

Retrofitting of Reinforced Concrete Beams Using Ferrocement & Epoxy Resin

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ABSTRACT: R.C components exhibit distress and collapse due to various factors and hence need strengthening. In this investigation the performance of R.C. beams is strengthened by epoxy injection and Ferrocement. 15 beams of rectangular cross section were casted using M₂₀ grade concrete and were tested for collapse load. Further beams were stressed upto 70%, 80%, 85%, & 90% respectively. The investigation shows that upto 85% the pre-damaged beams can be strengthened using epoxy and Ferrocement.

KEYWORDS: Ferrocement , Epoxy Injection , Pre – Damaged Beams

I. INTRODUCTION

Concrete structures are normally designed to last long some of them do last a great length of time, but some of them became unusable and are in need of restoration or repair. Old and ancient structures needing extensive amount of rehabilitation is not a matter of grave concern, however fact that some of the relatively newly constructed structures are also showing signs of decay in their early life spans, sometimes even within a decade or two of their construction is quite disturbing.

Various techniques like; plate bonding technique, concrete replacement technique and injection techniques are used to repair or retrofit these structures. But, ferro cement technique is commonly used for retrofitting due to its lightness and development of finer cracks for the same steel-stress under loading.

1.2 FERROCEMENT

Ferrocement is a term commonly used to describe a steel-and-mortar composite material. Essentially a form of reinforced concrete, it exhibits behaviour so different from conventional reinforced concrete in performance, strength, and potential application that it must be classed as a completely separate material. It differs from conventional reinforced concrete in that its reinforcement consists of closely spaced, multiple layers of steel mesh completely impregnated with cement mortar. Ferrocement can be formed into sections less than 1 inch thick (250mm), with only a fraction of an inch of cover over the outermost mesh layer. Conventional concrete is cast into sections several inches thick with an inch or so of concrete cover over the outermost steel rods.

1.3 PROCESS OF RETROFITTING

Step 1: Breaking open the damaged spalled cover or the affected zone or the cover of RCC elements (such as beams or columns) with the help of a chisel and hammer.

Step 2: Exposing the original reinforcing bars and scraping of corrosive layers of reinforcement and applying anti-corrosive paints (if any) or cutting and replacing the corroded reinforcement

Step 3: Roughening the concrete surface, and placing chicken and/or galvanised wire/ weld mesh in position and the mesh should get fixed/ embedded to original slab/beam/column reinforcement. Use skeletal reinforcement, if required.

Step 4: Applying cement mortar on the reinforcing wire-mesh by hand or through spraying (similar to Guniting/ Shotcreting methods)

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Step 5: Provide necessary curing for 28 days. Alternatively, ferrocement membrane protective layer can be carried out. In this, layers of closely spaced wires can be used on to the RCC surfaces to prevent crack widening. The cement matrix is in proportion of about 1:2 and has admixtures which reduce shrinkage and develop early high strength.

II. RELATED WORKS

2.1.MATERIAL PROPERTIES:

The properties of the material, which are used for the investigation, are presented in this section. All the experiments that are adopted to determine characteristics of the material are carried out as per Indian standard. This section includes design for concrete as per Indian standard. The materials used in this experimental work are Cement, fine aggregate, coarse aggregate.

2.1.1 CEMENT:

Cement is a well-known building material has occupied an indispensable place in construction works. Cement is an extremely ground material having adhesive ingredients.

2.1.2.FINE AGGREGATES:

River sand passing through IS sieve of size 1.180mm was used for this study. Partial size distribution of fine aggregate was determine from sieve analysis and the experiments are carried out to find the properties of fine aggregate.

2.1.3.COARSE AGGREGATES:

Crushed coarse aggregate of maximum size 20mm used. The experiments are carried out to find out the property of coarse aggregate.

2.1.4. STEEL BARS:

High Yield Strength Deformed (HYSD) 'TOR' steel bars of 8 mm and 10mm nominal diameter procured from the local market were used as tension reinforcement in all the test specimens, whereas 8 mm steel bars were used as hanger bars; 8 mm diameter bars of the same type were used as nominal shear reinforcement in the form of two legged closed stirrups in all the specimens at a spacing of 150 mm center to center.

