Experimental investigation on flexural behaviour of RC beam with rubber tube filled with rubberized concrete

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***Abstract* -** Modifications of various construction materials have an important significance on the building sector. Several attempts have therefore been made in the building material industry to put to use waste material products, example, worn-out tires and waste bicycle tire tubes into serviceable and cost effective items. Favorable outcome in this regard will contribute the reduction of waste material dumping problems by utilizing the waste materials as raw materials in construction industry. The current study involves the mechanical properties of rubberized concrete for a durable, ductile, light weight and shock resistant concrete. In this investigation a volume of coarse aggregate is replaced by crumb rubber and is filled inside a tire rubber tube. The mid-point of the rubber tube meets the neutral axis of the beam which is filled with normal concrete mix of M30 grade. The rubber particles composed of crumb rubber was used to replace 25%, 50%, 75%, 100% of a volume of coarse aggregate inside the tube. Tests are conducted to evaluate the flexural behavior of this RC beam.

***Keywords* -** Crumb rubber; Rubber tube; Partial Replacement; Cost efficient.

I. INTRODUCTION

Cement and aggregate are the most important constituents used in concrete production and are the vital materials needed for the construction industry. This obviously led to an increasing demand of natural materials used for the concrete production. Favorable outcome in this regard will contribute the reduction of waste material dumping problems by utilizing the waste materials as raw materials in construction industry.

Waste rubber from lorry tire and rubber tire tubes of bicycle has received a great deal of attention for utilization because of its large production volume and difficulty of disposal. This rubber is crumbed in the size of coarse aggregate and the coarse aggregate is partially replaced by crumb rubber.

This rubberized concrete is filled inside the rubber tube of various proportions and the rubber tube is placed inside the reinforcement so that the neutral axis of the concrete touches the mid-point of the rubber tube.

Bashar S. Mohammed et al [1] conducted to determine the fresh and hardened properties of crumb rubber concrete (CRC), concrete containing crumb rubber as partial replacement to fine aggregate. The benefits of outlined from these works include low density, good thermal resistivity, better sound absorption, increase slump values and toughness, and better impact resistivity of the resulting concrete. For the purpose of this work, sixty-four trial mixes were prepared to produce hollow concrete blocks of dimension 390 mm × 190 mm × 190 mm using 0%, 10%, 25% and 50% crumb rubber (CR) as replacement of fine aggregate.

Tests conducted on the hardened concrete include compressive strength, thermal conductivity, electrical resistivity, acoustic absorption and transmission loss, and electrical resistivity. It has been found that CRHCB can be produced as load-bearing hollow blocks as well as lightweight hollow blocks. The CRHCB also has better thermal, acoustic and electrical properties in comparison with conventional hollow block.

Piti Sukontasukkul et al [2] proposed the paper on crumb rubber concrete. In their study they decided to replace the course and fine aggregate in concrete for moulding pedestrian blocks. They believe that the concrete acting as a binder mixed with crumb rubber can make the concrete blocks more flexible and it provide softness to the surface.

In this study they saw that the pedestrian blocks with crumb rubber performed quite well in skid and abrasion resistance. In this study the process of making the concrete is economical due to the simplicity of the manufacturing process.

Camille A. Issa et al [3] studied the basic building materials in concrete construction are primarily aggregate and cement. The educated use of recycled materials can result in reduced cost potentials and may enhance performance; however, not all recycled materials are well suited for concrete construction applications.

In this study, the performance of recycled materials crumb rubber as valuable substitute for fine aggregates ranging from 0% to 100% in replacement of crushed sand in concrete mixes is investigated. An acceptable compressive strength was obtained with up to 25% by volume replacement of fine aggregates with crumb rubber.

Guneyisi et al [4] concluded experimental study on the mechanical properties of rubberized concretes with and without silica fume. It was observed that a large reduction in the strength and modulus values with the increase in rubber content.

In this study, the flexural strength of the concrete is calculated. This is achieved by replacing 25%, 50%, 75%, 100% of coarse aggregate using Crumb rubber inside the rubber tube and the mix proportion for the M-30 is calculated.

