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EXPERIMENTAL INVESTIGATION ON BEHAVIOR OF RC SHORT COLUMN USING GFRP REINFORCEMENT

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Abstract— **The main problem in RC structural element is due to corrosion. Fibre Reinforced Polymer (FRP) bars has attracted a significant amount of research attention in the last three decades to overcome the problems associated with the corrosion of steel reinforcing bars in reinforced concrete members. The high cost associated with corrosion of steel reinforcements demands an alternative for steel. FRP reinforcing bars provides a great alternative to steel reinforcement which leads to corrosion.FRP materials in general offer many advantages over the conventional steel, including one quarter to one fifth the density of steel, no corrosion even in harsh chemical environments, neutrality to electrical and magnetic disturbances, and greater tensile strength than steel. A limited number of studies, however, have investigated the behaviour of concrete columns reinforced with FRP bars. Also, available design standards either ignore the contribution of or do not recommend the use of GFRP bars in compression members. This study reports the result of experimental investigations of concrete specimens reinforced with GFRP bars to improve the strength and ductility of the specimen. Totally 8 column specimens of height 600mm and dimension of 100 X 100 were cast and tested under axial load. The experimental result showed that the replacing the reinforcement with GFRP increases the strength and ductility of the column specimen. Also, an analytical model has been developed using ANSYS for the axial load deformation behaviour of the concrete column specimen reinforced with GFRP bars. The model has been validated with the experimental results.**

Keywords- ***Reinforced concrete, column, GFRP rod, axial load, ANSYS.***

I. INTRODUCTION

Corrosion of reinforcing steel is a serious problem in concrete structures located in aggressive environments, especially, if the reinforcing steel is subjected to high stresses. Corrosion produces cavernous pitting and a severe loss of cross section of the reinforcing steel. Glass-fibre reinforced plastic (GFRP) rebars that have been produced in recent times are considered to be an idyllic candidate and have grand potential to fill such a need [1]. The ultimate load carrying capacity of the column specimen increased by the utilization of GFRP reinforcement and reduces the deformations [9]. The column can be strengthened by increasing the flexural strength. To augment flexural capacity of columns, the method referred to as Near-Surface Mounted (NSM) FRP rods is projected. Embedment of the rods is achieved by grooving the surface of the member to be strengthened by the side of the desired direction [2]. The shape of the rebars used in the column specimen also plays a role in improving strength of the specimen [3]. Increasing main reinforcement, transverse reinforcement ratios in the column ends and increasing characteristic strength of the concrete have a significant effect on the behavior of reinforced concrete columns with FRP [6] and also associated with the reduction of GFRP strain [7]. For all the specimens, when the maximum load was reached, the averaged stress (defined as the ratio between the maximum load applied and the gross sectional area) reached about the 90% of the average concrete strength [4] and increases the ductility. The ultimate strength of sand coated GFRP reinforced specimens was 1.4 -2 times greater than that of the mild steel reinforced specimens but exhibited a higher deflection [4]. The column member with steel reinforcement ductile more than the column with GFRP reinforcement [8]. In this study the GFRP reinforcement was used to strengthen the column specimen.

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II. OBJECTIVE

1. To analyze the structural behaviour of concrete short columns internally reinforced with GFRP rebars, under axial compression.
2. To compare the behaviour of GFRP reinforced columns with steel reinforced columns using ANSYS.

III. MATERIALS

The materials with the properties as per Indian standard code were used for specimen.

A.CEMENT

Ordinary Portland cement (53 grade) with specific gravity of 3.15 is used for the present study and conforming to IS 12269:1987. The cement was quality guaranteed and available locally.

B.FINE AGGREGATE

The fine aggregate passing through 4.75 mm sieve and having a specific gravity of 2.68 was used. The grading zone of fine aggregate was zone II as per Indian standard specification (IS: 383-1970).

C.*COARSE AGGREGATE*

The maximum size of coarse aggregate used for this investigation is 20 mm and the specific gravity is 2.40.

D.WATER

Water should be portable and free from acids, oil, alkalis and other organic impurities.

E.SUPERPLASTICIZER

Super plasticizer produces extreme workability and thus flowing concrete. They achieve reduction in water content without loss of workability. Their use generally leads to an overall reduction in the cost. They are capable of reducing water content by about 20%. Addition of super plasticizer to stiff concrete mix reduces its water reducing agent efficiency. For the present investigation, a super plasticizer by the name CERA PLAST 400 of Naphthalene Sulphonate based has to be used for obtaining workable concrete at low W/B ratio. CERA PLAST 400 complies with BIS 9103-1999 and BS: 5075-Part 3.

