvanized Welded Wire Mesh;
Flexural Strength;
Ductility Index;
Low-Cost Housing.

ARTICLE HISTORY:

Submitted : 18.05.2026
Revised : 12.06.2026
Accepted : 14.07.2026

DOI:
https://doi.org/10.17051/JSIES/03.03.01

Abstract

The increasing demand for affordable and durable housing has stimulated interest in precast ferrocement panels as an economical alternative to conventional reinforced concrete elements. Ferrocement panels with galvanized welded wire mesh reinforcement, however, need more experimental assessment in order to evaluate the flexural properties of such panels and ensure their suitability for application in the structural components of low-cost housing. The present study aims to explore the flexural behaviour of precast ferrocement panels reinforced using different types of galvanized welded wire mesh through an experimental study. The panels were cast and cured under controlled conditions using a cement–sand–mortar mix; tests for their structural response were conducted under the four-point bending method. The performance has been evaluated based on ultimate load capacity, midspan deflection, flexural strength, crack pattern and ductility index. The experimental results suggest that the panels reinforced by a higher number of galvanized welded wire mesh layers have higher flexural capacity, better crack distribution and higher energy absorption, but also lower ductility than the panels reinforced by fewer layers of welded wire meshes. The results confirm that the precast ferrocement panels are a novel solution, which can be used as a structurally efficient construction material for sustainable low cost housing applications, with light weight and cost-effective characteristics.

Author's e-mail: sarikadonthula@gmail.com, mukkalapriyanka@mrem.ac.in

How to cite this article: Sarika D, Priyankaa M, Experimental Investigation on the Flexural Behaviour of Precast Ferrocement Panels Reinforced With Galvanized Welded Wire Mesh for Low-Cost Housing Applications, Journal of Smart Infrastructure and Environmental Sustainability, Vol. 3, No. 3, 2026 (pp.1-7)

1. Introduction

The growing need for affordable, long-lasting, and sustainable housing solutions in cities has been further intensified by the rapid urbanization and population growth. The construction of conventional reinforced concrete buildings is generally inefficient in terms of resource utilization, time and manpower, and is therefore not the preferred option in low-cost housing applications. Ferrocement has been developed as a potential alternative for its low weight, high strength to weight ratio, ease of fabrication and high crack resistance. Ferrocement is a rich cement mortar, with a close spacing of wire mesh, providing greater efficiency in structures with less conventional reinforcement. All these qualities make ferrocement a very interesting material for precast structural components to be employed in residential building.

Precast construction has received significant attention as it has been shown to offer the potential to increase the quality of construction, decrease the need for labor during construction, reduce time for projects to complete, and decrease the amount of wastage of materials. Precast concrete construction in conjunction with ferrocement panels offers an effective combination for the production of standardized structures of good quality, low cost, and fast construction. Galvanized welded wire mesh is one of the available reinforcement materials, which can provide many advantages: such as high tensile strength, uniform reinforcement distribution, good bonding properties, corrosion resistance and high durability when used in special conditions. These

properties help in providing more crack control and higher load carrying capacity of ferrocement panels.

Despite the extensive use of ferrocement in building applications, the flexural behaviour of precast ferrocement panels reinforced with galvanized welded wire mesh has not been comprehensively investigated. Previous investigation has been mostly on wire meshes or cast-in-place ferrocement structures, while few studies have considered the behaviour of flexural strength, crack propagation, ductility, and the structural performance of the welded galvanized wire mesh in precast structures. Therefore, in the context of affordable housing the evidence supporting its use is still limited.

The present study addresses this research gap by an experimental study on four-point bending tests on precast ferrocement panels reinforced with GWWM. Ultimate load capacity, flexural strength, mid-span deflection, crack pattern and ductility are some of the parameters used to evaluate the structural performance. The findings of this research would offer practical suggestions for precast ferrocement panels in the building of sustainable low-cost housing which is durable, light and cost effective.

2. Literature Review

Ferrocement composites are widely studied and explored because of their high tensile strength, crack control property and the ease of fabrication, for use as lightweight cementitious material, either as a structural component or non-structural component [11]. The typical ferrocement element is a rich cement mortar made with multiple layers of closely spaced wire mesh, and have better strength-to-weight ratio and higher durability than conventional reinforced concrete [7]. Ferrocement has taken up various applications such as roofing structures, water tanks, wall panels, shells, and bridge structures due to these benefits [8]. The optimization of the properties of the mortar and reinforcement arrangements to enhance the mechanical properties and service life of ferrocement composites in a variety of loading situations has also been a subject of recent studies [9].

