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Retrofitting Of RC Square Column By Concrete Jacket Concoct By Replacing Coarse Aggregate With Broken Glass.

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Abstract

This thesis investigates some techniques of strengthening existing square reinforced concrete column under axial loading.12 columns were casted with Four groups (Three columns each) of reinforced concrete square columns made from normal strength concrete (M20) and kept for curing for 28 days. Columns of first group were reference columns which were tested under axial loading after 28 days and then retrofitted with classic reinforced concrete jacket and again tested after 28 days. Columns of second group were tested under axial loading after 28 days and then retrofitted with reinforced concrete jacket with replacement of 10% coarse aggregate with broken glass and again tested after 28 days. Columns of third group were tested under axial loading after 28 days and then retrofitted with reinforced concrete jacket with replacement of 20% of coarse aggregate with broken glass and again tested after 28 days. Columns of fourth group were tested under axial loading after 28 days and retrofitted with reinforced concrete jacket with replacement of 30% of coarse aggregate with broken glass and again tested after 28 days. Result of all this test were analysed and compared with each other and the conclusion were drawn.

Keywords—Concrete Jacketing; Broken Glass; Square Column; Axial Loading; Retrofitting etc.

I. INTRODUCTION

A. Background

In last few decades earthquake ground motions have become a critical design factor for modern structures. Recent severe earthquakes like the earthquakes in Nepal, Bhuj and Japan have forced the designers to continuously improve the structural stability of buildings also to prevent disaster in future earthquakes, the existing deficient buildings need to be retrofitted. To minimize the impact of earthquakes on both individuals and society, several retrofit techniques such as construction of shear walls, wing-walls, and column jacketing. Among these techniques, column jacketing is often the favourite choice due to its ability to increase the seismic resistance of a building in both orthogonal directions of a structure and advantages ventilation and natural light. Glass is a perfect material for reusing. The expanding familiarity with glass reusing speeds up examinations on the utilization of waste glass with various structures in different fields. The broken glass as a substitute for coarse aggregate in concrete helps the society as one of the possible solutions to the increasing solid waste

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problem. The use of solid wastes in the production of concrete has most adoptable on aggregates because they make use of large quantities of waste materials. In this experimental study, Waste Glass gathered from scraps, beer bottles and other means was used as a partial replacement of coarse aggregates.

B. Objectives

- To cast the square reinforced columns.
- To check the axial load carrying capacity of RC square columns.
- To improve the load carrying capacity of RC square columns by retrofitting it with concrete jackets.
- To replace the coarse aggregate in concrete jacket with broken glass in different proportions.
- To compare and analyse the result and give conclusion.

II. REVIEW OF LITERATURE

The performance of concrete jacketed concrete column and partial replacement of broken glass with coarse aggregate has been studied by various researchers. In early stages of research, evaluation of a RC column strengthened by concrete jacket was studied by K. P. Billimoria et.al (2019). This has shown that, concrete jacketing proves to be very effective method for retrofitting and also it proves to be an easy and effective method among other retrofitting methods. Also it is found that each specimen showed an increment in strength by 4% to 6% once after the failure of actual specimen under CTM machine. So further research was carried out on the seismic behaviour of columns strengthened by reinforced concrete (RC) Jacketing to increase their ultimate bending moment by Constantin E. Chalioris and Constantin N. Pourzitidis (2012). They found that, the capacity of the jacketed beams was fully restored or ameliorated with the respect to the corresponding initial tested specimens. Although the ultimate capacity of retrofitted beams has increased approximately 3 times with respect to the initially tested beams. In further research, (Vikas Srivastava et.al 2013) had studied that waste glass can effectively be used as coarse aggregate replacement up to 50% without substantial change in strength. 28 days strength is found to marginally increase up to 20% replacement level. Marginal decrease in strength is observed at 30% to 40% replacement level of waste glass with coarse aggregate. Then (D. Rajitha 2017) had investigated that waste glass can viably be utilized as fine aggregate and coarse aggregate substitution without generous change in quality up to certain percentages. Based on the studied conducted on waste glass concrete in which fine aggregate and coarse aggregate is replaced with waste glass in different proportions of 5%, 10% & 15% for M20 grade concrete, the compressive strength of the concrete increases up to 5% by replacement of glass and then gradually decrease with increases of glass content.