2.1.5. EPOXY RESIN:

Nitobond EP is used for the purpose of gluing the ferro cement jacket to the beam. The product achieves 50 MPa compressive strength; 20 MPa tensile strength, 35 MPa flexural strength and 20MPa shear strength. The ratio of epoxy to hardener adopted was 2:1 as recommended by the manufactures FosrocParchem, Ltd.

2.1.6. CHICKEN MESH:

Wire mesh is one of the essential components of ferrocement. Different types of wire meshes are available almost everywhere. These generally consist of thin wires, either woven or welded into a mesh, but the main requirement is that it must be easily handled and, if necessary, flexible enough to be bent around sharp corners.

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III. EXPERIMENTAL RESULTS

TABLE 1.1: MATERIAL TEST:

MATERIAL	VARIOUS TEST	OBTAINED VALUE	AS PER CODAL PROVISION
FINE AGGREGATE	Specific gravity	2.61	IS 10262 (2009) 2.5 – 2.9
	Sieve Analysis	conforming to zone II of IS 383	
COARSE AGGREGATE	Specific gravity	2.78	IS 10262 (2009) 2.5 – 2.9
	Sieve Analysis	conforming to table 2 of IS383.	
CEMENT	Specific gravity	3.17	IS 10262 (2009) 2.9 -3.4

TABLE 1.2.MIX PROPORTION:

CONTENT	CEMENT	WATER	FINE AGGREGATE	COARSE AGGREGATE
RATIO	1	0.5	1.81	2.9
QUANTITY	394kg/m ³	197kg/m ³	712kg/m ³	1140kg/m ³

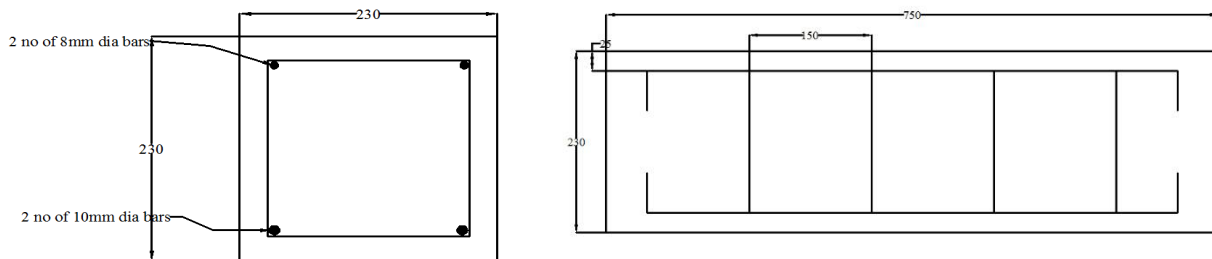


FIG 1.1 REINFORCEMENT DETAILS OF THE BEAM

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1.9.FLEXURAL STRENGTH

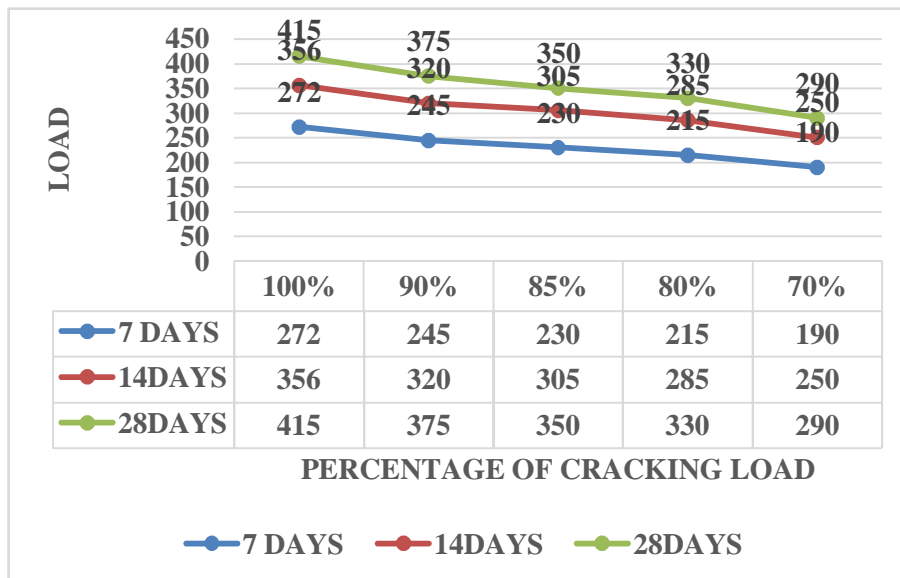


CHART1.1.FLEXURAL STRENGTH OF THE BEAM BEFORE RETROFITTING:



