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Rubberized Concrete Made with Crumb Rubber

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Abstract: ***About one crore 10 lakhs all types of new vehicles are added each year to the Indian roads. The increase of about three crores discarded tyres each year poses a potential threat to the environment. The best way to overcome this problem is to find alternate aggregates for construction. The proposed work presents an experimental study of effect of use of solid waste material (crumb rubber) in concrete by volume variation of crumb rubber. Crumb rubber usually consists of particles ranging in size from 4.75 mm (No.4 sieve) to less than 0.075 mm (No. 200 sieve). Most processes that incorporate crumb rubber as an asphalt modifier use particles ranging in size from 0.6 mm to 0.15 mm (No. 30 to No. 100 sieve).***

Keywords: Crumb rubber, specific gravity, Water absorption, Slump, compressive strength

1. Introduction

In order to prevent the environmental problem from growing, recycling Tyre is an innovative idea or way in this case. Recycling Tyre is the processes of recycling vehicles Tyres that are no longer suitable for use on vehicles due to wear or irreparable damage (such as punctures). The cracker mill process tears apart or reduces the size of Tyre rubber by passing the material between rotating corrugated steel drums. By this process an irregularly shaped torn particles having large surface area are produced and this particles are commonly known as crumb rubber

Figure 1: Crumb Rubber

This part presents a review of most recent literature to bring out the background of the study to be undertaken in the present work. The research contributions, which have direct relevance and have contributed greatly to the understanding of the behavior of the fibrous concrete, when tyre chips and waste plastic strips are used in concrete, are described. Early studies on the use of scrap tyres in asphalt mixes were very promising. They showed that rubberized asphalt had better skid resistance, reduced fatigue cracking, and achieved longer pavement life than conventional asphalt. Large benefits can result from the use of scrap tyre rubber in Portland cement concrete (pcc) mixtures, especially in circumstances where properties like lower density, increased toughness and ductility, higher impact resistance, and more efficient heat and sound insulation are desired. Although the reduction· in strength of rubberized mixtures may limit their use in some structural applications, one can rather appreciate their future potential in their enhanced toughness and failure mode.

Eldin and Senouci (1993), on the basis of test results, showed that there was about 85% reduction in compressive strength and 50% reduction in tensile strength when the coarse aggregate was fully replaced by coarse rubber chips. However, specimens lost up to65% of their compressive strength and up to 50% of their tensile strength when the fine aggregate was fully replaced by fine crumb rubber. He also showed that when loaded in compression specimens containing rubber did not exhibit brittle failure.

Topcu (1995)3, analyzed the results of compression tests conducted on ordinary and rubberized concrete and observed that the compressive strength of ordinary concrete obtained from cube tests is higher than that obtained from cylinder tests. Biel and Lee (1996)4, reported that the failure of plain concrete cylinder's resulted in explosive conical separations of cylinders, leaving the specimens in several pieces. As the amount of rubber in concrete was increased, the severity and explosiveness of the failures decreased. Failure of concrete specimens with 30, 45 and 60% replacement of fine aggregate with rubber particles occurred as a gradual shear that resulted in a diagonal failure plane. Topcu and Avcular (1997)8, studied that, the impact resistance of concrete increased when rubber aggregates were added to the mixture. It was argued that this increased resistance was derived from an increased ability of the material to absorb energy and insulate sound during impact. The increase became more prominent in concrete samples containing larger-size rubber aggregates.

2. Experimental Procedure, Materials

Materials: The basic ingredients of rubberized concrete and its products, which were used in this research work, are:

1- OPC 43 grade ultra tech cement.
2- Natural Coarse aggregate (sedimentary rock source).

3- Natural Fine aggregate (sand).
4- Water (fresh drinkable water)
5- Fine crumb rubber

Work Procedure: The following represents the methodology by which to study the effect of utilizing waste crumb tyres in concrete mixes were done.

No. of samples = no. of sample for each percentage x total no. of percentage x 2

No. of cubes = 5 x 5 x 2 = 50

Concrete mix design In the present investigation the existing method as per IS: 10262-2009 has been used for selecting the reference mix (M30), however new information given in IS 456 -2000 have been incorporated, procedure is modified to the extent. In order to get the final mix proportion for the reference mix design, three trial mixes had been prepared earlier and tested at 28 days. The mix proportion of trial mixes are given below in table

Therefore designed ratio for M30 is

Table 1

Water (kg/m3)	*Cement (kg/m3*	*Fine aggregate (kg/m3)*	*Coarse aggregate (kg/m3)*
15.94	50	53.96	121.87
0.318	1	1.06	2.42

Final mix design adopted

Table 2

Mix	Water (kg/m3)	Cement (kg/m3)	Fine aggregate (kg/m3)	Coarse aggregate (kg/m3)
M30	191.58	425.733	574.51	1202.55
	0.45	1	1.34	2.82