The flexural behaviour of ferrocement panels has been investigated in several experimental studies with monotonic loading [11]. As the mesh reinforcement increased the results show that the ultimate load capacity, stiffness, ductility and energy absorption increase and the width of crack decreases and propagation of crack delays.As the amount of mesh reinforcement becomes greater, the ultimate load capacity, stiffness, ductility and energy absorption increases and the crack width decreases and the propagation of the crack becomes delayed. It has been reported that the distribution and orientation of reinforcement greatly affect the load-deflection response and failure characteristics of ferrocement panels [2]. Besides, the precast production of panels has been noticed to exhibit greater dimensional accuracy, uniformity in material quality and time reduction in construction, in addition making it more and more appealing to use for the modular and industrialized building systems [1].

Galvanized welded wire mesh has become a hotspot of reinforcement material, which has excellent corrosion resistance, high strength and stable geometric shape, superior to the traditional woven wire mesh [6]. The use of the galvanized coating leads to better protection from moisture-induced corrosion, thus increasing the long-term durability of the elements of Ferrocement exposed to aggressive climatic conditions [14]. Also, the welded intersections provide consistent load transfer and reinforcement distribution throughout the mortar matrix, helping to enhance crack control and flexural performance [5]. Due to the above properties, galvanized welded wire mesh is considered to be a very appropriate material for precast ferrocement panels designed for economy in house production that must have a long life and be easily maintained [13].

Although previous studies have established the general benefits of ferrocement construction, limited research has specifically examined the flexural behaviour of precast ferrocement panels reinforced with galvanized welded wire mesh [11]. There is very limited experimental data available on the structural efficiency of galvanized welded wire mesh in precast applications as compared to traditional reinforcement types or cast-in-place ferrocement structures [4]. Thus, it is necessary to carry out a thorough experimental assessment to determine its effect on the ultimate load capacity, flexural strength, crack formation and ductility. The motivation of this study is to provide dependable experimental data to support the development of durable, lightweight and economical precast ferrocement panels which enable the construction of low cost eco-friendly houses.

3. Materials And Methods

3.1 Materials Characterization

Ordinary Portland Cement (OPC 53 grade), fine aggregate, potable water, and galvanized welded wire mesh were used to fabricate the precast ferrocement panels. The materials selected for the present experimental investigation were chosen because they have good strength, durability and workability. The physical and mechanical properties of constituent materials are given in Table 1.

Table 1. Physical and Mechanical Properties of Constituent Materials

Material	Property	Value
Ordinary Portland Cement (OPC 53)	Specific Gravity	3.15
	28-Day Compressive Strength	55 MPa
Fine Aggregate	Specific Gravity	2.64
	Fineness Modulus	2.68
Water	Type	Potable Water
Galvanized Welded Wire Mesh	Wire Diameter	1.2 mm
	Mesh Size	12 × 12 mm
	Yield Strength	450 MPa
Mortar	Mix Proportion (C:S)	1:2
	Water–Cement Ratio	0.45

As shown in Table 1, the OPC 53 grade cement has a specific gravity of 3.15 and a 28-day compressive strength of 55 MPa. The Specific Gravity of the fine aggregate is 2.64 and Fineness Modulus is 2.68. The reinforcement was made of galvanized welded wire mesh of 12 × 12 mm mesh size and 450 MPa yield strength. The suitable workability and strength of precast ferrocement panels were achieved by preparing the mortar with a ratio of 1:2 (cement to sand) and a water–cement ratio of 0.45.

3.2 Mix Design and Specimen Preparation

The precast ferrocement panels were made by the cement mortar with 1:2 (cement to sand) and 0.45:1 (water–cement) ratio that could have adequate

workability and strength. The panels were made in the steel moulds 1000mm X 300mm X 30mm. These were prepared with a 5 mm clear cover and nine specimens with one, two and three layers of galvanized welded wire mesh. All specimens were demoulded after the initial setting period and water cured 28 days prior to flexural testing. The selected proportions of composition of the mortar as well as the dimensions of the specimens used in this work are shown in Table 2.A total of nine test specimens were made, three for each reinforcement configuration: one, two and three mesh layers. To guarantee repeatability and reliability of measurement of flexural performance, the average values of flexural performance reported in the experiments were averaged over the three specimens in each group.