FIG1.2.EPOXY INJECTING ON CRACK



FIG 1.3.BEAM WRAPPED WITH MESH

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FIG.1.4 MORTAR APPLIED ON THE BEAM



FIG 1.5. FLEXURAL TEST AFTER RETROFITTING

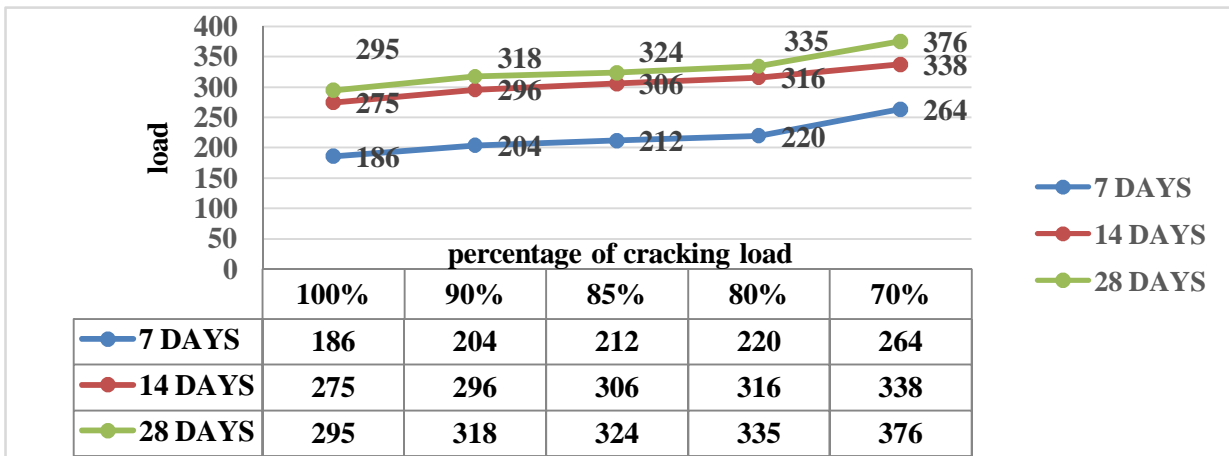
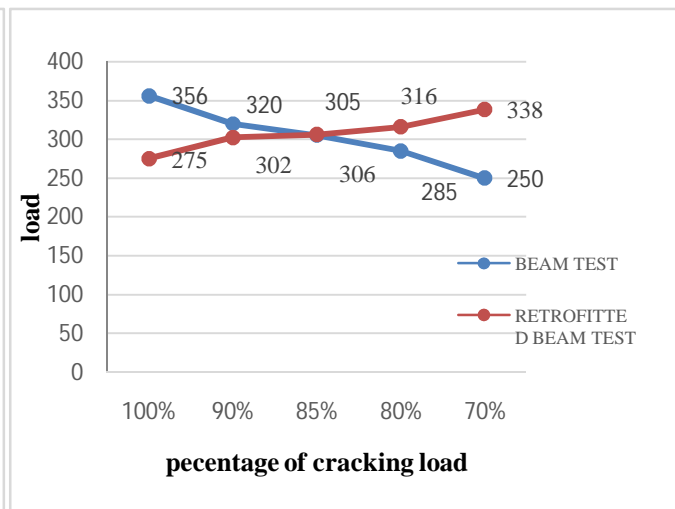
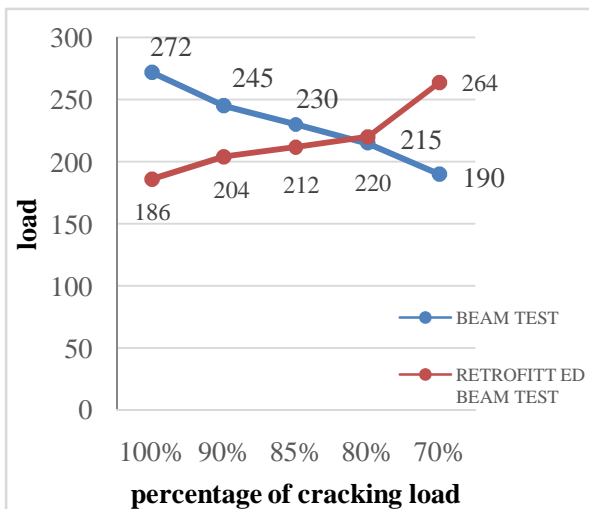


