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REHABILITATION OF RC BEAMS BY USING FERRO CEMENT JACKETING

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Abstract :

Retrofitting refers to the addition of new members or components to older systems. In terms of civil engineering it refers to the strengthening of old structures. Many of the existing reinforced concrete structures do not meet the current design standards because of inadequate design and construction or need structural upgrading. They are in urgent need of repair, retrofitting or reconstruction because of fail or collapse due to various factors like corrosion, lack of detailing, failure of bonding between beam-column joints, increase in service loads, etc., leading to spalling, cracking, loss of strength, deflection, etc. Innovative techniques for repair have many advantages over conventional techniques.

This paper presents the behavior and strength of reinforced concrete beams and columns strengthened with Ferro cement jackets. A total 15 beams were prepared from that three specimens of beams and columns are control beams. Remaining twelve beams are distressed at 60% and 80% of the ultimate load and retrofitted with Ferro cement in no of layers single and double layer respectively. The load deflection characteristics and mode of failure are studied. The test result indicates that load carrying capacity is increases after retrofitting.

Keywords: *Ferro cement wire mesh, Retrofitting, RCC beams.*

I. INTRODUCTION

1.1 General: Concrete is one of the most widely used building materials in the world because of its multiple advantages. Reinforced Concrete structures regardless of the experience gained over years still require repair and strengthening because of natural reasons, human mistakes and change in loading conditions. This necessitates the retrofitting of existing structures to meet safety requirements in seismic areas and where the load carrying capacity has to be enhanced. Research works have proved that the strength and deformation of RC columns can be increased through confinement of concrete core by jacketing techniques. The commonly used materials for jacketing include reinforced concrete, steel, fibre reinforced polymers (FRP), fibrocement etc. Though commonly used RC jackets enhance the strength and improve overall performance, they require labour intensive procedures. Also, these techniques increase member size and hence add to the dead load, reduce the available space and also alter stiffness. Researchers have established FRP as an efficient confinement material than conventional ones. However, FRP is an expensive material and it requires skilled labour for wrapping.

1.2 Welded Wire Mesh: Welded wire mesh of rectangular pattern is tied on skeletal steel framework and it provides a base for tying fine wire meshes on it. It has properties like better bonding, effective crack resistance, better in handling and placing also it is economical so mostly used for wrapping in single layer or double layer.

1.3 Aim: To investigate retrofitting of RC beam and column by using Ferro cement jacketing.

1.4 Objectives:

- To study rehabilitation of RC beams by using ferrocement jacketing wrapped by welded mesh.
- To study increase in load carrying capacity of strengthened beams.
- To determine the flexural rigidity of the RC beam retrofitted in single and double layer wrapping by measuring deflection of retrofitted beam and compare with control beam.

II. MATERIALS AND METHODOLOGY

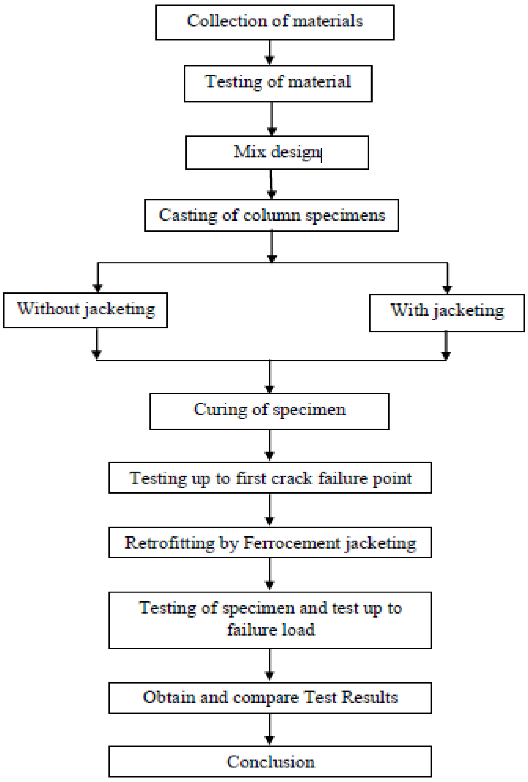


Figure 2.1 Methodology

2.1 Materials

Various tests are conducted on materials cement, sand and aggregate. For cement tests like consistency test, initial setting time and final setting time, soundness and compressive test are conducted. Sieve analysis and water absorption are conducted for both fine aggregate and coarse aggregate.

