Journal of Science and Technology
ISSN: 2456-5660 Volume 8, Issue 03 (March -2023)
www.jst.org.in *DOI:https://doi.org/10.46243/jst.2023.v8.i03.pp10 - 16*

EXPERIMENTAL STUDY ON REINFORCED CONCRETE COLUMN STRENGTHENED WITH FERROCEMENT JACKET

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To Cite this Article

BOJJA RAKESH*, K. RAMAKRISHNAREDDY**, EXPERIMENTAL STUDY ON REINFORCED CONCRETE COLUMN STRENGTHENED WITH FERROCEMENT JACKET"** *Journal of Science and Technology, Vol. 08, Issue 03,-March 2023, pp10-16*

Article Info

Received: 22-01-2023 *Revised: 17-02-2023* *Accepted: 27-02-2023* *Published: 08-03-2023*

ABSTRACT: This investigates the behavior of ferro-cement encased square reinforced concrete (RC) column subjected to monotonically increasing the small eccentric load or axially. Three different types of square jacketing techniques have been studied experimentally to find out the effectiveness of ferro-cement confinement of RC columns against eccentric loading. Six scaled down ferro-cement jacketed specimens (two from each group) and two non jacketed scale down specimens (square column) were tested for this purpose. The result obtained from this study show that the benchmark specimens (column without firrocement encasement) fail with non ductile mode of failure when the load reaches to its peak value, however incase of jacketed specimens load carrying capacity and ductility performance are obtained to be more than those obtained from bench mark specimen.

INTRODUCTION Defined as a thin wall reinforced concrete and made of cement mortar and layers of fine wire mesh closely bound together to create a stiff structural form, ferro-cement has a great potential to be used as a strengthening jacket material for substandard reinforced concrete columns. Several researchers, Andrew and Sharma, Basanbul et al. and Lub and Wainroi, have investigated on ferro-cement as a strengthening material for RC beams. Meanwhile, Arya and Singh have studied on ferrocement as a repair and strengthening materials for low rises housing. However, data on application and the behavior of ferro-cement as a strengthening material for RC column are not available. A technique by using ferro-cement jacket for seismic strengthening of reinforced concrete column is investigated and compared with different strengthening method. Three methods of

strengthening were studied, including steel jacket, carbon fiber sheet, and ferro-cement jacket. This research work is part of are-search program aimed at developing methods for strengthening existing reinforced concrete columns by ferro-cement jacket to enhance their seismic resistance. There are different methods for strengthening of existing structures. Jacketing is one of the most popular method for columns. Steel jacket, reinforced concrete jacket, fiber reinforced polymer composite jacket, etc are most common examples of jacketing. Strengthening of concrete member with externally applied steel and Ferro cement is an accepted option for repair and rehabilitation of structures, which will improve the load carrying capacity together with ductile characteristics, required in the case of seismic retrofit. In this study, two method of retrofitting of short reinforced concrete square columns were attempted. Wire mesh mortar jacketing were given to the reinforced concrete column. For analysis of test results, a plain reinforced column (CS) was tested. the design and the testing was done as per the Indian Standard.

OBJECTIVES A strengthening method using square ferro-cement jacket to improve the confinement of a substandard column was investigated and compared with control specimens and different strengthening methods

- In order to improve the strength of the column
- Testing of control specimens and jacketing specimens with ferro-cement
- Analysis of test result of control specimens and jacketed with ferro-cement columns
- To study the failure behavior of column

METHODOLOGY

MATERIALS USED

CEMET: Portland cement (OPC) 53 grade conforming of M20 grade of concrete.

SAND: Locally available natural river sand owing to its rounded shape was used in this work, as it ensures better packing characteristics than the crushed sand.

COARSE AGGREGATE: Crushed graded aggregate of quartzite origin having a maximum size of 20 mm was used as coarse aggregate. Coarse aggregate had negligible water absorption.

CASTING For this investigation, square moulds of size 110mm of width and depth and 500 mm in length were casted. A total no. of cylindrical specimens was casted 30 and three

unconfined specimens also casted. The test specimens were casted in a steel mould, and oil was applied on the inner side of the mould for easy removal of the specimens. The concrete was mixed by using concrete mixer. First, cement and fine aggregate were mixed in a dry form until uniformity was achieved and lastly coarse aggregate was added. Then, water was sprinkled and mixed thoroughly until a uniform mix was obtained. The concrete was then placed as suitable layers of equal thickness, and each layer was compacted by hand compaction. The specimens were demoulded after 24 h, and the specimens were kept for curing in a water tank till the age of the testing (28 days). Confinement of plain cement concrete For the preparation of confined specimens, the plain cement concrete specimens were wrapped with ferrocement laminates. The specimens were taken out after curing (28 d), and then the surface of the specimen was roughened. A rich mortar of 1:1 was applied on the roughened surface of the specimens, and then welded wire mesh (WWM) of a single layer mesh or double layer mesh as per the requirement was wrapped around the specimen. Finally, the specimens were plastered with 1:2 mix mortars with water: cement ratio of 0.45 with a confinement thickness of 20 mm

