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Behavior of Columns Made from Concrete Content Waste Rubber as Aggregate Replacement

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Abstract: Disposal of tyre rubber is becoming a huge problem in India day by day. Researchers are trying to use those rubber in civil engineering projects from long day back. Crumb rubber replaced fine aggregate is quite a common practice now a days. An attempt was made to replace 10% chipped rubber with coarse aggregate and columns were casted with that concrete mix. They were tested to failure. Load carrying capacity of columns, ultimate load, stress vsstrain,Youngs modulus are all studied. Efforts have been taken to identify the potential application of waste tyres in civil engineering projects. This study can show an alternative way of recycling tyre by incorporating them into concrete construction. Main focus was made on the behaviour of column made from recycled rubber chips.

Key words: Tyre, rubberized concrete, replacement of coarse aggregate by used rubber, chipped rubber concrete, stress vs strain

INTRODUCTION

Now a day's sustainability is the main key of the research. For environment impact researcher tried to use waste product as much as they can and recycling of waste product is the main criteria for research. In this particular research programme researchers used waste tyre rubber as coarse aggregate which replaced 10% of conventional coarse aggregate. RCC columns were prepared and tested and the properties were then compared to that of conventional beam. Potential of rubber in concrete project is the research purpose because in India dumping of it is a big problem. The concrete mixed with waste rubber added in different volume proportions is called rubberized concrete partially replacing the coarse aggregate of concrete with some quantity of small waste tyre chips can improve qualities such as low unit weight, high resistance to abrasion, absorbing the shocks and vibrations. In constructions that are subjected to impact effects the use of rubberized concrete will be beneficial due to the altered state of its properties.

Literature review: Aniruddh *et al*. (2016) this research paper deals with the effect on compressive strength of concrete using waste rubber as partial replacement of fine aggregate. It is evident that the compressive and tensile strengths of rubberized concrete decreases with the increase in rubber content but some other properties like toughness and ductility of the hardened rubberized mix increases. Economically rubberized concrete is more expensive than the normal mixes. Fire resistance of rubberized concrete is greater than normal mixes. By Hilal, (2011) these studies deal with the effect of crumb rubber tyres on foamed concrete. A partial sand Replacement in foamed concrete by crumb tyres rubber leads to reduce the density of the final product, because of the specific gravity of rubber used was less than it of sand. Water absorption (%) increases with increasing of crumb rubber of tyres content. Rubberized foamed concrete shows a cohesive behaviour at failure than Foamed Concrete (FC) and this is obviously appear in splitting tensile test. Addition of rubber causes deceasing in foamed concrete strength. By Othman (2006) he studied on fracture resistance of rubber-modified asphaltic mixtures exposed to high-temperature cyclic aging. Fracture resistance at different duration of high temperature cyclic aging is investigated using J-integral approach.The rubber-modified mixture has a higher fracture load compared to the unmodified mixture at same thermal cyclic level and crack length. The area under the load-deflection curve for the rubber modified mixture is also higher than its counterpart for the unmodified mixture. By Hunt (2002), she studied the properties of crumb rubber modified asphalt concrete in Oregon. Life cycle cost analyses done in Ontario indicate a potential for cost savings assuming a longer life expectancy and reduced maintenance with the addition of rubber to the binder.

MATERIALS AND METHODS

Experimental investigation

Materials used

- Cement-53 grade opc
- Fine aggregate

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- Coarse aggregate
- Chipped rubber aggregate-20 mm size
- Grade of concrete-M 25
- Glenium-an admixture used for higher workability
- Strain gauges 120 Ω

Cement and aggregates: In the present study ordinary portland cement of grade 53, confirming to 1989 (BIS., 2013) was used for preparing the concrete. The specific gravity of cement was 3.15. Fine aggregate: Natural River sand passing through 4.75 mm IS sieve is used for making concrete. As per IS: 383-1970 (Anonymous, 1970) natural river sand was categorized under grading zone I. The specific gravity and fineness modulus of sand is found to be 2.65 and 3.05. Coarse aggregate-coarse aggregate was passed through 80 mm sieve and retained on 4.75 mm sieve confirming (Anonymous, 1970) was used for concreting. The specific gravity and fineness modulus of coarse aggregate is found to be 2.695 and 7.7.

Rubber aggregate: This study has concentrated on the performance of a single gradation of rubber prepared by manual cutting (Fig. 1). In this study 5% of coarse aggregate is replaced by this chipped rubber. The maximum size of the rubber aggregate was 40 mm. The properties of the rubber used as aggregate is given below in Table 1.

Water: Clean potable water free from suspended particles, chemical substances, biological elements etc. is used both for mixing of concrete and curing.

Glenium: Glenium 51 superplasticizer is used for higher workability. In this study 0.5% of cementitious material is used as Glenium. It is an admixture of a new generation based on modified polycarboxylic ether.

Typical properties:
- Aspect light brown liquid
- Specific gravity 1082-1142 kg/L at 20°C
- pH 6-7
- Chloride content: ≤0.10% by mass
- Alkali content: ≤3.0% by mass

Mix design (as per IS 10262-2009): Based on the trial mixes the final design mix was prepared for M25 grade of concrete as per IS 10262:2009 (BIS., 2009). The concrete mix proportions were shown in Table 2-4.

Casting of columns: Size of column = (150×150×900 mm) (Fig. 2-6).