F.QUARRY DUST

Quarry dust passing through 4.75 mm sieve and having a specific gravity of 2.7 was used in this specimen.

Fig 1 Quarry Dust

G.REINFORCEMENT:

The HYSD reinforcement with the tensile strength of 500 KN/m^3 was used. The diameter of the rod was 12mm. The sand sprinkled type Glass Fiber Reinforced Polymer (GFRP) with the tensile strength of 450 KN/m^3 was used. The diameter of the GFRP rod was 12mm.

Fig 2 Sand sprinkled GFRP rebars

IV. CASTING OF SPECIMENS

In this research, tests were carried out on 8-column specimens, where all columns had the same dimensions 100*100 mm and 600 mm height. The detailing of the column specimen was shown in the Fig 4.1. Tested specimens were divided into four groups:

Group 1: contains two specimens with steel reinforcement 4#12mm,the transverse reinforcement was closed stirrups ø8mm@100mm spread all the specimens lengths.

Group 2: contains two specimen with steel reinforcement 4#12mm, the transverse reinforcement was closed stirrups ø8mm@100mm spread all the specimen length, and in addition to that 30 % of quarry dust have been used.

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Group 3: contains two specimens with sand coated GFRP reinforcement 4#12mm, the transverse reinforcement was closed stirrups ø8mm@100mm spread all the specimens lengths.

Group 4: contains two specimens with GFRP reinforcement 4#12mm, and the transverse reinforcement was closed stirrups ø8mm@100mm spread all the length of specimen in addition to that 30% of quarry dust have been used.

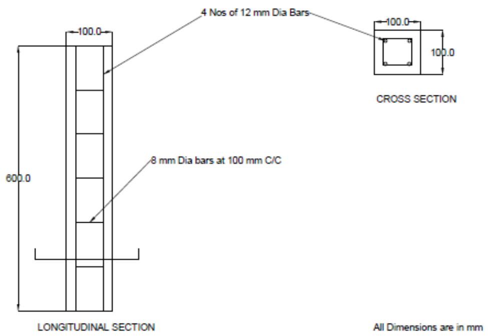

Fig 3 Detailing of column specimen

V. EXPERIMENTAL SETUP AND INSTRUMENTATION

The axial load was applied using a universal testing machine of 1000 kN capacity. Axial load was transmitted to the column through steel plates placed over it to provide hinge condition. Figure 5.8 shows the support condition. The column specimens were adjusted so that the centre line of the axial load coincides with column faces. A dial gauge with a least count of 0.01mm was used to measure the axial deformation. A dial gauge was attached to the plate placed over the top column surface which is used to transfer the load uniformly to measure the deflection.

VI. TEST PROCEDURE

Initially 8 column specimens were tested under axial load and the ultimate load carrying capacity and ultimate deflection of columns were calculated. Initially the specimens were white washed. For the axially compressed specimens, the centre point (centre of gravity) of the section was marked. Initially, an axial load of 5kN was applied to hold the specimen in its position and then the instruments were normalized and initial readings were observed. The axial deformations were measured using the dial gauge attached to the steel plate placed over the column. The load was applied gradually and the deflections were measured at every 10 KN load stages.. Initiation of crack was observed and the corresponding load was noted, ultimate load to failure and mode of failure were taken. The testing of column is shown in the Fig 4.

Fig 4 Test Setup of column

VII. RESULT AND DISCUSSION

The load deflection curve is used to define the value of load and deflection of a structure at various loads. The fig 5 shows the load deflection curve for conventional, quarry dust replaced column, GFRP replaced column and column with GFRP rod and quarry dust. From the figure it was found that column replaced with both quarry dust and GFRP reinforcement had more load carrying capacity and deflection than other types of columns.

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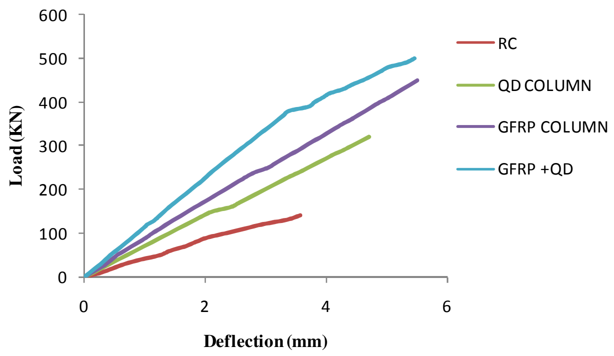

FIG 5 LOAD DEFLECTION CURVE FOR COLUMN SPECIMENS

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