Deformability And Load Carrying Capacity of Rubberized Reinforced Concrete Column

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Abstract- *This study aims to represent the effect on lateral deflection and load carrying capacity of RC column filled with waste tyre crumb rubber particle of size passing through 1.18 mm IS sieve and retaining on 600 µ IS sieve at varying percentages. The percentages used for this study are 0.5 %, 1%, 1.5% and 2% of crumb rubber replaced to the total weight of fine aggregate in concrete. 15 column specimens of size 150x150x 800mm were cast using 25 MPa concrete compressive strength and tested after 28 days of curing. From the results of investigation it is concluded that the lateral deflection before buckling failure at mid height of column specimen increases while load carrying capacity decreases with an increase in rubber content. This type of concrete can offer good ductility which makes it suitable for seismic applications.*

Keywords- Rubber filled concrete, lateral deflection, load carrying capacity, ductility.

I. INTRODUCTION

Day by day the stockpiles of waste tyre are increasing, these increasing stockyard of waste tyre creates problem of disposal. Because of improper disposal environmental problems are created. For proper disposal landfill method is suitable, but now a days landfill spaces are decreased. So the use of waste tyre rubber in concrete add benefits to society through environmental concern and related to human being. The use of waste tyre rubber particle in concrete gives good mechanical properties.

Many Researchers studied the properties of concrete with waste tyre crumb rubber particles, Camille A. Issa, George salem(1) shows that, use of recycled crumb rubber in concrete mix as fine aggregates, lowers the compressive strength beyond 25 % replacement of crumb rubber to fine aggregates. F. Hernandez-olivare(2) in his study presented the static and dynamic behaviour of recycled tyre rubber filled concrete. Ki sang son (3) showed that, the compressive strength and load carrying capacity of RC column specimen decreases with increase in rubber content, but due to increase in lateral deflection curvature ductility increases. He concluded that, rubber filled RC column gives better energy absorption capacity. Khatib and Bayomy(4) shows that, fine crumb rubber and tyre chips partially replaced to aggregate in concrete, the compressive strength was reduced while its energy dissipation capacity and toughness was increased. Pitisukontasukkul(5) shows that, crumb rubber concrete panel are lighter in weight, higher sound absorption and lower heat transfer properties than conventional concrete panel.

TABLE 1.CONCRETE MIXDESIGN PROPORTIONS
(Water cement ratio = 0.50)

Material	25MPa concrete Weight (kg/m^3)
Cement	383.2
Water	191.6
Fine aggregate	741.74
Coarse aggregate	1067.27

Fig.1 crumb rubber particle
(size passing through 1.18 mm IS sieve and retaining on 600 µ)

TABLE 2. PERCENTAGE REPLACEMENT OF CRUMB RUBBERTO THE TOTAL WEIGHT OF FINE AGGREGATE IN CONCRETE MIX

Proportions of crumb rubber	Weight of crumb rubber (kg/m^3)	Weight of fine aggregate (kg/m^3)
0.5 %	3.708	738.03
1.0 %	7.417	734.32
1.5 %	11.126	730.61
2.0 %	14.834	726.90

II. EXPERIMENTAL PROGRAMME

A) Material

i) NaOH treatment:

The NaOH treatment to the surface of rubber particle enhances the adhesion between rubber particle and cement paste. The immersion of rubber in NaOH aqueous solution for 20 minute to wash the rubber surface could improve the adhesion leading to a high strength performance of concrete rubber composites. The NaOH removes zinc stearate from the rubber surface, an additive responsible for the poor adhesion characteristics, enhancing the surface homogeneity.

ii) Crumb rubber

The crumb rubber particle of size passing through 1.18 mm IS sieve and retaining on 600 µIS sieve with percentage variation of 0.5 %, 1.0 %, 1.5 % and 2.0 % replaced to fine aggregate in concrete mix was used for the study.

iii) Concrete column specimen

To investigate the effect of varying percentages of crumb rubber particle on lateral deflection and load carrying capacity of rubber filled RC column, fifteen RC column specimens were casted with 25 MPa concrete compressive strength and all columns were tested after 28days under UTM of capacity 1000 kN for load carrying capacity and lateral deflection was measured by using dial gauges 0.01 mm least count. For concrete mix design 0.5 w/c ratio was used. Naturally occurring river bed sand and crushed stone aggregate was used as fine aggregate and coarse aggregate respectively. OPC was used throughout the study. This concrete mix design was used for preparing batches of varying percentages of crumb rubber in the concrete mix.

All rubberized reinforced concrete column specimens of size 150 x 150 x 800 mm were cured under similar condition and demoulded after 24 hrs of casting. The wooden moulds were prepared to cast all the RC column specimens.