TEST ON CEMENET

Sl no.	Properties	Results
1	Specific Gravity	3.12
2	Normal consistency	35%
3	Initial setting time	40 min
4	Final setting time	190 min

TESTS ON FINE AGGREGATE

Sl no.	Sieve size	Cumulative % passing Finer	Recommended Cumulative % passing Finer as per IS 383-1970 [11]
1	4.75 mm	93.1	90-100
2	2.36 mm	80.1	60-95
3	1.18 mm	57.1	30-70
4	600 mic	44.9	15-34
5	300 mic	7.8	5-20
6	150 mic	0	0-10
7	Pan	0	0
8	Specific gravity = 2.58		
9	Bulk density = 1.60g/cc		
10	Finess modulus = 3.164		
11	Zone II		

- F M = 316.4/100 = 3.164
- Specific Gravity = 2.58
- Bulk Density = 1.60 g/cc

PHYSICAL PROPERTIES OF 12.5 MM SIZE AGGREGATE

Sl.No	Properties	Results
1	Specific gravity	2.795
2	Fineness Modulus	7.47
3	Water absorption	2.07%
4	Bulk density	1.50 g/cc

PROPORTION:

Cement: Sand: Coarse Aggregate: Water-Cement Ratio

1:1.5:3:0.5

TABLE 1.

Details of column section and no's:

	SPECIFICATIONS	CS	SCFC
COLUMN SECTION	COLUMN HEIGHT H	510	510
	COLUMN WIDTH B	110	110
	COLUMN DEPTH D	110	110
	CAST IN-SITU NO'S	06	06

Without considering CF and FC thickness.

Ferrocement jacket Woven wire mesh, comes in 900 mm wide roll of 2.5-mm square opening and 0.45-mm wire diameter was used.The required width of 440 mm and length for single-layers of wire mesh was cut and properly wrapped by two people around the entire column. One person held the first end of the wire mesh in position while the second person wrapped the rest of it around the column. At several places, the first and the second layer of the wire mesh were tie together with the same diameter of steel wire. Similarly, this process can be repeated when the third layer, and the fourth layer has to wrapped around the column. One hundred mm overlapping of wire mesh can be provide in lateral direction. The infill concrete and mortar for Ferro-cement jacket were cast at the same time. Even though special care was applied when fresh infill concrete with slump of 180 mm was cast, and properly vibrated by tamping rod for each layer 25 blows to scatter all around periphery of mould. some defects were observed on the surface of concrete. It was observed that only about 20 mm of jacket height was penetrated properly by mortar. Meanwhile within almost 90 % of the

rest part of jacket, mortar penetrated up to the outer layer of wire mesh, and a number of layers of wire mesh was not fully covered by mortar on the rest part of jacket. This 10 % part was concentrated mostly at the corner of the square section of original column. Therefore, repair work can be execute with epoxy resin fill-up the 3-mm cover and part of the jacket that did not filled-out by mortar. To provide with ferro-cement jacket, at first to the column wrapped with square welded wire mesh and again hexagonal wire mesh was wrapped over square welded wire mesh to hold the mortar on it equally. This causes fine finish of ferrocement jacket. And providing hexagonal wire mesh is the extra aid for jacketing to column

CONCLUSIONS

1. Ferrocement jacketing could be used an effective restrengthening material for column element of building subjected to eccentric loading.

2. Confinement with the ferrocement encasement improves the ultimate load carrying capacity and increases the axial and lateral deflection of RC column.

3. Type single layer wire mesh and type two layer wire mesh encasements show almost same ultimate load carrying capacity. However, type two layer wire mesh encasement gives higher ultimate deflections than type single layer wire mesh encasement.

4. Failure pattern 0f two layer wire mesh type encasement is more ductile than single layer wire mesh type.

5. Compressive strength of two layer wire mesh column shows more than that of the zero layer and single layer wire mesh column.

6. By increasing the number of wire mesh layers the strain value of the columns also increases.

7.The result of this investigation indicate that strengthening of a square reinforced concrete column with circular ferrocement jacket was considered to successful.

8. By providing external circular confinement using ferrocement jacket to the origin columns, the stiffness, strength, energy dissipation, and ductility are improved significantly and the mode of failure changed from brittle shear failure to ductile flexural failure.

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