Table 2. Mortar Mix Proportions and Specimen Dimensions

Parameter	Specification
Cement: Sand Ratio	1: 2
Water–Cement Ratio	0.45
Panel Length	1000 mm
Panel Width	300 mm
Panel Thickness	30 mm
Number of Specimens	9
Number of Reinforcement Layers	1, 2, and 3
Clear Cover	5 mm
Curing Period	28 days

3.3 Reinforcement Configuration

Galvanized welded wire mesh was used as the primary reinforcement in all precast ferrocement panels. The opening was 12 × 12 mm and the wire diameter was 1.2 mm for the mesh. The reinforcement was set within the length and width of the panel to provide continuous tensile resistance and to control the cracks. The three different configurations of reinforcement, one-layer, two-layer and three-layer, are shown in Figure 1.

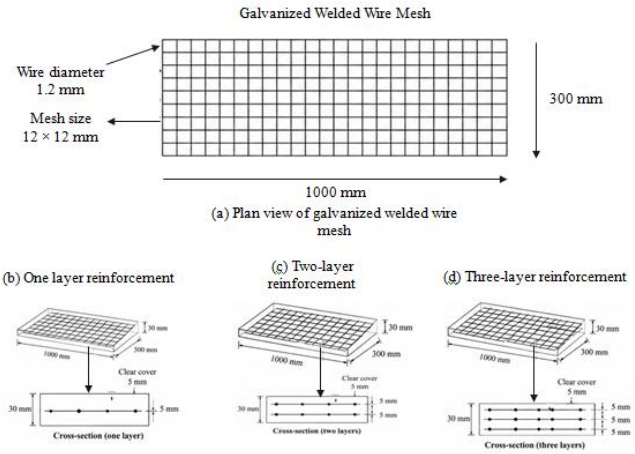

Fig. 1. Reinforcement Layout of Galvanized Welded Wire Mesh

A total of nine panels were divided into three reinforcement groups, as summarized in Table 3. Specimens FP-1 to FP-3 had one layer of mesh; FP-4 to FP-6 had two mesh layers and FP-7 to FP-9 had three mesh layers. All specimens had the same wire diameter and mesh size to help isolate the influence of the number of reinforcement layers on flexural performance.

Table 3. Reinforcement Details of Test Specimens

Group	Specimens	Number of Mesh Layers
G1	FP-1 - FP-3	1
G2	FP-4 - FP-6	2
G3	FP-7 - FP-9	3

A uniform clear cover of 5 mm was maintained to protect the galvanized mesh and provide good bond

with the mortar matrix. In the case of multilayer panels, the mesh layers were arranged evenly across the thickness of the panel at the proper spacing and in proper alignment. This reinforcement arrangement was chosen to study its effect on load-carrying capacity, load-carrying crack distribution, deflection and ductility.

3.4 Experimental Flexural Test Setup

The flexural performance of the precast ferrocement panels were tested under static loading conditions on a four-point bending test. Tests were conducted on all of them with a universal testing machine (UTM) using simply supported loading to assure a constant bending moment in the central area of the panel. The experimental setup comprised of two support rollers, two loading rollers connected by spreader beam, hydraulic actuator and calibrated load cell. The four-point flexural test set-up is illustrated in Figure 2.

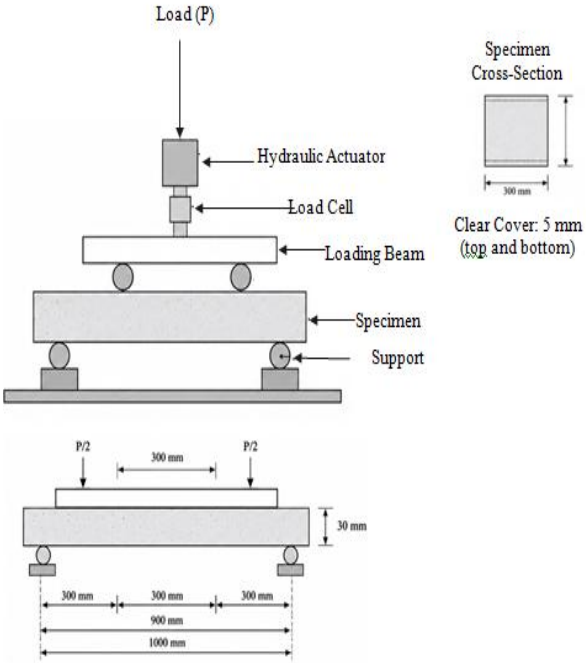

Fig. 2. Four-Point Flexural Test Setup

The specimen was mounted on two support rollers, having an effective support span of 900 mm and the load was applied through the two load points symmetrically distributed about the mid-span. Load was slowly increased until the failure was reached. Load applied was measured with the load cell, and mid span deflection was measured with the use of a Linear Variable Differential Transformer (LVDT) during the test. All crack initiation, propagation, ultimate load and failure mode were observed during loading.