CHART1.2 FLEXURAL STRENGTH OF THE BEAM AFTER RETROFITTING:



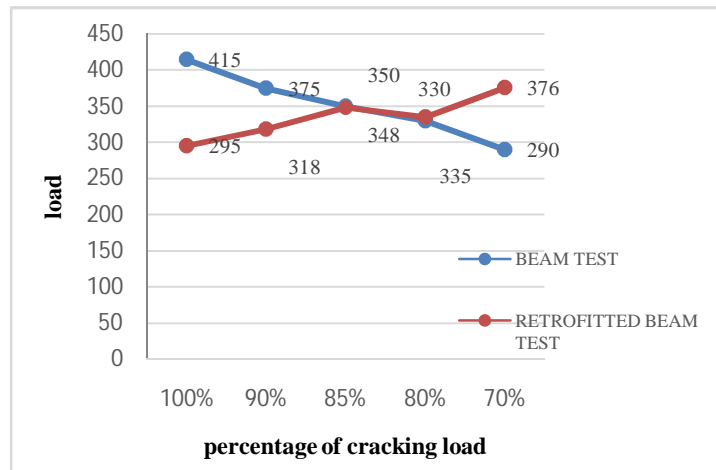
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CHART 1.3. 7 DAYS COMPARISON



IV. CONCLUSION

The strengthened beam gives higher strength when compared to the conventional concrete beam. The flexural strength of the preloaded beams are higher (70%, >80%, >85% >90%). Hence the existing damaged beams can be strengthened upto 85% of the failure or collapse using Ferrocement and epoxy resin.

REFERENCES

- [1] Gurbir Singh Benipal, Kamaldeep Singh, "Reinforced concrete beams retrofitted Ferrocement" International journal of engineering development and research, Vol. 3, No. 4.
- [2] Ladi Y V and Mohite P M (2013), 'Experimental evaluation of reinforced concrete beam retrofitted with ferrocement', International journal of research in engineering and technology, Vol. 2, No. 3.
- [3] Gurpreet Singh Dhanoa, Jagmeet Singh and Rajindervir Singh, "Retrofitting of reinforced concrete beam by ferrocement technique" Indian journal of science and technology, Vol 9, No 15.
- [4] MdIhtesham Hussian, Vaijanath Halhalli, Raj Kiran Nanduri .P.M.B 'Shear & Flexural Behavior of Ferrocement Deep Beams' " International Journal of Research in Engineering and Technology" 2013, pp 85 - 91.
- [5] Mahmood Abo El Wafa, Kimio Fukuzawa, ' Flexural Behaviour of Lightweight Ferrocement sandwich Composite Beams' " Journal of Science and Technology" Vol.15-2010 JST 4.
- [6] Ozgur Anil ' Strengthening of RC T-Section beams with low strength concrete using CFRP Composites subjected to cyclic load' "Construction and Building Materials" Vol.22 2008 pp 2355-236.
- [7] Prem Pal Bansal, Kumar Maneeq, Kausik S.K 'Effect of Wire Mesh Orientation On Strength Of Beams Retrofitted Using Ferrocement jackets' "International Journal of Engineering" Vol.(2); Issue (1)
- [8] Nassif. H.H., Chirravuri. G., Sanders. M.C., "Flexural Behaviour of Ferrocement/Concrete Composite Beams", Proceedings of the Sixth International Symposium on Ferrocement, Naaman, A.E. (Eds.), University of Michigan. Ann Arbor, June 1998, 7 - 10, pp. 251 - 258.
- [9] Paramasivam.P, Ong. K.C.G, Ong .Lim.C.T.E. 'Flexural Strengthening of R.C Beams with Ferrocement Laminates', "Cement & Concrete Composites" Vol.20 1998 pp 53-65