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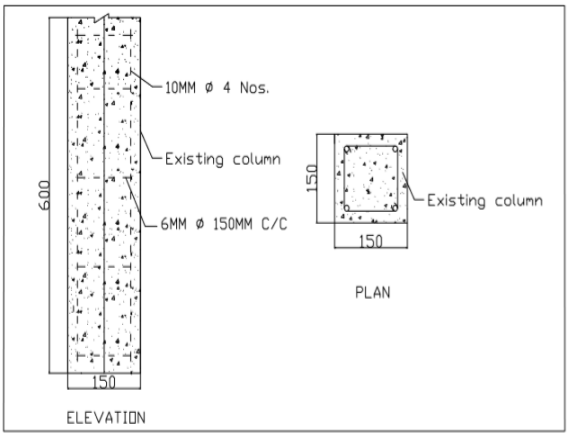

Fig. 1 Virgin specimen without jacketing

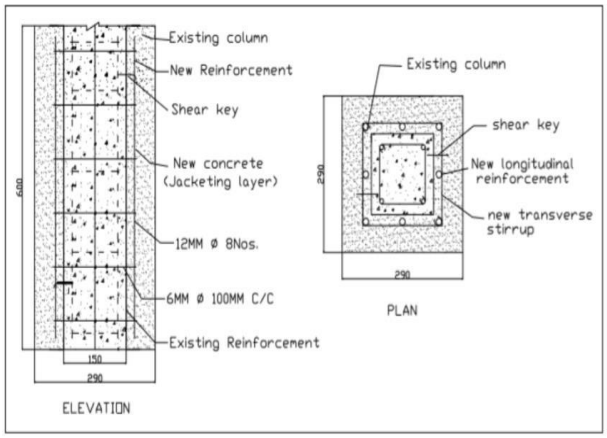

Fig. 2 Specimen with jacketing layer.

K. P. Billimoria et.al (2019)

III. METHODOLOGY

Reinforced concrete columns of square shape were to be cast. Square columns were to be casted. Therefore moulds were prepared according to the requirement of project. Materials were tested for different properties and mix proportions of M20 grade were fixed. Square columns were casted and kept for curing in curing tank for 28 days. After completion of curing period specimens were removed from curing tank and left for drying. Then axial loading was applied on the specimens through UTM machine until cracks were noticed on specimens and readings were noted down. After that specimens were retrofitted using concrete jacket and kept in curing tank for further 28 days. After curing period is over then the specimen were removed from curing tank and left for drying. Then axial load was applied on the retrofitted specimens through UTM machine and readings were noted down. Then the results were compared between jacketed and non-jacketed specimens and conclusions were made.

IV. EXPERIMENTAL PROGRAM

Design of reinforced concrete column using IS 456:2000. The experimental setup consists of the testing 12 reinforced concrete columns specimens with cross sections 150mm X 150mm with overall depth 500mm. Reinforced cage was placed in mould by providing 50mm covering on bottom and side face. The column was reinforced with 4 Nos. of 8mm dia. Tor steel bars. The lateral ties in the specimen are 6mm dia. @ 140mm c/c.

Design of Reinforced concrete column jacket using IS 15988:213

After observing the crack pattern of damaged specimen, the same was cleaned by removing the crack portion. For developing the bond between original specimen and outer jacketed layer, surface was made rough. 8 longitudinal reinforcement bars of 10mm dia. At each corner and middle of the surface were tied with 6mm lateral ties 100mm c/c spacing and proper covering on all sides. In this study, concrete jacketing is carried out as per recommendations of Indian standard code IS 15988:2013: Seismic evaluation and strengthening of existing reinforced concrete buildings – Guidelines published by Bureau of Indian Standards. Reinforced column jackets improve column flexural and ductility.

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Closely spaced traverse reinforcement provided in the jacket improves the shear strength and ductility of columns.