The flexural strength of the tested panels was calculated using

$$f_r = \frac{PL}{bd^2}, \qquad (1)$$

where f_r is the flexural strength (MPa), P is the ultimate load (N), L is the effective span (mm), b is the panel width (mm), and d is the panel thickness (mm).

The recorded load and deflection data were used to evaluate the flexural performance of the ferrocement panels in terms of ultimate load capacity, stiffness, crack behaviour, and ductility.

3.5 Experimental Procedure and Performance Evaluation

The flexural tests were conducted by placing each precast ferrocement panel on the support rollers of the four-point bending test setup. The load was applied by the loading rollers by means of a hydraulic actuator, incrementally applied up to failure. During the test applied load was measured and corresponding deflection at mid-span was also measured. The following four test types were observed: crack initiation, crack propagation, crack distribution and failure mode. Failure was considered as the maximum load carrying capacity, followed by an appreciable drop in load carrying capacity or excessive deflection. Three performance parameters such as ultimate load capacity, flexural strength, mid span deflection, crack pattern and ductility index were considered in the performance evaluation of the ferrocement panels. The flexural behaviour of the one-, two- and three-layer panels reinforced with galvanized welded wire meshes was compared to study the influence of the reinforcement configuration

4. Results And Discussion

4.1 Load-Deflection Behaviour

The load-deflection behaviour of the precast ferrocement panels reinforced with one, two, and three layers of galvanized welded wire mesh is presented in Figure 3. All the specimens showed a linear response prior to crack initiation and a decrease in stiffness with increasing loads.

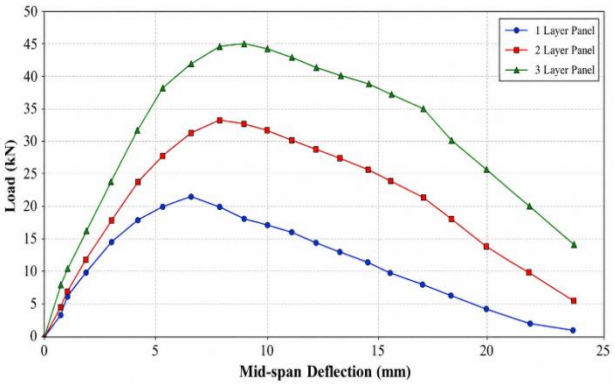

Fig. 3. Load-Deflection Curves of Tested Panels

The one-layer panel was able to support an ultimate load of approx. 21.5 kN, with a mid-span deflection of 6.5 mm, as shown in Figure 3. The ultimate load values obtained for the two-layer panel were approximately 33.0 kN, and the three-layer panel had the highest ultimate load value of approximately 45.0 kN. The added reinforcement layers enhanced load carrying capacity and the deformation of the panels.

The flexural stiffness was calculated using

$$K = \frac{P}{\delta}, \quad \text{(2)}$$

where $K$is the flexural stiffness (N/mm), $P$is the applied load (N), and $\delta$is the mid-span deflection (mm).

The results indicate that increasing the number of galvanized welded wire mesh layers enhanced the initial stiffness, ultimate load capacity, and overall flexural performance of the precast ferrocement panels.

4.2 Flexural Strength Performance

The flexural strength comparison of panels with one, two and three layers of galvanized welded wire mesh is presented in Figure 4.