Cement: - Ultratech OPC 53

Fine aggregate: - natural river sand of specific gravity 2.75

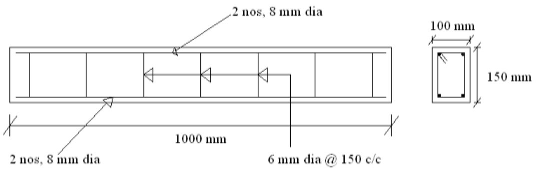
Coarse aggregate: - nominal size of 20mm having specific gravity 2.74

Welded Wire Mesh

Steel reinforcement:-High yield strength deformed bar of 2 nos.of 8mm dia. used as main reinforcement and 2nos.of 8mm dia. used as stirrups of clear cover 20mm.

This study is a cross-sectional investigation which was based on a self-administered online discussion. The study included civil engineers aging between 22 and 65 years, who are currently working either in an office job or a field job from various construction firm whose offices and projects are all located nearby area. The data collection took place from june 2020 to august 2020, during which 50 engineers as well as faculty participated in discussion. It also based on various workshop, FDP, expert lecture etc attended by faculty through online mode

Figure 2.2 Steel reinforcement



2.2 Mix Proportions:

Table 1. Design mix proportion (M20)

Descriptions	Cement	Fine aggregate	Coarse aggregate	Water
Mix proportion by weight	1	1.37	2.47	0.45

Table 2. Casting schedule

Sr.no.	Beam Type	Designation	No. of beams
1	Controlled beam	CB	03
2	Beam distressed up to 60% of ultimate load and wrapped with single layer wire mesh	P1,Q1,R1	03
3	Beam distressed up to 80% of ultimate load and wrapped with single layer wire mesh	P2,Q2,R2	03
4	Beam distressed up to 60% of ultimate load and wrapped with double layer wire mesh	P3,Q3,R3	03
5	Beam distressed up to 60% of ultimate load and wrapped with double layer wire mesh	P4,Q4,R4	03

Figure 2.2 Casting of specimen

2.4 Pre- retrofitting technique:

Except for the control beam C1, C2, C3 which are loaded monotonically, all other beams are preloaded up to 60% and 80% until the first cracked is not formed. During loading, the specimen is visually inspected and cracks are marked. The specimen is then unloaded and then retrofitting is carried out by welded wire mesh jacketing.

Figure 2.3 Pre- retrofitting loading

2.5 Process Of Retrofitting:-

After first stage of loading, the distressed beams were retrofitted by using ferrocement jacketing. Ferrocement is another sort of ferroconcrete during which cement sand mortar is reinforced with closely spaced MS welded wire mesh. The surface of the distressed beam are roughened by using hacker and wire mesh was wound over it. The mesh was tightened using binding wires. A thick cement paste was applied as bonding agent before the appliance of mortar having the ratio of 1:3 by weight and water cement ratio was kept as 0.5. The 20 mm thickness of mortar was applied on the beam surface. The retrofitted beams were cured for 28 days in curing tank.

Figure 2.4 Process Of Retrofitting

III.Experimental programme:

The beams are tested within the loading frame of "Testing of Machine" Laboratory of Amrutvahini College of Engineering, Sangamner. The testing procedure for the all the specimen is same. First the beams are cured for a period of 28 days then its surface is cleaned with the assistance of sand paper for clear visibility of cracks. The two-arm loading arrangement was used for testing of beams.

All beams were tested one by one. All of them are tested within the above arrangement. The gradual increase in load and therefore the deformation within the dial gauge reading are taken throughout the test. The dial gauge reading shows the deformation. The load at which reading gets reversed are recorded. The deflections at two salient points mentioned for the beams with and without wire mesh jacketing are recorded with reference to increase of load and moment resistance been calculated.