Fig. 3 Mould and Reinforcement for Virgin Specimen

Fig. 4 Virgin Specimen for Testing under Axial load

Fig. 5 Virgin specimen after testing

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Fig. 6 Drilling of Virgin Specimen for providing Concrete Jacket Fig. 7 Virgin Specimen with Reinforcement for Concrete Jacket

Fig no. 8 Mixture including waste glass Fig no. 9 Preparation of concrete mixture

Fig. 10 Mould and filling of Concrete Jacket

V. RESULTS

All the columns were tested on Universal Testing Machine (UTM) according to the above details. When the retrofitted columns were tested under UTM it has been seen that there is significant increase in load carrying capacity of column as compared to the virgin column. The load carrying capacity of each column under axial load is given in table I & II.

TABLE I

Specimen details of non - jacketed member

NO OF COLUMNS	DIMENSIONS (mm)	GRADE OF CONCRETE	LOAD (KN)	AVERAGE	COMPRESSIVE STRENGTH

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					(N/mm^2)
1	150 X150 X 500	M20	456.8	461.13	20.49
2	150 X150 X 500		458.7		
3	150 X150 X 500		467.9		
4	150 X150 X 500		457.8	465.13	20.67
5	150 X150 X 500		444.1		
6	150 X150 X 500		493.5		
7	150 X150 X 500		497.4	487.53	21.66
8	150 X150 X 500		488.4		
9	150 X150 X 500		476.8		
10	150 X150 X 500		467.8	469	20.84
11	150 X150 X 500		449.9		
12	150 X150 X 500		489.3		

TABLE II

Specimen details of concrete jacketed member

NO. OF COLUMNS	**DIMENSIONS**	**GRADE OF CONCRETE**	**PERCENTAGE OF WASTE GLASS REPLACEMENT**	**LOAD (KN)**	**AVERAGE**	**COMPRESSIVE STRENGTH**
1	250 X 250 X 500	M20	0%	1411.13	1415.46	22.64
2	250 X 250 X 500			1413.03		
3	250 X 250 X 500			1422.23		
4	250 X 250 X 500		10%	1484.04	1485.68	23.77
5	250 X 250 X 500			1485.02		
6	250 X 250 X 500			1488		
7	250 X 250 X 500		20%	1411.46	1412.56	22.63
8	250 X 250 X 500			1414.01		
9	250 X 250 X 500			1412.22		
10	250 X 250 X 500		30%	1147.01	1145.08	18.32
11	250 X 250 X 500			1142.12		
12	250 X 250 X 500			1145.11		

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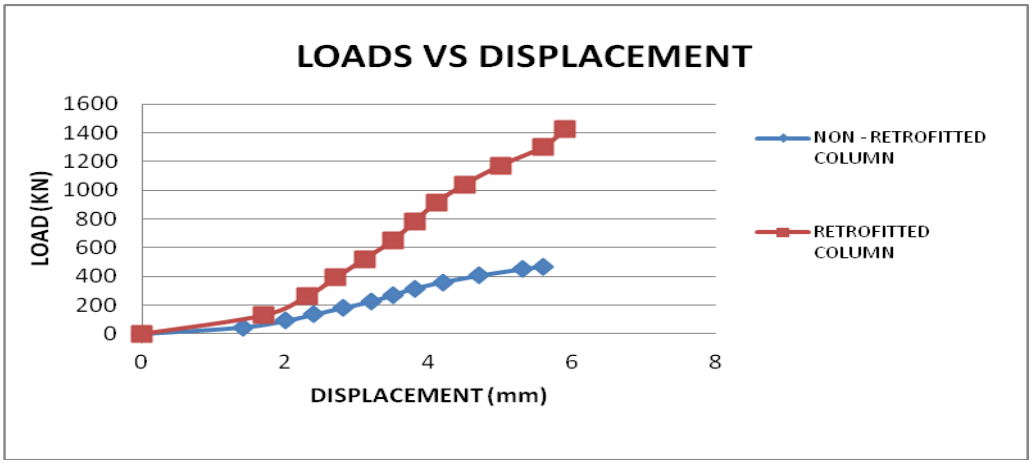

