Experimental Studies on Light Weight Concrete of Waste Tire Rubber in Concrete

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Abstract- **In our world, products are used and then discarded. Even when materials are recycled, the remaining refuse can create an environmental concern. An economically viable solution to this problem should include utilization of waste materials, partially replacing concrete aggregates with recycled materials that could help to combat the decreasing availability of some natural resources (natural sand) and at the same time help to utilize growing quantities of waste material like used tires. This idea has been put into practice to develop a more sustainable concrete material called rubberized concrete or crumbed rubber concrete (CRC). Experimental studies are done using the waste tire rubber in concrete in the form of crumb rubber as a replacement of fine aggregate & in the form of rubber chips as a replacement of coarse aggregate. From the literature study, the replacement percentage of fine and coarse aggregate with crumb rubber and rubber chips is identified as 25%, 50%, and 75%.A High range water reducer is used as super plasticizers for all the mixes. These specimens are tested for 7 & 28days to determine their strength parameters by conducting compressive strength test, split tensile strength, flexural strength and nondestructive tests such as Rebound hammer & Ultrasonic pulse velocity. From the detailed study conducted, it was concluded that the compressive strength was found to decrease with the increase in the percentage of rubber. The structural application of rubber concrete is very less but can be used in pavements to have better skid resistance, rutting resistance and improved fatigue cracking resistance.**

Index Terms- **Rubber chips, Crumb Rubber, Replacement, and Rubber Concrete.**

I. INTRODUCTION

Solid waste management, especially of non-biodegradable waste, is one of the major environmental challenges across the world. An estimated number of one-two billion scrap tires have been disposed of in huge piles across the United States. An additional 250 million tires unaccounted for are discarded yearly.

Investigations have shown that scrapped rubber tires contain materials that do not decompose under environmental conditions and cause serious problems. One choice of decomposition is burning, but that would also result in harmful pollutions.

Therefore it is very difficult to manage the waste produced by the rubber-tire industry and to handle the waste. It is not easily biodegradable waste form.

II.LITERATURE REVIEW

This literature review investigates the past uses and effects of recycled waste tires used in concrete mixture design. This review covers the various topics researchers have investigated and the rubberized concrete trends that have been discovered that has facilitated the current utilization of waste rubber tire chips in civil engineering applications.

Touting (1996) conducted research on the use of rubber tire particles in concrete to replace mineral aggregates. His results showed a reduction in both compressive and flexural strengths. The reduction in compressive strength was greater than that of the flexural strength. He concluded that the reduction in both strengths increased with increasing the rubber aggregate volume content.

Garrick (2004) investigated waste tire modified concrete by replacing 15% (by volume) of coarse aggregate by the waste tire. He used the waste tire as tire fiber and chips dispersed in the concrete mix. His results showed an increase in toughness, plastic deformation, impact resistance and cracking resistance (Garrick, 2004). He also found a reduction in the strength and stiffness of the rubberized sample. Rubberized concrete has many advantages in its use in the construction industry. It is affordable, cost effective, able to withstand more pressure, and more impact and temperature when comparing to conventional concrete. Rubber Modified Concrete (RMC) is weak in compressive and tensile strength, but has good water resistance with low absorption, improved acid resistance, low shrinkage, high impact resistance, and excellent sound and thermal insulation.

III. MATERIALS

A. *Cement*

The cement used in this study is Ordinary Portland Cement (OPC) -53 grade.

S. No	Name of the experiment	Result
1	Specific Gravity	3.1
2	Standard Consistency	25 %

B. *Fine Aggregate*

The grading zone of Fine aggregate is zone III as per Indian Standard Specifications.

S. No	Name of the experiment	Result
1	Specific Gravity	3.1
2	Standard Consistency	8

C. *Coarse Aggregate*

The coarse aggregate particles are greater than 4.75mm; the size of coarse aggregate was 20 mm and 12.5mm.

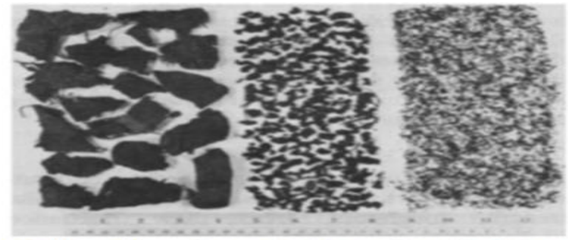
S. No	Name of the experiment	Result
1	Specific Gravity	3.1
2	Aggregate Impact test	9.36
3	Aggregate Crushing Test	15

D. *Water*

Water fit for drinking is considered for making concrete.

