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Experimental Investigation on Replacement of Course Aggregate by Shredded Rubber Tyre

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Abstract : This paper presents the results, obtained after replacement of coarse aggregates, in concrete mix, with tyre rubber. Solid waste management has gained a lot of attention to the research community now-a- days. Out of the various solid waste, accumulated waste tyres has become a problem of interest because of its non- biodegradable nature. Researchers have investigated over the years, the use of recycled tyre rubber waste as a replacement for aggregate in concrete. In this study an attempt has been made to identify the various properties required for the design of concrete mix with the scrap tyre rubber as aggregate. "Rubcrete-Mix" which would result from such replacement found to have many engineering applications, one of which is it has good mechanical property. Hence itis considered to be one of the best and economical ways of reusing the waste tyres. The present experimental study has the aim of partial replacement of scrap tyre material for the aggregates in concrete, for various engineering applications. For achieving a proper bond with the surrounding concrete paste, the scrap tyre have been designed with respect to their size and shape. With the water – cement ratio being kept constant fine and coarse aggregate has been replaced with tyre. In preparing the concrete, Ordinary Portland cement has been used.
Keywords : Rubcrete-Mix ,Rubberized Portland cement concrete, Specific gravity, Strength, Rubber tyre.

1.0 Introduction

Concrete is the most important construction material used in most of the structures. Concrete is the mixture of fine aggregate, coarse aggregate, cement and water. Cement is used to fill space between fine aggregate and fine aggregate is used to fill the space between coarse aggregate. When the water is mixed with cement, hydration takes place as a result of which cement paste is formed and it binds the aggregates together. It is found that about 1 billion of waste tyres produced per annum. Since it is not easily bio-degradable for long period it should be reused in other ways. Hence the scrap tyres can be used in concrete by partial replacement of coarse aggregate. It would minimize the environmental impact and increases the conservation of natural resources.

2.0 Literature Survey

This Paper aims at the study of Partial Replacement of coarse aggregate with waste tyre to attain high strength and economical concrete Also, this research deals with the environmental waste reduction by using tyres aggregate waste as coarse aggregate.

TOUTANJI. H.A [1] Paper titled "THE USE OF RUBBER TYRE PARTICLES IN CONCRETE TO REPLACE MINERAL AGGREGATES" published in 1996 tells effect of replacement of mineral coarse aggregate by rubber tyre aggregate. He used shredded rubber tyres used having a maximum size of 12.7mm and

a specific gravity of about 0.61. He said that this would reduction in compressive and flexural strength. The concert contained rubber tyre aggregate shows ductile failure and undergoes displacement before fracture.

KHATIB Z.K AND BAYON F.M (1999) has developed "Rubberized Portland cement concrete" to conduct experimental program in which two types of rubber fine Crumb Rubber and coarse tyre chips were used in Portland cement concrete (PCC) mixtures. Rubberized PCC mixes were made by partially replacing the aggregate with rubber and tested for compressive and flexural strength in accordance to Indian standards. Tyre chips were elongated particles that ranged in size from about 10 to 50mm. Results show that rubberized PCC mixes can be made and are workable to a certain degree with the tyre rubber content being as much as 57percentage of the total aggregate volume. However, strength results show that large reductions in strength would prohibit the use of such high rubber constant. It is suggested that rubber contents should not exceed 20percentage of the total aggregate volume.

MOHAMMED MUSTAFA AL BAKARI. A. SYED NUZUL FAZL S.A, ABU BAKAR M."Comparison of rubber as aggregate and rubber as filler in concrete" this research will attempt to use rubber waste replacement of coarse aggregates to produce early age concrete. It carried out two different type of concrete which are rubberized concrete and rubber filler in concrete. In rubberized concrete, rubbers were used to replace coarse aggregates and sand as fine aggregate. Coarse aggregate usually gravel or crushed stone and shredded rubber as filler in concrete. The compressive strength was reduced in rubberized concrete for several reasons including the inclusion of the waste tyres rubber aggregate acted like voids in the matrix. This is because of the weak bond between the waste tyres rubber aggregate and concrete matrix. With the increase in void content of the concrete, there will be a corresponding decrease in strength. Portland cement concrete strength is dependent greatly on the coarse aggregate, density, size and hardness. Since the aggregates are partially replaced by the rubber, the reduction in strength is only natural.