3. Results and Discussion

Test results for compressive strength at 7 days

Table 3

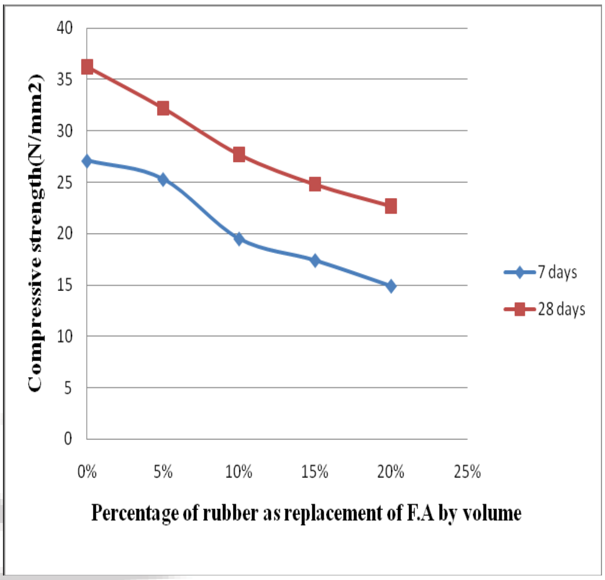
S. No.	*Percentage of crumb rubber*	*Load at failure (KN)*	*Compressive strength(N/mm2)*
1	0%	609.94	27.1
2	5%	567.9	25.2
3	10%	437.6	19.3
4	15%	390.8	17.5
5	20%	335.1	15.0

Test results for compressive strength at 28 days

Size of cubes 150mm X 150mm X 150mm Concrete mix used M30 grade

Table 4

S. No.	*Percentage of crumb rubber*	*Load at failure (KN*	*Compressive strength(N/mm2)*
1	0%	814.4	36.1
2	5%	724.4	32.1
3	10%	622.7	27.6
4	15%	559.0	24.6
5	20%	510.5	22.6



Variation of compressive strength at 7 and 28 days v/s percentage of crumb rubber as replacement for FA (fig.2)

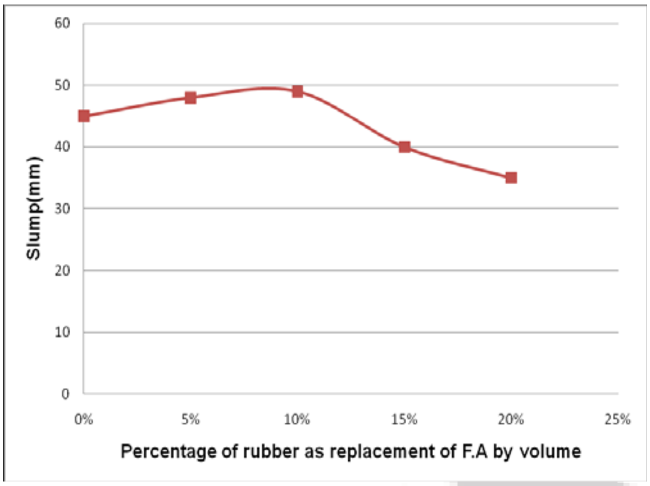
Compressive strength behavior of rubberized concrete:

The effect of crumb rubber on concrete compressive strength is given in Table 1, 2, and is demonstrated in Figure 1. It is observed that the use of crumb rubber reduced compressive strength. As expected, the higher the rubber content in the mix, the higher the reduction in compressive (fc) strength. Detailed examination of the Figure shows that increasing the crumb rubber up to 10% exhibited a linear relationship between the increase of crumb rubber and the compressive strength, showing a loss of about 24% of the compressive strength at 10% rubber content. Therefore, this result limits the use of the modified concrete when strength is the prime requirement.

Test results for slump value

Cone size – 10cm X 20cm X 30cm Concrete mix M30 grade

S. No.	*Percentage of crumb rubber*	*Slump value (mm)*
1	0%	44
2	5%	487
3	10%	48
4	15%	41
5	20%	33



Variation of slump v/s percentage of crumb rubber as replacement for FA (fig.3)

Slump behaviour of rubberized concrete

The results of the slump of concrete with and without inclusion of crumb rubber are shown in Table 5 .The Figure shows the effect of partial replacement of sand with crumb rubber on the slump value of concrete. It can be noted that with increase in the crumb rubber up to 10%, the slump value increases after that it started decreasing .As seen in Table 5, the increase of the crumb rubber content in the mix resulted in an increase in the slump. At rubber contents of higher than 10% (10% by fine aggregate volume), the slump decreases. However despite the decrease in measured slump, observation during mixing and casting showed that increasing the crumb content in the mix still produced a workable mix in comparison with the control mix. Effect of rubber particles on the workability of concrete is attributed to a reduction in the density of concrete or to actual changes in the yield value and plastic viscosity of the mixture.

4. Conclusion

The test results of this study indicate that there is great potential for the utilization of waste tyres in concrete mixes in several percentages, ranging from 5% to 20%. Based on present study, the following can be concluded:

The strength of modified concrete is reduced with an increase in the rubber content; however lower unit weight meets the criteria of light weight concrete that full fill the strength requirements as per given by Neville in 1995. Concrete with higher percentage of crumb rubber possess high toughness The slump of the modified concrete increases about 1.08%, with the use of 1 to 10% of crumb rubber. Energy generated in the modified concrete is mainly plastic. Concrete with higher percentage of crumb rubber possess high toughness The slump of the modified concrete increases about 1.08%, with the use of 1 to 10% of crumb rubber.

The light unit weight qualities of rubberized concrete may be suitable f or architectural application, false facdes, stone baking, interior construction, in building as an earthquake shock wave absorber, where vibration damping is required such as in foundation pads f or machinery railway station, where resistance to impact or explosion is required, such as in jersey barrier, railway buffers, bunkers and f or trench filling.

The compressive strength of the concrete decreases about 37%when 20% sand is replaced by crumb rubber. For large percentage of crumb rubber the compressive strength gain rate is lower than that of plain concrete.

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