E. *Waste Tire Rubber*

Waste tires that are no longer suitable for use on vehicles due to wear or irreparable damage. Recycled rubber from ELT's (End of Life Tires) can undergo a shredding process to produce one of four products: shredded rubber, rubber chips, ground rubber and crumb rubber. Each type has a rough surface and may contain small fractions of residual steel and textile wires in short lengths.



F. *Admixture*

In the present paper, the admixture which is suitable for Rubber concrete based on the literature review Super plasticizers- High Range water reducer is used to reduce the amount of water by 12% to 30% while maintaining a certain level of consistency and workability with early concrete enhancement up to 50 to 75%.

G. *Preliminary Test conducted on M20 Concrete*

S. No	Name of the experiment	Result
1	Slump Cone Test	60mm
2	Compressive Strength	21.02 N/mm2
3	Split Tensile Test	3.05 N/mm2
4	Flexural Testing	3.21 N/mm2

IV. EXPERIMENTAL STUDY

In this present study, the trial mix used for the casting of cubes is M20.Based on the specifications in IS10262:2009, the materials are taken in volume based instead of weight based, as the specific weight of rubber is approximately 0.9-1.16 g/cm3 which is lower than 10-20% of the total aggregate volume.

In the present study, the crumb rubber is replaced with the fine aggregates in 25, 50, 75% while the other materials such as cement and coarse aggregates are as per the trial mix design.

Similarly, the rubber chips are replaced with the coarse aggregates in 25, 50, and 75% while the other materials such as cement and fine aggregates are as per the trial mix design.

A dosage of 0.6% of High-Range Water reducer is added to every trial mix.

A. *Sample Notation*:

If the Rubber is replaced for 25% of Aggregate, with admixture added to it the sample is noted as 25A and in the absence of admixture it is noted as only 25.

Tests Conducted for Crumb Rubber as a replacement of Fine Aggregates

Name of the test conducted	Name of the sample with % replacement	Result
Compressive Strength	75A	4.513
	75	4.403
	50A	7.84
	50	7.84
	25A	13.12
	25	13.073
Split Tensile Strength	75A	1.4
	75	1.41
	50A	1.78
	50	1.62
	25A	2.21
	25	2.10
Flexural Strength	75A	1.51
	75	1.3
	50A	2.0
	50	1.97
	25A	2.53
	25	2.5
Rebound hammer	75A	16
	75	14
	50A	16
	50	16
	25A	14
	25	16
Ultrasonic Pulse Velocity	75A	4
	75	4
	50A	3.5
	50	3.2
	25A	3
	25	3.1

Tests Conducted for Rubber Chips as a replacement of Coarse Aggregates

Name of the test conducted	Name of the sample with % replacement	Result
Compressive Strength	75A	6.306
	75	6.376
	50A	14.43
	50	12.98
	25A	15.67
	25	15.213
Split Tensile Strength	75A	1.62
	75	1.7
	50A	2.12
	50	2.07
	25A	2.69
	25	2.61
Flexural Strength	75A	1.74
	75	1.72
	50A	2.5
	50	2.56
	25A	2.77
	25	2.73
Rebound hammer	75A	20
	75	20
	50A	16
	50	14
	25A	18
	25	20
Ultrasonic Pulse Velocity	75A	4
	75	4
	50A	3.8
	50	3.6
	25A	3.1
	25	3

V. CONCLUSION

1) Over 25% compressive strength losses were found reduced, for every 25% replacement of fine aggregate with crumb rubber and 20% reduce in rubber chips with the replacement of coarse aggregate. As the adhesion between the rubber particles and cement paste is not as strong as other mineral materials because of the hydrophobic nature of a rubber surface.
2) The Split tensile strength was found to decrease 20% in both crumb rubber and rubber chips. Rubber particles tend to move upward because they have a lower specific gravity than mineral materials. This creates a concentration of softer materials, which fail at lower stresses.
3) Flexural or bending strength also decreased when the level of replacement of aggregate with rubber increased. This also attributed to the weakness of the interface area between the rubber particle surface and cement paste, which is easily recognizable by examining, samples that failed, and by the ease of removing the rubber chips from test specimens.

4) The result obtained from the non-destructive test we could assess the quality of the concrete as Good.

In Conclusion, the Rubberized concrete has higher impact strength and toughness used for sidewalks, driveways, etc. Rubber Concrete is weak in compressive and tensile strength, but has good water resistance with low absorption, improved acid resistance, and low shrinkage. Pavement, bunkers, and crash barriers around bridges and highway barriers due to its high toughness and impact resistance. Rubberized concrete has low density; it can be considered as a lightweight construction material. Sound barriers such as lightweight concrete blocks and tiles due to its higher sound absorption properties.

Thus, use of waste tire rubber concrete in the applications mentioned above represents a suitable means of disposal for both environmental and economic reasons.

VI. REFERENCES

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