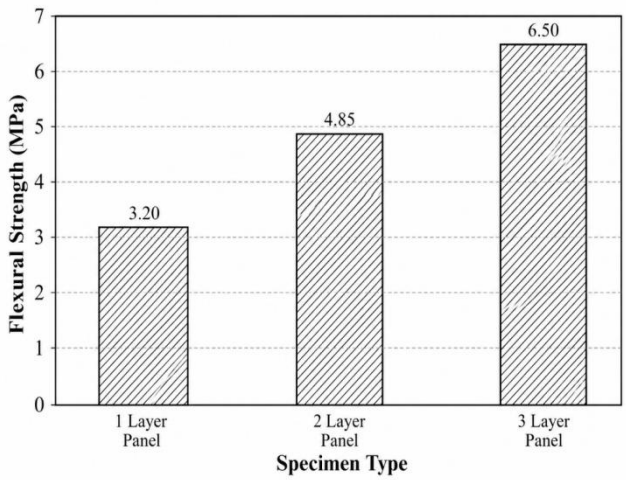

Fig. 4. Flexural Strength Comparison

The one layer panel had a flexural strength of 3.20MPa and the two layer panel had a flexural strength of 4.85MPa, which is about 51.6% increase. The panel with three layers, with flexural strength of 6.50MPa, showed the greatest increase by some 103.1% compared to the one-layer panel and 34.0% compared to the two-layer panel. The results in the present study indicate that the flexural capacity of precast ferrocement panels increases with the number of the welded galvanized wire mesh layers. To find the ultimate bending moment, the following formula was used:

$$M_u = \frac{PL}{4}, \quad \text{(3)}$$

where $M_u$is the ultimate bending moment (N·mm), $P$is the ultimate load (N), and $L$is the effective span (mm). The results confirm that increasing the number of galvanized welded wire mesh layers significantly improves the flexural capacity of the precast ferrocement panels.

4.3 Crack Initiation and Failure Modes

The crack initiation and failure behaviour of the precast ferrocement panels varied with the number of galvanized welded wire mesh reinforcement layers. The first indication of cracking was always found at the mid-span tension zone where the maximum bending moment was seen. As the applied load increased, the cracks propagated upwards and kept growing towards the compression zone. The one-layer panel had a predominant flexural crack and relatively wide crack opening. This resulted in early failure of the panel. The two layer panel, on the other hand, showed several fine cracks spread throughout the tension zone, which allowed to achieve better crack control and delayed failure. Among the three layer panels, the one with the highest crack distribution, having the narrowest crack width, had good stress redistribution and higher structural integrity. Both ultimate and failure load were dominated by flexural cracking of all specimens with localized crushing in compression zone in the mortar. The flexural performance of precast ferrocement panels, in terms of crack width and delay of crack propagation was observed to improve with the increase in number of reinforcement layers used, showing the effectiveness of galvanized welded wire mesh in improving the flexural performance of precast ferrocement panels.

4.4 Ductility Performance

The ductility behaviour of the precast ferrocement panels was evaluated based on the mid-span deformation recorded during the flexural tests. The panels made from higher number of layers of galvanized welded wire mesh showed higher deformation capacity before failure, which was considered as better ductile behaviour. This three layered panel had the highest ultimate deflection followed by the two layered panel and finally the one layered panel, which had comparatively less deflection and failed early.

The ductility index was calculated using

$$\mu = \frac{\delta_u}{\delta_y}, \quad \text{(4)}$$

where $\mu$is the ductility index, $\delta_u$is the ultimate deflection (mm), and $\delta_y$is the deflection at yield (mm).

The increase in reinforcement layers enhanced the energy absorption capacity and post-cracking performance of the ferrocement panels. The multi-layer reinforcement effectively mitigated the widening

of cracks and improved the ductility and structural resilience of the panels by allowing them to withstand larger deformations before failure.

4.5 Discussion

The experimental results demonstrated that increasing the number of galvanized welded wire mesh reinforcement layers significantly improved the flexural behaviour of the precast ferrocement panels. The two-layer and three-layer panels had a higher load carrying capacity, higher flexural strength, higher stiffness, narrower crack width and higher ductility than the one-layer panel. The three-layer panel always proved to have the best structural performance, which suggests that the more layers of reinforcement, the more it delayed the propagation of cracks and the greater the deformation capacity until failure. The behaviour observed is similar to that seen in earlier studies, which found that a multilayer mesh of reinforcement did provide an improved stress distribution, crack control and improved flexural capacity of the ferrocement structural elements. The corrosion resistance of galvanized welded wire mesh allows for long-term use in structures, adding to its durability. The results show that precast ferrocement panels reinforced with GWM are lightweight, easy to cast and present a practical and cost-effective alternative to low cost housing, as they exhibit better structural performance. This study, however, only examines the flexural behavior of the materials under static loading conditions on a laboratory scale. To assess long-term durability, environmental exposure, fatigue behaviour and full-scale structural performance in the field, future investigations should be conducted.

