Behaviour of GFRP Wrapped Hollow RC Rectangular Column Under Axial Load

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Abstract

This dissertation investigates some techniques of strengthening existing rectangular reinforced concrete column under axial. Three groups of hollow rectangular reinforced concrete column were made from M20 grade concrete. Reinforcement was kept at minimum ratio, so that the columns tends to fail under axial load and require the retrofitting. Three groups of columns were casted each of group contain 3 columns. Columns of first group were casted with M20 grade concrete. The column size of each of the column is kept same. In the second group, 3 columns were wrapped with single layer of GFRP. In third group, there were three columns chamfered at their edges and cover of 20mm is provided for reinforcement. 4 bars of 20mm were used for minimum reinforcement of hollow rectangular column. Result of all this test were analysed and compared with each other and the conclusion were drawn.

Keywords— Axial loading; GFRP wrapping; Rectangular column; Retrofitting; chamfering etc

I. INTRODUCTION

A. Background

The retrofitting of the structure is better alternative instead of total replacement of structure. Retrofitting by using fibre reinforced polymer (FRP) has been increasing interest. There are many techniques of retrofitting such as adding new shear walls, adding steel bracing, jacketing, base isolation and mass reduction technique. A large number of existing bridges have hollow piers, which obviously results in large flexural strength and stiffness than solid piers with same mass. It may even be economical to use hollow RC members to minimize the weight of concrete members or the cost of concrete production. However even in modern codes there is lack of information regarding the hollow sections. Then researchers applied various techniques to the square column to increase the efficiency of column with different fibres confinement such as chamfering of edges or complete shape modification. But in case of rectangular column there was still a need of study to increase the efficiency of FRP confinement. Therefore, in this study experimentation was carried out on rectangular column to increase the efficiency of FRP confinement in case of rectangular column. It has been seen that the research regarding hollow rectangular column was not to the extent as it had for circular column. Hollow RC members may dissipate energy by forming ductile plastic hinges when they are subjected to seismic forces.

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Fig.1 GFRP Sheet

B. Objectives

- To check the load carrying capacity of hollow Rectangular RC column.
- To improve the load carrying capacity of hollow Rectangular RC column by retrofitting it with GFRP wrapping.
- To improve the efficiency of GFRP wrapping of Hollow Rectangular RC column by chamfering its edges.
- To compare the results of all the column & give the conclusion

II. REVIEW OF LITERATURE

To provide a detailed review of literature related to GFRP wrapping and its efficiency in load carrying capacity of hollow rectangular column as well as and its efficiency for different shape of column section is presented in this chapter. This literature review focuses on recent contribution related to GFRP wrapping of hollow rectangular column and its efficiency for different shape of hollow column section as well as shape modification for the purpose of increase in efficiency of FRP wrapping N. Elangovan and P. Shriram In this paper study of Behavior of hollow square section strengthened with carbon fiber reinforced polymer and aramid fiber reinforced polymer are carried out. Square hollow sections were used as columns and AFRP and CFRP as a strengthening material. AFRP and CFRP bonded columns with various numbers of layers of AFRP and GFRP also the width of the AFRP and GFRP. In this paper the column sections were analyzed using ANSYS 14.5. The dimensions of columns used were used as reference. Georgios Tsionis and Artur V. Pinto; In this paper of Retrofit of Large Bridge Pier With Rectangular-Hollow Cross-Section The paper deals with the seismic retrofit of bridge piers with rectangular hollow cross-section using fiber reinforced polymer (FRP) jackets. Finite element method (FEM) analyses show that the existing empirical laws for FRP-confined concrete are not suitable for hollow piers with large dimensions. G.P. Lignola et.al; In this paper Experimental Performance of RC Hollow Columns Confined With CFRP Column jacketing with fiber-reinforced polymer FRP composite materials has been extensively investigated in the last decade to address the issue of seismic upgrade and retrofit of existing reinforced concrete RC columns. Researchers have mainly focused their attention on solid columns, while very little research has been done on hollow columns strengthened with FRP.