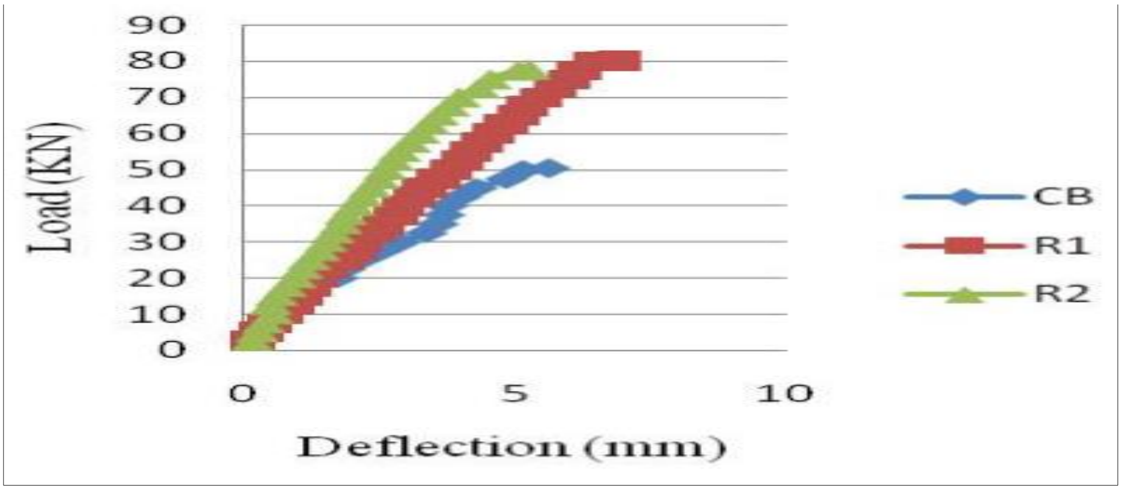
IV. Results and Discussion:

Table 4.1 Ultimate load and failure mode for beams

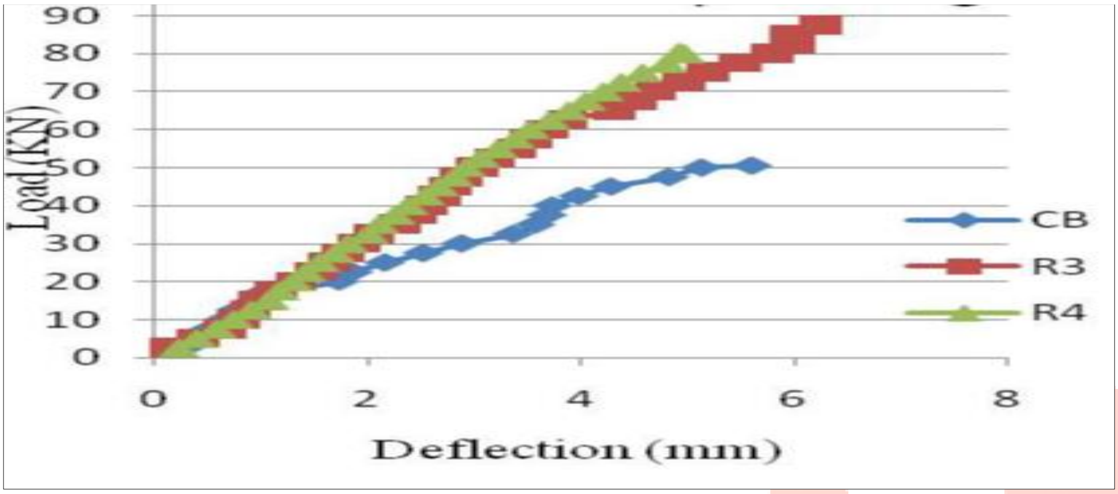
Type of Beam	Beam Designation	First crack load (KN)	Ultimate load (KN)	Deflection (mm)	Moment of resistance (KN-m)	Nature of failure
Controlled Beam	C1	18.20	50.20	5.40		Flexural failure
	C2	18.75	50.70	5.45	7.605	Flexural failure
	C3	19.00	50.40	5.61		Flexural failure
Beam distressed up to 60% of ultimate load and wrapped with single layer wire mesh	P1	29.35	80.75	6.00		Flexural failure
	Q1	29.50	80.60	6.50	12.03	Flexural failure
	R1	29.40	80.00	6.89		Flexural failure
Beam distressed up to 80% of ultimate load and wrapped with single layer wire mesh	P2	29.10	77.75	5.15		Flexural failure
	Q2	29.10	77.60	5.20	11.66	Flexural failure
	R2	29.20	77.00	5.25		Flexural failure
Beam distressed up to 60% of ultimate load and wrapped with double layer wire mesh	P3	30.35	84.30	5.40		Flexural failure
	Q2	31.30	84.50	5.60	12.67	Flexural failure
	R3	32.75	84.50	5.80		Flexural failure
Beam distressed up to 80% of ultimate load and wrapped with double layer wire mesh	P4	32.10	80.60	5.12		Flexural failure
	Q4	32.15	80.50	5.10	12.07	Flexural failure
	R4	32.20	80.30	5.10		Flexural failure