Fig. 11 Load VS Displacement for column no. 3

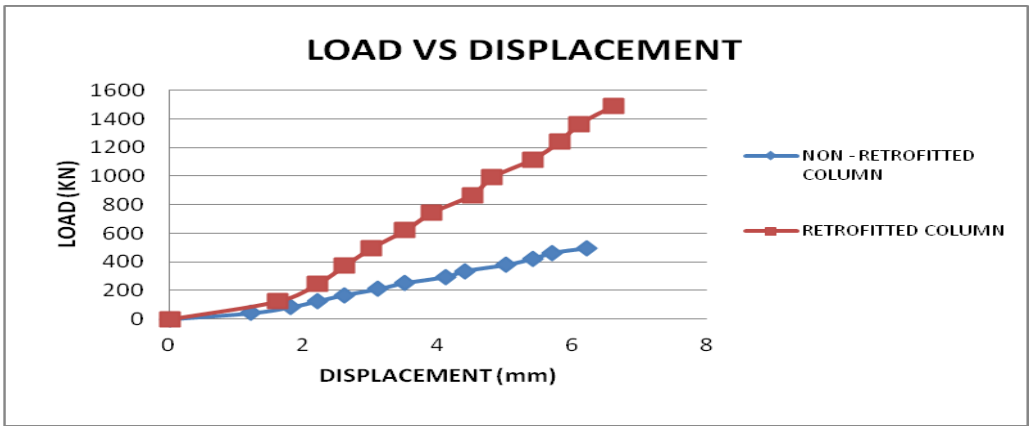

Fig. 12 Load VS Displacement for column no. 6

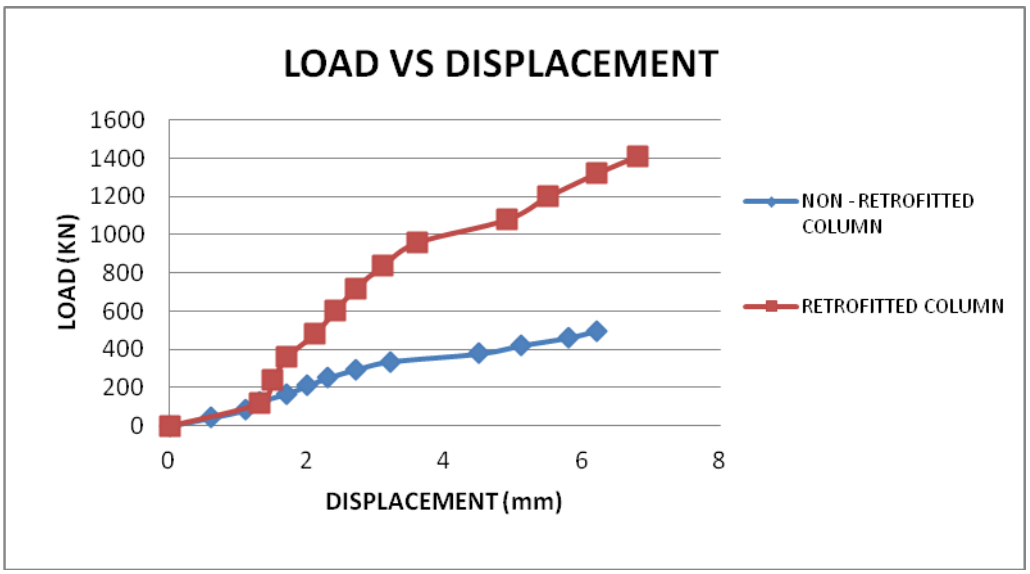

Fig. 13 Load VS Displacement for column no. 7

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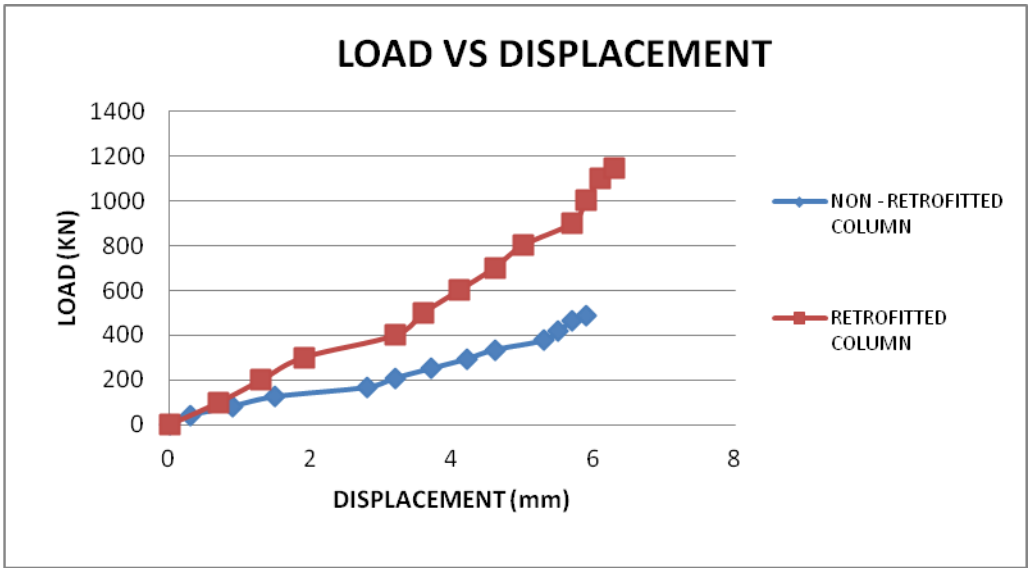
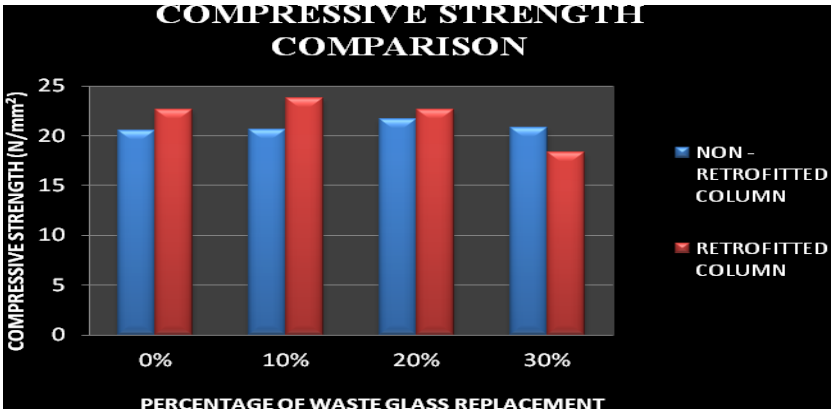


Fig. 14 load VS Displacement for column no. 12



From this comparison between compressive strength of both retrofitted (with broken glass replacement) and non – retrofitted column, it has been seen that the highest strength for retrofitted column is upto 10% replacement, lowest strength is upto 30% replacement and moderate strength upto 20% replacement under axial load.

VI. CONCLUSION

From the analysis of the results following conclusions are drawn:

1. Concrete jacket proves to be very easy and effective method among other retrofitting methods.
2. Columns for M20 were casted and tested under axial load on UTM machine and the result shows that the strength of specimen with 10% and 20% replacement has increased.
3. Marginal decrease in strength with 30% replacement level of waste glass with coarse aggregate as compared to M20 concrete.

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4. From the above conclusion it is concluded that the optimum replacement level of waste glass as coarse aggregate is 10%.
5. Waste glass can be effectively used as coarse aggregate replacement in concrete jacketing.

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It gives me great pleasure to present Thesis report on "Retrofitting of RC square column by Concrete Jacket concoct by Replacing Coarse Aggregate with Broken Glass". No good work is complete unless a well-versed teacher guides it. To complete this proposal, I have the pleasure of being advised by eminent personalities. I wish to convey my deep sense of gratitude to all of them. I express my sincere thanks to my guide Mr. J. P. Chaudhari and Head of Department of Civil Engineering Dr.I. M. Jain for their valuable guidance and continuous support. Without their inspiration and help, it would not have been possible for me to complete this report. I would like to express my sincere thanks to Dr. R. S. Prasad, Principal of Sinhgad Institute Of Technology and Science for his helpful suggestions. Last but not least, I would like to thank all our teaching and non-teaching staff and my colleagues for their direct or indirect co-operation in the successful completion of this dissertation report.

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