

Strengthening and Retrofitting of Beam by Using Ferrocement

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ABSTRACT

This study investigates the effectiveness of ferrocement jacketing as a strengthening and retrofitting technique for reinforced concrete (RC) beams. An experimental program was conducted on a control beam and beams retrofitted with 19-gauge and 23-gauge wire mesh using single, double, and triple layers. Load-deflection behavior, crack patterns, stiffness, and failure modes were examined. The results demonstrate significant improvement in load-carrying capacity, stiffness, and crack resistance for retrofitted beams, with superior performance observed for lower-gauge (thicker) wire mesh and multiple layers. The study confirms ferrocement as a cost-effective and efficient solution for extending the service life of deteriorated RC beams.

Keywords- Ferrocement, Retrofitting, Reinforced concrete beam, Wire mesh, Strengthening.

I. INTRODUCTION

Ferrocement is a thin composite material consisting of cement mortar reinforced with layers of fine wire mesh. It offers high tensile strength, improved crack resistance, and enhanced durability. Originally introduced by Joseph Monier in the nineteenth century and later developed by P. L. Nervi in the 1940s, ferrocement was initially used in boats and shell structures and has since gained wide application in strengthening and retrofitting reinforced concrete and masonry structures.

Reinforced concrete structures deteriorate over time due to corrosion of reinforcement, chemical attack, overloading, environmental exposure, and poor construction practices. Such deterioration leads to cracking, spalling, and reduction in load-carrying capacity. Retrofitting becomes essential to restore structural performance and ensure safety. Ferrocement jacketing provides a lightweight, economical, and effective strengthening solution with minimal increase in member dimensions.

The present study aims to experimentally evaluate the performance of RC beams strengthened and retrofitted using ferrocement wire mesh jackets and to compare their behavior with a control beam.

II. MATERIALS USED AND METHODS

i) Materials used

The experimental program utilized M25 grade concrete with a characteristic compressive strength of 25 MPa. Ordinary Portland Cement (OPC) 53 grade conforming to IS 12269 was used as the binder. Fine aggregate consisted of locally available river sand with a fineness modulus of 2.5, and coarse aggregate was crushed stone with a nominal size of 20 mm.

To improve workability and strength characteristics, Auromax superplasticizer was added at 1% by weight of cement. Steel reinforcement bars of Fe 500 grade were used in the beam specimens.

For Strengthening purposes, galvanized iron (GI) wire mesh of 19 gauge (1.0 mm) and 23 gauge (0.6mm) were used. The mesh was wrapped around the beam surfaces. The ferrocement jacket improved the shear and flexural performance of the beam under loading.

ii) Methodology

An experimental investigation was carried out on reinforced concrete beams cast and tested under flexural loading. One beam was tested as a control specimen without any strengthening. Additional beams were retrofitted using ferrocement jacketing incorporating 19-gauge and 23-gauge wire mesh. Single-layer, double-layer, and triple-layer mesh configurations were adopted.

The ferrocement mortar was applied around the beam surface after proper surface preparation. The beams were tested under gradually applied load, and deflections were measured using dial gauges and LVDTs. Crack initiation, crack propagation, ultimate load, and failure modes were carefully observed and recorded.

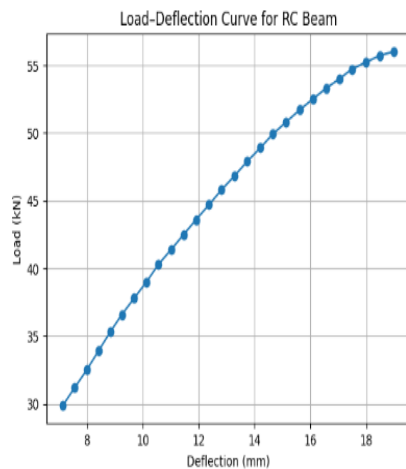
III. RESULTS

The control beam exhibited the lowest load-carrying capacity and higher deflections, serving as a baseline for comparison. Beams retrofitted with ferrocement showed significant improvement in strength, stiffness, and crack control. (fig. a)

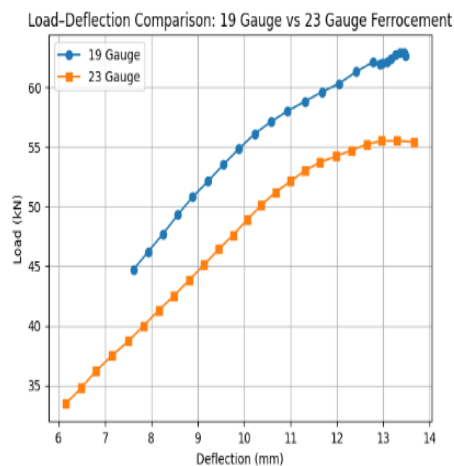
Comparison between mesh gauges indicated that beams retrofitted with 19-gauge wire mesh performed better than those with 23-gauge mesh. The thicker mesh provided better stress transfer and higher stiffness. Increasing the number of wire mesh layers further enhanced load-carrying capacity and reduced deflections. Double-layer retrofitting improved capacity by approximately 20–25% compared to single-layer retrofitting. (fig. b)

Load–deflection curves revealed that retrofitted beams carried substantially higher loads at the same deflection levels. Failure modes of retrofitted beams were more ductile, characterized by multiple fine cracks with delayed propagation, whereas control beams failed in a brittle manner.

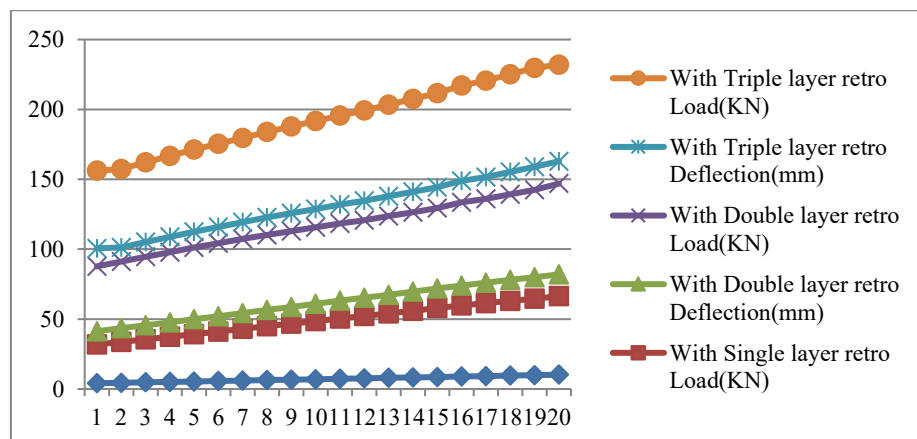
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(fig. a)



(fig. b)



(fig. c)

IV. DISCUSSION

The results indicate that strengthening and retrofitting of beams using ferrocement significantly enhance load-carrying capacity and stiffness compared to conventional beams. The application of ferrocement layers effectively controls crack propagation and reduces deflection under loading. Improved ductility and energy absorption were also observed, demonstrating the suitability of ferrocement for structural rehabilitation. Overall, ferrocement proves to be a cost-effective and efficient technique for extending the service life of existing reinforced concrete beams.

V. CONCLUSIONS

The experimental investigation confirms that ferrocement jacketing is an effective technique for strengthening and retrofitting reinforced concrete beams. Beams retrofitted with lower-gauge (thicker) wire mesh and multiple mesh layers demonstrated superior performance in terms of strength, stiffness, ductility, and crack resistance. Ferrocement retrofitting offers a practical, economical, and durable solution for extending the service life of existing RC structures.

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