4.2 Discussion:

R1, R2 beams were 60%, 80% distressed respectively and retrofitted with single layer of wire mesh. Control beams were loaded under two point loading, the first crack was observed at a load of 19.0 KN. Control beam was failed at a load of 50.70 KN and deflection at middle was 5.61 mm Table 4.1 and Graph 4.1 shows linear elastic behavior up to yielding of steel at a load 80.25 KN, 77.75 KN in R1, R2 beams respectively. Deflection in retrofitted beam at load of 50.70 KN was 4.02 mm, 2.61 mm in R1, R2 beams, respectively. First crack was observed in retrofitted beam 29.5 KN, 29.0 KN, respectively. The failure of control and retrofitted beam was purely due to flexural cracks. From this curve it was observed that the ultimate load increased by 58.28% in R1 beam and in R2 beam it increased about 53.63%.The performance of the R1 beam was increased as compared to RC beam.



Graph 4.1 Load vs deflection curve for beam C1, retrofitted beam R1 and R2 wrap with single wire mesh.



Graph 4.2 Load vs deflection curve for beam C1, retrofitted beam R3 and R4 wrap with double layer wire mesh.

R3, R4 beams were 60% and 80% distressed beams retrofitted with double layer of wire mesh. From Table 4.1 and Graph 4.2 ultimate load in beam R3 and R4 were 84.50 KN, 80.50 KN, respectively. Also the deflection in retrofitted beam at a 50.70 KN load of three .185 mm, 3.06 mm in R3, R4 beams, respectively. First crack was observed R3, R4 beams at a load of 33.75 KN, 32.0 KN, respectively.

Load deflection behavior of the beams evaluated by double layers of wire mesh in graph 4.2 From this curve it had been observed that the last word load increased by 66.66 you bored with R3 beam and 58.77% increased in R4 beam. However, it's seen that deflection of the retrofitted beam was decreased as compared to regulate beam. The performance of the 60% distressed beam in ultimate load was increased as compared to 80% distressed beam. Also it had been observed a rise in stiffness, first crack load, ultimate load wrap with double layer wire mesh..

V.CONCLUSION

From the above discussed results it can be concluded that:

1. All the beams retrofitted with ferrocement in single layer and two layers of wire mesh at various orientations experience flexural failures. None of the beams exhibit premature brittle failure or shear failure.
2. Test results indicated that repairing similar reinforced concrete beam preloaded up to 60% and 80% of their ultimate load carrying capacity, with the same jackets showed about 28% and 15% increase in load carrying capacity as compared to control beams.
3. Jacketing with welded wire mesh increases the load carrying capacity.
4. Retrofitting with ferrocement jacketing gives adequate strength to the beam hence, ferrocement jacketing can be used as strengthening material for various structural material.
5. The strength of existing RC structure can be increase.

6. Increase in life span of structure up to 10-15 years.

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