MAVROULIDO.MAND FIGUEIREDO.J (2010) [2]. "Discarded tyre rubber as concrete aggregate: a possible outlet for used tyres" it can be concluded that despite the observed lower values of the mechanical properties of concrete there is a potential large market for concrete products in which inclusion of rubber aggregate would be feasible. These can also include nonprime structural applications of the medium to low strength requirements, benefiting from other features of this type of concrete. Even if the rubber tyre aggregate was used at relatively low percentages in concrete, the amount of waste tyre rubber could be greatly reduced due to the very large market for concrete products worldwide. Therefore the use of discarded tyre rubber aggregates in concrete shows promise for developing an additional route for used

HUMPHREY (1999), some of the advantageous properties of tyre chips include low material density, high bulk permeability, high thermal insulation, high durability, and high bulk compressibility. In many cases, scrap tyre chips may also represent the least expensive alternative to other fill materials. Crumb rubber has been successfully used as an alternative aggregate source in both asphalt concrete and PCC. This waste material has been used in several engineering structures like highway base courses, embankments, etc.

2.1 Interference

From these journals I have get some ideas where the demerits conveyed here are vanished by implementing my project.

3.0 Materials Used

Generally concrete consists of only Cement, fine aggregate and Coarse aggregate. Cement is the only binder material used in the project and hence OPC53 grade cement is used [3]. Coarse aggregate size of 12mm to 20mm is used in the project to obtain maximum strength.

Apart from Cement and Aggregates, tyres aggregate of size 20mm are graded and used in this research project. Which helps to improve the strength of the concrete.

4.0 Testing on Materials

3.1 Test For Cement

Average percentage of weight residue of cement is2.33%

3.2 Initial Setting Time Test on Cement

The Initial Setting time of the cement is 30 minutes.

3.3 Specific Gravity of Fine Aggregate

Average Specific gravity of fine aggregate (Sand) is 2.62

3.4 Fineness Modulus of Fine Aggregate

The fineness modules of the sample of fine aggregate is 2.77

3.5 Specific Gravity of Coarse Aggregate

Average Specific gravity of coarse aggregate (S_{ca}) is2.84

3.6 Fineness Modulus of Coarse Aggregate

The Fineness modulus of the sample of coarse aggregate is 4.37

3.7 Specific Gravity of Tyre

Average Specific gravity of Tyre (S_{ty}) is 1.15

5.0 Mix Design

Based on the results obtained from various test

For Nominal Mix

Cement	=	400kg/m^3
Water	=	186kg/m^3
Fine aggregate	=	665.978kg/m^3
Coarse aggregate	=	1229.188kg/m^3
Mix ratio	**=**	**1: 1.66: 3.1**

Table 1: Trial Mix Proportions

	Mix 1	**Mix 2**	**Mix 3**
Mix Ratio	1: 1.66: 2.92: 0.06	1: 1.66: 2.76: 0.12	1: 1.66: 2.61: 0.18
Water cement ratio	0.4	0.4	0.4
% of replacement of tyre	5%	10%	15%

6.0 Mechanical Properties

6.1 Compressive Strength Test On Cubes

The contact surfaces of the testing machine are cleaned and the compression plates are free from any kind of dust. In case of cubes, the specimen shall be placed in the machine as shown in fig 5.1. The top surface of specimen should be on adjacent side of applied load . The load is applied gradually without any shock and increased continuously at the rate of 140kg/Sq.cm/min (approximately) until thespecimen gets break [4]. The maximum load that the specimen shall be resisted is noted down.

$$\text{Compressive strength} = \frac{\text{Load}}{\text{Cross sectional Area}}$$

Figure 6.1 Compressive Testing Machines

6.2 Split Tensile Test n Cylinders:

After cleaning and wiping the contact surface of the machine, the cylindrical specimen is placed as shown in fig.5.1,and the load is applied along the circumference and not through the cross section [5]. The maximum load when the specimen gets failure is noted.