Fig. 1: Rubber aggregate

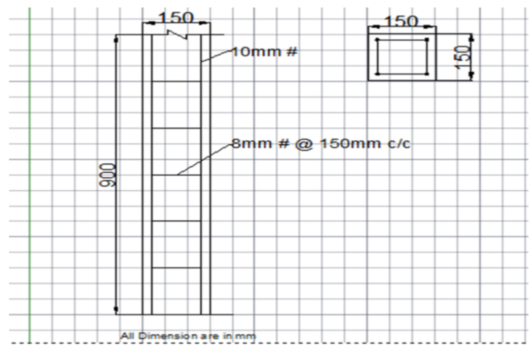

Fig. 2: Section of column

Fig. 3: Preparation of mould

Table 1: Rubber properties

Parameters/Units	Standard specs
Acetone extraction (%)	5-10
Ash content (%)	4 Max
Bulk density (gm/cc)	0.30-0.45
Sieve analysis passing 40 mm sieve (%)	99
Sieve analysis passing 2 mm sieve (%)	1

Table 2 Mix proportions

Grade of concrete	Target mean strength (N/mm^2)	W/C ratio	Mix proportion
M 25	31. 60	0.45	1:2.20:2.72

Table 3: Load carrying capacity of column

Sample No.	Conventional column (kN)	Chipped rubber concerete column (kN)
1	268.2	214.89
2	287.0	224.00
3	227.9	186.00

Table 4: Modulus of elasticity

Materials	E (N/mm^2)
Rubber concrete (10%)	16111
Normal concrete	23265

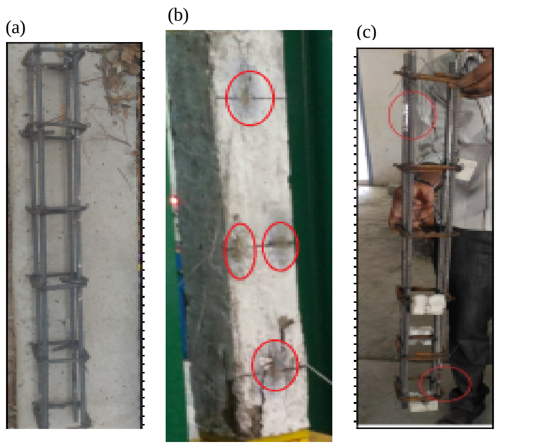

Fig. 4: a-c) Position of external strain gauge; position of internal strain gauge

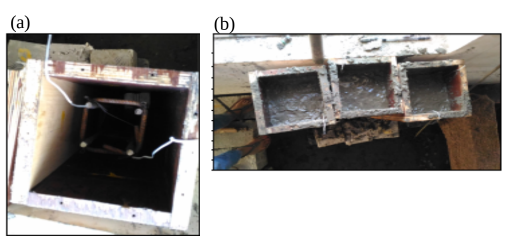

Fig. 5: a, b) Reinforcement, strain gauge positions and casting of specimens

Fig. 6: Curing of specimens

RESULTS AND DISCUSSION

Load carrying capacity is studied in a column testing machine of capacity 100 tons (Fig. 7-10).

Behaviour of column: This experiment indicates that there is a crushing failure as shown in figure when axial load is applied on the column.

Fig. 7: Column testing machine (100 tons)

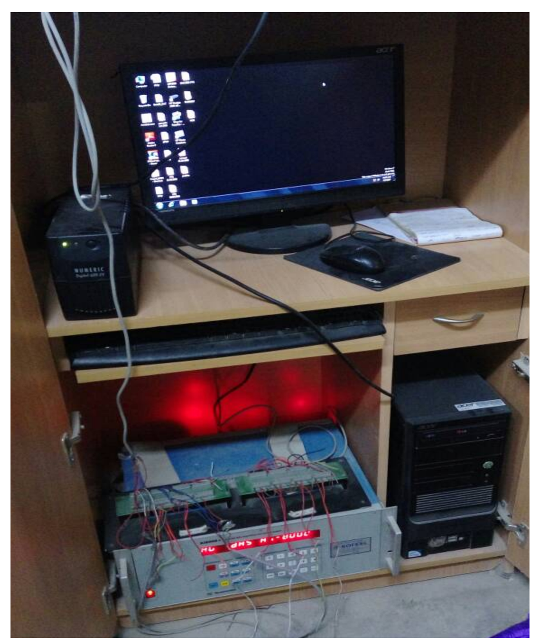

Fig. 8: Data acquisition system

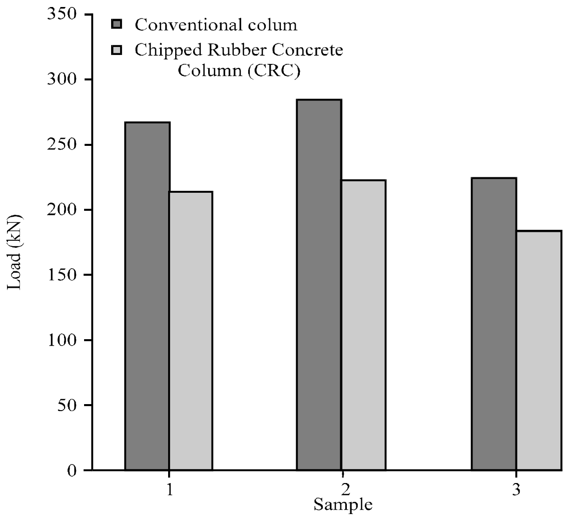

Fig. 9: Comparision of load carrying capacity of conventional and rubber concrete

Fig. 10: Crushing failure of column

CONCLUSION

By replacing 10% of coarse aggregate by rubber, we can gain strength upto 80-90% of strength that of conventional concrete. Mode of failure is crushing failure. By replacing 10% of coarse aggregate by rubber the Youngs modulus of elasticity is decreasing by almost 30%. From the preliminary tests, we got a conclusion that by adding 10% replacement of rubber with coarse aggregate the capacity decreases by only 10-20%.

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