B)Column Design

In RC column specimens longitudinal reinforcement used with characteristic value of yield stress was 500 MPa. And for transverse reinforcement characteristic value of yield stress was 250 MPa.According to IS 456-2000, the gross c/s area of longitudinal reinforcement shall be not less than 0.8 % nor more than 6 % of the gross c/s area of the column.Gross c/s area of the column = 150 x 150 = 22500 mm^2. Longitudinal reinforcement was used 4 numbers 10 mm diameter. The diameter of lateral ties shall be not less than one fourth of the diameter of the largest longitudinal bar and in no case less than 6 mm. Transverse reinforcement (Lateral ties) was used 6 mm diameter @ 150 mm c/c.

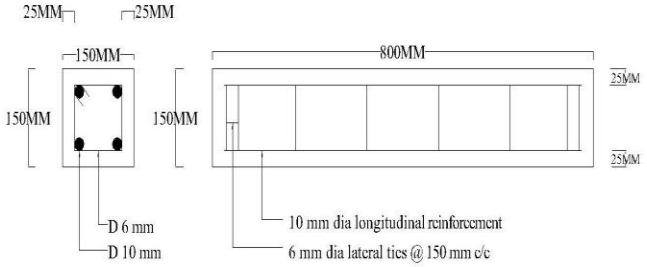

Fig 2. Reinforcement details of column specimen

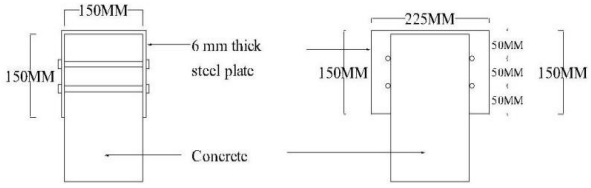

Fig 3. Steel jacket to prevent local buckling of longitudinal reinforcement at column ends

C) Specimen

In this study four different batches of RC column specimens with varying percentages of crumb rubber particle replaced to fine aggregate in concrete mix were prepared, to evaluate the effect of rubberized concrete on the lateral deflection and load carrying capacity of RC column specimens. Three normal concrete column specimens were casted for comparison purpose. For each batch of rubberized concrete three RC column specimens were casted and test was conducted after 28 days of curing. All column specimens were 800 mm long , 150 mm wide and 150 mm deep cast with longitudinal and transverse reinforcement of diameter 10 mm

and 6 mm respectively.a clear concrete cover provided from all sides of column specimen was 25 mm. the reinforcement details column specimen are shown in fig 2. Strengthening steel jacket was provided to minimize the local buckling of longitudinal reinforcement at top and bottom end of column specimen.(fig. 3) and also extra lateral ties at the top and bottom end of longitudinal reinforcement was provided to reduce buckling at the ends of column

Fig 4. Experimental set up for column specimen

Fig 5.Hinge at top of column

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D) Experimental set up

All RC column specimens of size 150 x 150 x 800 mm were tested under pure axial load by using UTM of capacity 1000 kN the experimental set up shown in fig 4 for test column specimen .The cross section of column used 150 x150 mm, So the direction of hinged support were provided along any one side of c/s but on the same side at top and bottom of column specimen as shown in fig 4 and fig 5. Two square steel plate of size 150 x150 mm and 6 mm thickness was provided at top and bottom end of column specimen. For strengthening jacket two steel plates of size 225 x 150 mm were provided along the hinge direction from two sides laterally at top and bottom of column specimen .Two dial gauges of least count 0.01 mm were fixed at mid height of column to measure the lateral deflection as shown in fig 4. The load carrying capacity and lateral deflection before buckling failure were recorded for each column specimen.

III. RESULTS AND DISCUSSION

A) Concrete properties

Based on experimental tests on three normal concrete column specimen and twelve column specimen for varying percentages of crumb rubber replaced to fine aggregate in concrete mix, the compressive load carrying capacity and lateral deflection at 28 days of curing were evaluated. For each batch average results of three specimen are calculated. The results are shown in table no. 3

TABLE NO 3. LATERAL DEFLECTION AND LOAD CARRYING CAPACITY

Proportions of crumb rubber	Lateral Deflection (mm)	Load carrying capacity (KN)
Normal concrete	3.35	369.8
0.5 % CR	5.30	370.0
1.0 % CR	6.73	369.75
1.5 % CR	7.92	361.0
2.0 % CR	10.35	359.7

(CR- crumb rubber)

B) Lateral Deflection

The mid span lateral deflection for all RC column specimens with varying percentages of crumb rubber measured with dial gauges (L.C. 0.01 mm) fixed from two sides opposite to hinge direction .The results are shown in table no 3, The result indicate that, the lateral deflection before buckling failure at mid span of column specimens increases with an increase in the rubber content . In this experiment

maximum replacement of crumb rubber was 2 %, so the lateral deflection for 2 % replacement of crumb rubber to the total weight of fine aggregate in concrete increased by 3.09 times the lateral deflection of normal RC column specimen without crumb rubber before buckling failure occurs.