The concrete mixtures were produced, cured & tested for 28 days for the determination of flexural strength of the concrete. The study also involves the comparison of flexural strength of this concrete and conventional concrete for 28 days.

II. MATERIALS AND METHODS

A. *Materials*

- *Cement* - The ordinary Portland cement of 53 Grade conforming to IS 12269-(1987) was used in this study. The specific gravity, initial and final setting of OPC 53 grade were 3.15, 131 and 173 min, respectively.
- *Fine aggregate* - Crushed sand conforming to grading zone II of IS 4031-(1998). Sand passing through IS 4.75 mm sieve was used with the specific gravity of 2.71.
- *Coarse aggregate* - Coarse aggregate 20mm grading conforming to single size aggregate of nominal size 20 mm and 10mm grading conforming to graded aggregate of nominal size of 12.5mm as per IS 383-(1970) with the specific gravity of 2.70 was used respectively.
- *Crumb rubber* - crumb rubber, crumbed in the size of coarse aggregate, 20mm grading conforming to single size aggregate with the specific gravity of 1.15 was used respectively.
- *Rubber tube* – Cycle Rubber tube made up of combination of butyl and EPDM(ethylene propylene diene monomer) of 50mm diameter and 700mm length and specific gravity of 1.12 was used respectively.
- *Water* - Casting and curing of specimens were done with the potable water that is available in the lab premises.

B. *Mix Proportions*

The mixes of M-30 grade were designed as per IS 10262:2009 and the same was used to prepare the test samples. The design mix proportion is shown in Table 1.

Table 1: Concrete Mix Proportion

Concrete Grade	M30
Cement (Kg/m³)	360
Fine aggregate (Kg/m³)	539
Coarse aggregate (Kg/m³)	1309
Water (li/m³)	168
Water cement ratio	0.46
Mix ratio	1:1.5:3.63

Figure 1: Placement of rubber tire tube inside reinforcement

Figure 2: Casting of the specimen

C. *Flexural strength Test*

The specimens of each proportions of rubberized concrete inside the rubber tube were tested using a 1000 kN Universal Testing Machine; a dial gauge having a travel of 100 mm was used to record the vertical deflection at the bottom of the mid-span of the beam. The behaviour of the beams were keenly observed from beginning to failure. The appearance of the first crack, the development and the propagation of cracks due to the increase of load were also recorded. The loading was continued after the initial cracking load and was stopped when the beam was just on the verge of collapse.

The universal testing machine consists of a set up for testing the one point bending set up facilities.. The values of load applied and deflection are noted directly and further the plot of load vs deflection is performed which is taken as the output. The load in kN is applied with uniformly increasing the value of the load and the deflection under the different applied loads is noted down. The applied load increased up to the breaking point or till the failure of the material.

III. TEST RESULTS AND DISCUSSIONS

A. Flexural Strength Test

The mean flexural strength of the beam for 28 days was calculated and tabulated in Table 2

Table 2: Flexural strength of concrete

S.No	Rubber inside rubber tube (%)	Flexural strength (N/mm²)
1.	0	11.02
2.	25	16.84
3.	50	16.26
4.	75	15.38
5.	100	14.95

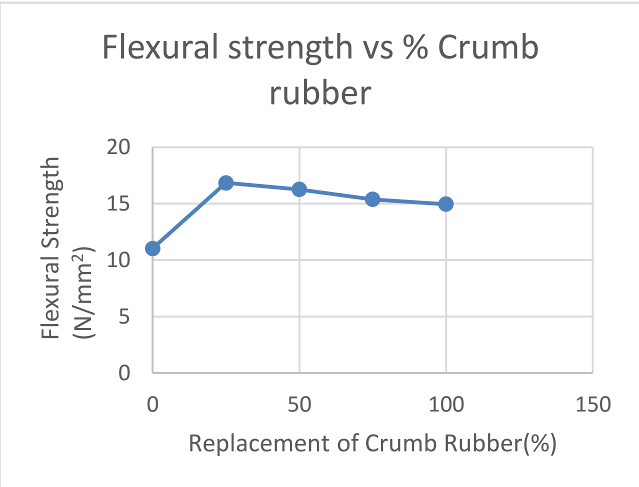

Figure 3: Plot for Flexural strength vs crumb rubber

B. Load vs Deflection

Due to increase in the load, deflection of the beams starts, up to certain level the load vs. deflection graph will be linear that is load will be directly proportional to deflection and with increase in percentage of rubber inside the rubber tube increases the deflection value.