5. Conclusion

In this study, the flexural behaviour of precast ferrocement panel with galvanized welded wire mesh as reinforcement was investigated experimentally for low-cost house construction. The outcome showed that more the number of the reinforcement layers, more was the flexural performance of the reinforced panels. The one-layer panels had relatively lower structural performance as compared to the three-layer reinforced panels which showed the highest ultimate load capacity, flexural strength, ductility and crack resistance. The application of galvanized welded wire mesh was effective to decrease the propagation of cracks, enhance the post-cracking behaviour and increase the energy absorption ability of the ferrocement panels. The results of the experiments have been shown to validate the use of the multilayer galvanized welded wire mesh reinforcement as an effective way of enhancing the structural behaviour and serviceability of precast ferrocement panels. In conclusion, the proposed precast ferrocement panel system promises to be a lightweight, cost-effective, and structurally sound approach to building affordable housing. Future research should address the durability, cyclic and impact load characteristics, environmental exposure, and implementation in full-scale applications in order to further validate the suitability of the proposed system of load transfer for use in actual engineering applications.

References

1. Abubakar, A. B., &Kushefati, W. H. (2025). Mechanical and durability properties of alkali-activated composites: a review and statistical inference on critical parameters. *Innovative Infrastructure Solutions*, *10*(8), 346.
2. Ali, M., Liu, A., Sou, H., &Chouw, N. (2012). Mechanical and dynamic properties of coconut fibre reinforced concrete. *Construction and Building Materials*, *30*, 814-825.
3. BIS, I. (2013). 12269: 2013; Ordinary Portland Cement, 53 Grade Specification. *Bureau of Indian Standards (BIS): New Delhi, India*, 1-14.
4. Caggiano, A., Folino, P., Lima, C., Martinelli, E., & Pepe, M. (2017). On the mechanical response of hybrid fiber reinforced concrete with recycled and industrial steel fibers. *Construction and Building Materials*, *147*, 286-295.
5. Li, J., Zhou, J., Bao, Y., & Zhang, B. (2026). A review on carbon-reducing and sequestrating building materials in the context of green development. *Materials Research Express*, *13*(1), 012002.
6. Luo, X., Xie, K., & Qin, Y. (2025). Study of the modification mechanism and reinforcement performance of functionalized graphene-based structural adhesives. *Composite Interfaces*, *32*(7), 1069-1095.
7. Mechtcherine, V. (2013). Novel cement-based composites for the strengthening and repair of concrete structures. *Construction and building materials*, *41*, 365-373.
8. Popescu, C., Sas, G., Blanksvärd, T., &Täljsten, B. (2017). Performance of RC Walls with Openings Strengthened by Fiber Reinforced Polymers: An Experimental and Theoretical Investigation. In *International Conference on Advances in Construction Materials and Systems & 71st RILEM Annual Week, Chennai, India, September 3-8 2017* (Vol. 2, pp. 509-517). Rilem publications.
9. Sakir, S., Raman, S. N., Safiuddin, M., Kaish, A. A., & Mutalib, A. A. (2020). Utilization of by-products and wastes as supplementary cementitious materials in structural mortar for sustainable construction. *Sustainability*, *12*(9), 3888.
10. Salawu, G., & Glen, B. (2026). Integrating Artificial Intelligence into Mechatronics: A Comprehensive Study of Its Influence on System Performance, Autonomy, and Manufacturing Efficiency. *Technologies (2227-7080)*, *14*(3), 143.
11. Shaheen, Y. B., Eltaly, B. A., Yousef, S. G., & Fayed, S. (2023). Structural performance of ferrocement beams incorporating longitudinal hole filled with lightweight concrete. *International Journal of Concrete Structures and Materials*, *17*(1), 21.

12. Standard, I. (2019). IS 10262: 2019 Concrete Mix Proportioning-Guidelines. *Bur. Indian Stand., vol. Second Rev*, 1-40.
13. Yassin, M. H., Farhat, M. H., Soleimanpour, R., & Nahas, M. (2024). Fiber Bragg grating (FBG)-based sensors: a review of technology and recent applications in structural health monitoring (SHM) of civil engineering structures. *Discover Civil Engineering*, *1*(1), 151.
14. Zheng, Y., Wang, L., Xu, H., Zhang, T., Zhang, P., & Qi, M. (2025). Microbial Mineral Gel Network for Enhancing the Performance of Recycled Concrete: A Review. *Gels*, *11*(8), 581.