III. METHODOLOGY

First of all the molds of plywood are prepared of required size that is 530X290mm. Total 9 hollow rectangular columns we had cast and tested under axial loading. The shape of the section is hollow rectangular. The column dimension of first set of columns is 530X290 mm (1:1.66:2.40). The height of all the columns was 600 mm. Each set have 3 columns. In the second set of columns the column dimensions are same as first set of columns and they are horizontally wrapped with single layer of GFRP. In the third set columns the chamfering of corners is to be carried out. Then these columns will be tested under the axial loading. In case of first set of three columns simply the casting of columns is

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done as per traditional method of casting after 28 days there axial compressive strength is tested under universal testing machine. After that another set of three columns is casted and after curing of 28 days these columns are allowed to dry for further treatment. On second day these three columns are wrapped with GFRP polymer horizontally. The adhesive material is used for proper bond between column surface and GFRP. These columns are allowed to dry for one day and on next day the axial compressive test on columns is carried out under the universal testing machine. After completing second cycle we had casted another set of three columns and chamfered their edges manually by providing the rounded edges the stress concentration at corners is minimized to much more extent which will be included in results further. The set of third cycle of column is also tested under an axial compressive load.

Fig.2. Mould of rectangular specimen

IV. EXPERIMENTAL PROGRAM

Total 9 hollow rectangular columns we were cast and tested under axial loading. The shape of the section is hollow rectangular. The column dimension of first set of columns is 340X290 mm (1:1.66:2.40). The height of all the columns was 600 mm. Each set have 3 columns. In the second set of columns the column dimensions are same as first set of columns and they are horizontally wrapped with single layer of GFRP. In the third set columns the chamfering of corners is to be carried out. Then this columns will be tested under the axial loading.

Table 1

Type of column	**Type of loading**	**Dimensions**
Hollow RC reference column (A)	Axial loading	340X290X600 MM
GFRP wrapped hollow RC rectangular column (B)	Axial loading	340X290X600 MM
Chamfered and GFRP wrapped hollow RC rectangular column (C)	Axial loading	340X290X600 MM

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Fig.3 Casted Specimen

V. RESULTS

TABLE 2 INPUT AND OUTPUT DETAILS OF A

Input parameter	Output parameters
Bach No. A	Ultimate load (KN) 700
Specimen Type Rectangular	Compressive strength (N/mm^2) 7.09
Length(mm) 340	Displacement at ultimate load (mm)
Width(mm) 290	Maximum displacement(mm)
Hight(mm) 600	Yield load(KN) 630
C/S Area(mm^2) 98600	Yield strength (N/mm^2) 6.38

TABLE 3 INPUT AND OUTPUT DETAILS FOR B

Input parameter	Output parameters
Bach No. B	Ultimate load (KN) 810
Specimen Type Rectangular	Compressive strength (N/mm^2) 7.09
Length(mm) 340	Displacement at ultimate load (mm)
Width(mm) 290	Maximum displacement(mm)
Hight(mm) 600	Yield load(KN) 630
C/S Area(mm^2) 98600	Yield strength (N/mm^2) 6.38

TABLE 4 INPUT AND OUTPUT DETAILS FOR C

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Input parameter	**Output parameters**
Bach No. C	Ultimate load (KN) 895
Specimen Type Rectangular	Compressive strength (N/mm^2) 7.09
Length(mm) 340	Displacement at ultimate load (mm)
Width(mm) 290	Maximum displacement(mm)
Hight(mm) 600	Yield load(KN) 820
C/S Area(mm^2) 98600	Yield strength (N/mm^2) 8.31

VI. CONCLUSIONS

Table no.5 Set A

Type of column	**Load Applied (KN)**	**Average (KN)**
	740	
Rectangular RC column hollow column	680	700
	690	

Table no.6 Set B

Type of column	**Load Applied (KN)**	**Average (KN)**
	820	
GFRP wrapped RC hollow rectangular column	800	810
	810	

Table no.7 Set C

Type of column	**Load Applied (KN)**	**Average (KN)**
	820	
Chamfered and GFRP wrapped RC hollow rectangular column	800	810
	810	

1. The compressive strength of chamfered hollow rectangular column with GFRP wrapping is more than hollow RC rectangular RC column.
2. The variation is being observed in ultimate load carrying capacity of different sets of column.
3. It may even be economical to use hollow RC members to minimize the weight of concrete members. And ultimately reduces production cost of concrete.
4. This proved to be an ecofriendly technique of retro fitting.

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