Experimental Investigation on Scrap Tyre as Partial Replacement for Fine Aggregate in Concrete

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Abstract

An experimental study had made on waste product and utilizing it for manufacturing of concrete. The disposal of waste tires is becoming a major waste management problem in the world at the moment. Environmental concerns are also being raised against uncontrolled extraction of natural sand. In this essence, the present study aims to investigate the optimal use of waste tyre rubber crumbs as fine aggregate in concrete composite. A total of 85 cubes, cylinders and beam specimens were cast with the replacement of fine aggregate by shredded rubber crumbs with the proportion of 5, 10, and 15% by weight and compared with 21 conventional specimens. Fresh and hardened properties of concrete such as workability, compressive strength, tensile strength and flexural strength were identified and finally it will suggest 10% replacement of waste tyre rubber aggregate with fine aggregate will gives optimal and safest replacement in concrete composites.
Keywords: Waste, Management, Shredded Rubber Crumbs

I. Introduction

In 1990, over 240 million scrap tires were discarded in the United States [United States Environmental Protection Agency, 1993] and approximately 3 billion waste tires had accumulated in stockpiles or uncontrolled tire dumps throughout the country, with millions more scattered in ravines, deserts, woods and empty lots [Everett, et al 1998, Jang, et al 1998 and Brown, et al 2001]. Each year, over 77% of the annual production of scrap tires, about 188 million tires per year, were landfilled, stockpiled or illegally dumped [United States Environmental Protection Agency, 1993]. Tires are bulky, and 75% of the space a tire occupies is void, so that the land filling of scrap tires has several difficulties: Whole tire land filling requires a large amount of space. Tires tend to float or rise in a landfill and come to the surface. The void space provides potential sites for the harboring of rodents. Shredding the tire eliminates the above problems but requires high processing costs.

Because of the above difficulties and the resulting high costs, tire stockpiles have turned up across the country. These waste tires represent a significant environmental, human health, and aesthetic problem. Waste tires pose a health hazard since tire piles are excellent breeding grounds for mosquitoes. Because of the shape and impermeability of tires, they may hold water for long periods providing sites for mosquito larvae development. Waste tires also pose a serious fire hazard since waste tires and waste tire stockpiles are difficult to ignite. However, once ignited tires burn very hot and are very difficult to extinguish. This is due to the 75% void space present in a whole waste tire, which makes it difficult to quench the tires with water or to eliminate the oxygen supply. In addition, the doughnut-shaped tire casings allow air drafts to stoke the fire. A large tire fire can smolder for several weeks or even months, sometimes with dramatic effect on the surrounding environment. In 1983, a 7-million-tire fire in Virginia burned for almost nine months, polluting nearby water sources [United States Environmental Protection Agency, 1993]. By 1998, 48 states had passed scrap tire laws, regulations or amendments and 34 states provide market incentives to regulate scrap tires. Thirty-five states had banned whole tire landfilling, and eight states had banned any scrap tire landfilling. Only six states did not have any landfill restrictions on tire disposal. Sixty percent of scrap tires have been recycled and the stockpiles have decreased to about 500 million tires. Even though the situation in the United States has improved, tire stockpiles still exist and pose a threat to public health and safety.

II. STUDY METHODOLOGY

This study is mainly divided into four stages, the first stage dealt with material collection. In the second stage the preliminary tests were the third stage dealt with casting of cubes, cylinders, and beams. At last the final stage the, compressive strength, tensile strength and flexural strength tests were conducted.

A. Material Collection

First, the material is collected either from the dump yard or directly from the site. Then it is transported to the unit where crushing is done.

B. Material Investigation

Cementisabasicrequisiteforanyconstructionworkandalsoprovidesabindingmediumforthediscreteingredients.InthepresentstudyOrdinaryPortlandCementof53grade,whichisreadilyavailableisused.Thespecificgravityofcementis3.15.NaturalRiversandpassingthrough4.75mmISsieveisusedformakingof concrete.

Fig. 1:

III. PROPERTIES OF SCRAP TYRE

The unit weight is the ratio of the weight of a substance to the volume of a substance, whereas specific gravity is the ratio of the unit weight of solids divided by the unit weight of water. A material whose unit weight of solids equals the unit weight of water has a specific gravity of 1.0. The specific gravity of tire shreds ranges from 1.02 to 1.36, depending on the amount of glass belting or steel wire in the tire (Edil and Bosscher, 1994; Zimmerman, 1997; ASTM, 1998). Tire shreds that have high specific gravity generally possess a greater proportion of shreds with steelbelts. The specific gravity of soils typically ranges from 2.6 to 2.8, which is more than twice that of tire shreds. The tire shreds tested ranged in size from 0.08 inches to 5.5 inches. Based on these tests, the dry unit weight of tire shreds was found to vary from 15 pcf (pounds per cubic feet) for a loose tire shred mix containing shreds of 0.08 to 1 inches in size to 53 pcf for compacted tire shreds of 1 to 3 inches in size.