The load values and corresponding deflection for percentage of rubber inside rubber tube given in table.

TABLE 3: Load vs Deflection

LOAD (KN)	DEFLECTION (mm)				
	0%	25%	50%	75%	100%
0	0	0	0	0	0
5	0.04	0.06	0.08	0.09	0.12
10	0.08	0.10	0.12	0.17	0.25
15	0.16	0.19	0.22	0.27	0.35
20	0.23	0.26	0.31	0.36	0.43
25	0.28	0.31	0.36	0.41	0.50
30	0.32	0.42	0.46	0.50	0.58
35	0.39	0.50	0.56	0.58	0.68
40	0.45	0.60	0.62	0.66	0.75
45	0.59	0.72	0.74	0.77	0.84
50	0.69	0.81	0.84	0.86	0.92
55	0.79	0.96	0.99	1.03	1.05
60	0.88	1.08	1.10	1.15	1.19
65	0.97	1.19	1.22	1.24	1.28
68.9	1.08	-	-	-	-
70	-	1.24	1.28	1.31	1.39
72.1	-	-	-	-	1.42
74.2	-	-	-	1.36	-
75	-	1.31	1.34	-	-
78.4	-	-	1.48	-	-
80	-	1.50	-	-	-
81.2	-	1.51	-	-	-

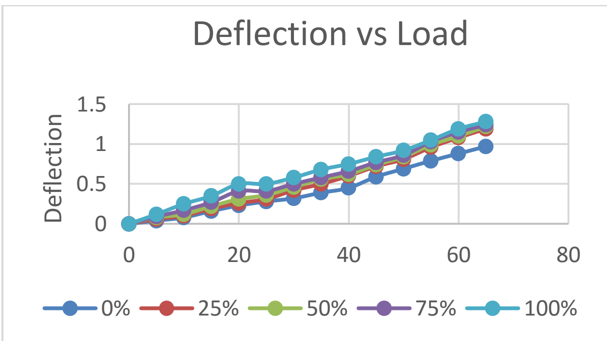

Figure 4: Plot for Deflection vs Load

IV. SUMMARY AND CONCLUSION

This paper presented the experimental investigation of rubberized concrete inside a rubber tube placed inside the concrete. Based on this investigation, the following can be concluded

1. The flexural strength of this concrete is higher for all proportions of rubber inside the rubber tube when compared to nominal concrete.
2. The flexural strength of concrete in which 25% aggregate is replaced by rubber inside the rubber tube is 52% greater than conventional concrete beam.
3. The flexural strength of concrete in which 50% aggregate is replaced by rubber inside the rubber tube is 47% greater than conventional concrete beam.
4. The flexural strength of concrete in which 75% aggregate is replaced by rubber inside the rubber tube is 39% greater than conventional concrete beam.
5. The flexural strength of concrete in which 100% aggregate is replaced by rubber inside the rubber tube is 35% greater than conventional concrete beam.
6. Increased ductility and durability of the concrete.
7. This concrete is economical when compared to conventional concrete since the aggregate is replaced by crumb rubber.
8. Reduced unit weight of concrete when compared to conventional concrete.
9. Rubber tube has a heat resistant upto 130° C.
10. Rubber present inside concrete is said to have shock resisting properties.
11. Initial crack resistance is high due to presence of rubber and rubber tube inside the concrete.
12. Deflection values are higher when compared to conventional concrete.

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BIOGRAPHY

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