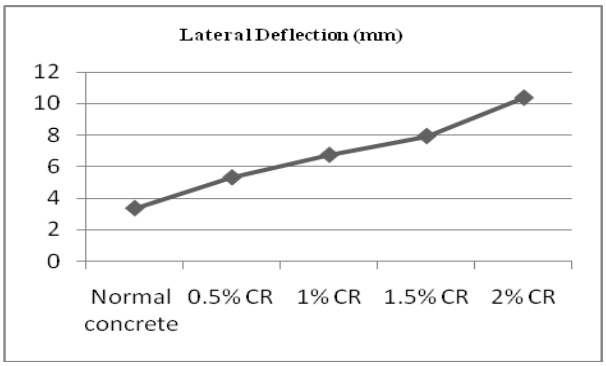

Fig. 6 (a)

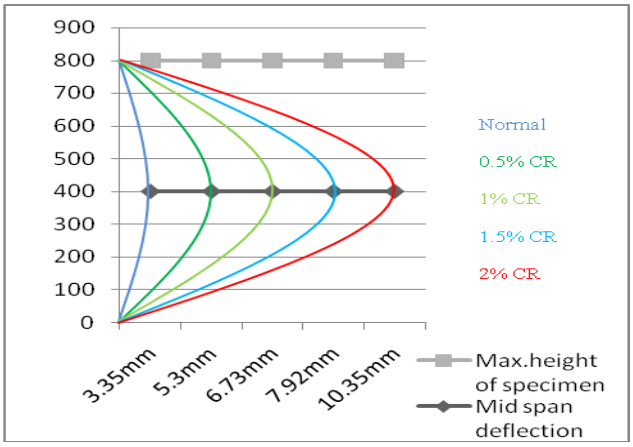

Fig. 6 (b)

C) Load carrying capacity of column

The result indicated that, the average load carrying capacity of RC column specimens for 0.5 % and 1.0 % crumb rubber replacement remains same when compared with similar normal RC column specimen. For 1.5 % and 2.0% crumb rubber replacement the average load carrying capacity of column specimen decreased by 2.44 % and 2.81 % respectively, when compared with similar normal RC column specimen without waste tyre rubber particle.

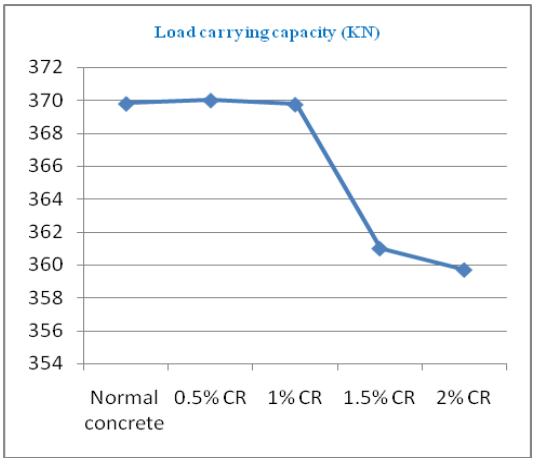

Fig 7.

D) Failure modes in column

For the tested RC column specimens the ratio of unsupported length to the least dimension of the cross section is equal to 5.33. The local buckling of longitudinal reinforcement at both the ends of column specimen was prevented by steel jackets. Failure always occur prior to concrete compressive crushing . As expected bending occurred at mid height of column. The failure mode of column as shown in fig 8.

Fig 8. Failure of column specimen.

IV. CONCLUSION

This study investigated the effect on lateral deflection before buckling failure and load carrying capacity of rubberized RC columns. Based on the experimental results following conclusions can be drawn:

- Utilizing waste tyre crumb rubber particle of size passing through 1.18 mm IS sieve and retaining on 600 µ IS sieve at varying percentages in 25 MPa concrete, the load carrying capacity decreases with increase in the rubber content.
- The results indicate that, for 0.5 % and 1.0 % crumb rubber replacement to the total weight of fine aggregate in concrete there was no effect on the load carrying capacity of RC column specimen, but for 1.5 % and 2 % crumb rubber replacement the average load carrying capacity decreased by 2.44 % and 2.81% respectively.when compared with similar normal RC column specimens.
- The average lateral deflection of RC column specimen with 2 % crumb rubber replacement increased by 3.09 times the average lateral deflection of normal RC column specimen before buckling failure occur.
- Waste tyre rubber filled RC column specimen gives better ductility than normal RC column specimen. It is suitable for structural member subjected to seismic forces.

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