A. Mix Design

Mix design was carried out as per Indian Standard Code Method (IS10262–2009) forth test specimen.
The mix design was

Table – 1
Mix proportion

S.no	*Grade of concrete*	*Target Mean Strength N/mm^2*	*W/C Ratio*	*Mix Proportion*
1	*M35*	*38.25*	*0.45*	*1:1.8:2.41*

Table - 2
Material Quantity for 1 Cube

s.no	*% Replacement*	*Cement in kg*	*Fine aggregate in kg*	*Scrap tyre in kg*	*coarse aggregate in kg*	*Water In liters*
1	*0*	*1.43*	*2.585*	*0*	*3.461*	*0.68*
2	*5*	*1.43*	*2.455*	*0.129*	*3.461*	*0.68*
3	*10*	*1.43*	*2.326*	*0.258*	*3.461*	*0.68*
4	*15*	*1.43*	*2.197*	*0.387*	*3.461*	*0.68*

Table - 3
Material Quantity for 1 Cylinder

s.no	*% Replacement*	*Cement in kg*	*Fine aggregate in kg*	*Scrap tyre in kg*	*coarse aggregate in kg*	*Water In liters*
1	*0*	*2.25*	*4.059*	*0*	*5.435*	*1.07*
2	*5*	*2.25*	*3.856*	*0.202*	*5.435*	*1.07*
3	*10*	*2.25*	*3.653*	*0.405*	*5.435*	*1.07*
4	*15*	*2.25*	*3.450*	*0.608*	*5.435*	*1.07*

Table - 4
Material Quantity for 1 Beam

s.no	% Replacement	Cement in kg	Fine aggregate in kg	Scrap tyre in kg	coarse aggregate in kg	Water In liters
1	0	5.107	4.059	0	12.307	2.434
2	5	5.107	3.856	0.202	12.307	2.434
3	10	5.107	3.653	0.405	12.307	2.434
4	15	5.107	3.450	0.608	12.307	2.434

B. Casting of Specimens

The test cubes, cylinders&beamswerecastinM35Gradeby weight with water cement ratios of 0.40 .Themouldsofsize150 x150 x 150 mm cube, 150x300mm cylinder and 100x100x1200mm beam were placed on an even surface and the materials were mixed in hand mixer .First coarse aggregate and fine aggregate were added.

C. Experimental Investigation

A Total of 85 specimens of cube, cylinder & beam were prepared with M35 mix forth is study with 5, 10, &15percentage of replacement of waste tyre rubber with fine aggregate. The specimen details are available in Table 4.

Table - 4
Cubes cylinders beams

s.no	Notations	7 days	14 days	28 days	7 days	14 days	28 days	28 days
1	conventional	3	3	3	3	3	3	3
2	R5	3	3	3	3	3	3	3
3	R10	3	3	3	3	3	3	3
4	R15	3	3	3	3	3	3	3

- R5 – Replacement of 5 scrap tyre as fine aggregate
- R10 – Replacement of 10% scrap tyre as fine aggregate
- R15 – Replacement of 15% scrap tyre as fine aggregate

D. Experimental Results and Discussions

The physical characteristics of the materials which were obtained from tests results mentioned that were made on lab:

Table – 5

S.No	Description	Values
1	Specific Gravity of Cement	3.15
2	Specific Gravity of Fine Aggregate	2.65
3	Specific Gravity of Scrap tyre	1.5
4	Specific Gravity of Coarse Aggregate	2.70
5	Dry Density of Coarse Aggregate	1560 kg/m
6	Fineness Modulus of Fine Aggregate	2.40
7	Fineness Modulus of Coarse Aggregate	7.20

Table – 6
Results of M35 Grade of Average compressive Strength.N/mm^2

S.no	7 days specimen	14days specimen	28 days specimen
R0	31.7	34.3	35.8
R5	27.28	31.86	31.89
R10	26.39	29.97	31.84
R15	23.56	28.67	28.89

Table- 7
Results of M35 Grade of Average splite tensile Strength.N/mm^2

S.no	7 days specimen	14days specimen	28 days specimen
R0	1.64	2.23	2.61
R5	1.56	2.12	2.43
R10	1.46	1.98	2.38
R15	1.34	1.69	1.85

Table – 8
Results of M35 Grade of Average flexural Strength.N/mm^2

S.no	28 days specimen
R0	9.5
R5	9.3
R10	9.2
R15	7.5

IV. CONCLUSIONS

Based on the results and analysis done as a part of this research, the following can be concluded:
1) Compressive strength decreases as the percent of waste crumb tire replacement increases for various PCC categories.
2) Density decreases as the percent of waste crumb tire replacement increases for various PCC categories.
3) Slump test results showed no change in consistency during all mixes; there was no effect of increasing waste crumb tires replacement on consistency.
4) Split tensile strength decreases at the maximum of 9 KN when rubber crumbs replaces up to 10% in fine aggregate.
5) Flexural strength of concrete increases when rubber crumbs increases up to3.5 KN.
6) The disposal of waste tires is becoming a major waste management problem in the world at the moment. Environmental concerns are also being raised against uncontrolled extraction of natural sand.
7) Using waste crumb tires in the production of concrete blocks, ribbed concrete block, and for paving is strongly recommended.

REFERENCES

[1] Utilization of Waste Tires in the Production of Non-Structural Portland cements Concrete By Prof. Osama A. Abaza.
[2] Amirkhanian, S.N. and L.C.Arnold, 2001. ‘A Feasibility Study of the use of Waste Tyre sinA sphaltic Concrete Mixtures’, Report No.FHWA-SC-92-04.
[3] Yoon, S., Prezzi, M., Siddiki, N. Z., Kim, B. (2006). Consruction of a test embankment using a sand-tire shred mixture as fill material. Waste Management, 26, pp 1033-1044.
[4] Cement Composites Containing Shredded Rubber Waste’, Cement & Concrete Composites, 29(4):337-338. Bignozzi, M.C.andF.Sandrolini,2006.‘Tyre Rubber Waste Recyclingin Self-compacting Concrete’, Cement & Concrete Research,3(4):735-739.