Split tensile strength=$(2P/\pi DL)$

Figure 6.1 Split Tensile Test

7.0 Results and Discussion

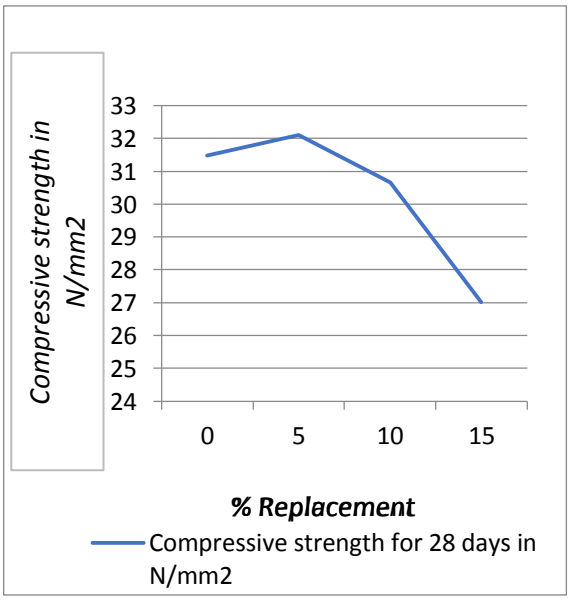
7.1 Compressive Strength Test on Cubes

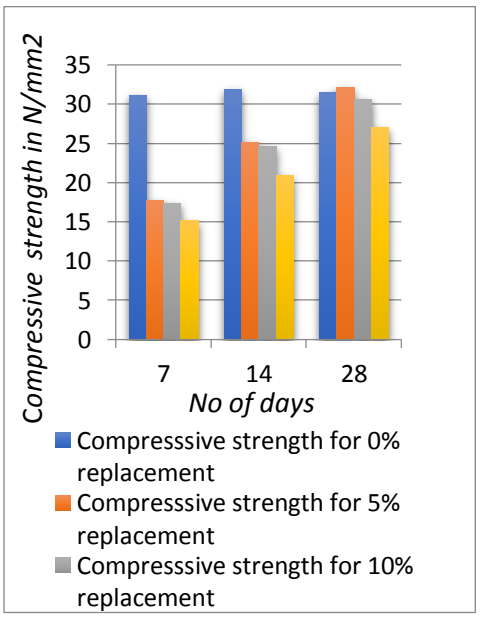
Characteristic compressive strength of cubes after 28 days where taken and results are as follows:

Table 2: Compressive Strength

S. No	% Replacement Of Coarse Aggregate With Tyre	Area (mm^2)	Average compressive strength (N/mm^2)
1	0	150 x 150	31.48
2	5	150 x 150	32.11
3	10	150 x 150	30.66
4	15	150 x 150	27.005

7.1 Graph





Bar Chart

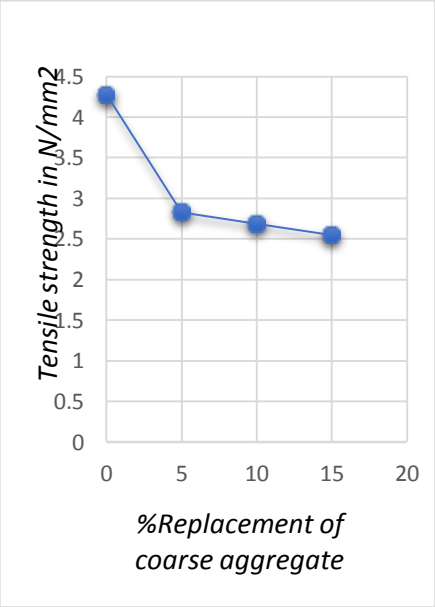
7.2 Split Tensile Strength Test On Cylinders:

The calculated values for split tensile from the test results are noted and tabulated below

Table 3: Split Tensile Strength

S.No	% Replacement Coarse Aggregate With Tyre	Area (mm^2)	Average Split-tensile Strength (N/mm^2)
1	0	150*300	4.28
2	5	150*300	2.83
3	10	150*300	2.69
4	15	150*300	2.55

7.3 Graph:



8.0 Conclusion and Future Scope

The substitution of waste tyre to concrete is taken to 5% replacement of weight of coarse aggregate and the compressive strength is somewhat same to the concrete without substitution (Graph 7.1). At the same time, 15% replacement of weight of coarse aggregate, the compressive strength drops down compared to conventional concrete. The presence of tyre more than 5% weight tends to reduce the bonding between cement and aggregate leading to a consequent decrease in strength. The use of rubber aggregates from waste tyres addresses many issues such as reduction of the environmental threats caused by waste tires, introduction of an alternative source to aggregates in concrete, the introduction of different ingredients other than the conventionally used natural aggregates and ultimately leading to the conservation of natural resources [7]. Though rubber tyre aggregate may be used at relatively low percentages in concrete, there will be a huge reduction in the amount of waste rubber tyre since the concrete products have very large market worldwide. Finally, concluded that, the use of tyre in concrete reduces the pollution due to non-biodegradable tyres, performs as low weight concrete and also shows a promising route for the reuse of waste tyres.

9.0 References

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