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Effect of Rubber Tyre Waste in Concrete

KEYWORDS: Rubber tyre, compressive strength, Tensile strength

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ABSTRACT *The disposal of waste tyres is becoming a major waste management problem in the world at the moment. It is estimated that 1.2 billions of waste tyre rubber produced globally in a year, in which 11% of post consumer tyres are exported and 27% are sent to landfill, stockpiled or dumped illegally and only 4% is used for civil engineering projects. Hence efforts have been taken to identify the potential application of waste tyres in civil engineering projects. In this essence, our present study aims to investigate the optimal use of waste tyre rubber crumbs as fine aggregate in concrete composite. A total of 72 cubes and cylinders specimens were cast with the replacement of fine aggregate by rubber crumbs with the proportion of 3%, 6%, 9% by weight and compared with the conventional specimens. Hardened properties of concrete such as compressive strength and tensile strength were carried out .From the test results, it is recommended that 3% replacement level of waste tyre rubber aggregate will be optimum replacement in concrete composites*

INTRODUCTION

It was estimated that more than 250.000.000 post consumption tires were accumulated annually in the 15 States of the European Union. In 1992, about 65% of the quantity produced in the 12 member states was stored in dumps and only 35% underwent other regeneration methodologies. Ten years later, in 2002, the situation was completely overturned in the 15 member states. More than 65% of post consumption tires were prepared for reuse export, rebuilding, recycling and energy regeneration, where as less than 35% was stored in dumps. Energetic and material product recycling represented the two principle types of regeneration and amounted to 44% of the total.

The practice of absorbing used tires in controlled dumps should be avoided because it creates another source of pollution. Tires represent a bulky refusal and require huge dump sites as more than 75% of a tire's volume is void. The presence of cavities and rubber elasticity also create mechanical instability with danger of fires in the stocked refuse mass. Furthermore, dumps can turn into a fertile habitat for the proliferation of rats and insects. To worsen matters, tires tend to re emerge in time from the dump and micro organisms may take more than 100 years to biodegrade them. The necessity to find alternative solutions to used tires is thus clear.

Moreover, the increased consumption of concrete in building construction raised the problem of impoverishment of natural resources. Such considerations confirmed the necessity to individuate innovative technologies and alternative materials to improve not only the performance level of concrete but, and above all, to support the policy of environmental protection.It must also be remembered that most developing countries had to raise their awareness regarding the recycling of waste materials but have not yet developed effective standards and laws with regards the local reuse of waste materials.

Over the past few years, a number of researches have focused on the use of different shapes and sizes of waste tires in concrete. A mixture composed of ordinary Portland cement in concrete and rubber from recycled tires has been presented in technical literature under the names of Rubber Concrete. The rubber used in most cases was derived from post consumption tires of motor vehicles and trucks subjected to mechanical titration or to cryogenic processes. Given the applications and performances required by the final product, the rubber was used as it is or, in some occasions, the textile component was removed and the steel fibers unstrained.

In this investigation, the strength properties of concrete incorporating crumb tyre rubber waste at 3%, 6%, 9% of rubber tyre waste by weight as a partial replacement for fine aggregate in the concrete are studied. The results are then compared with the control specimens which contains no rubber tyre waste.

MATERIALS, MIX-PROPORTIONS AND DESCRIPTION OF SPECIMENS

- **Cement**

The cement used for the concrete mix is Ordinary Portland Cement of 53 Grade. The specific gravity of cement is 3.14.

- **Fine aggregate**

The sand used for the experimental program was locally procured and conformed to Indian Standard Specifications IS: 383-1970. The sand was first sieved through 4.75mm sieve to remove any particles greater than 4.75mm and then was washed to remove the dust. The specific gravity of fine aggregate is 2.68. The fine aggregated belonged to grading zone III.

- **Coarse aggregate**

Locally available coarse aggregate having the maximum

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size of 20mm was used in our work. The aggregates were washed to remove dust and dirt and were dried to surface dry condition. The aggregate were tested per Indian Standard Specifications IS: 383-1970. The specific gravity of coarse aggregate is 2.8.

- **Rubber tyre waste**

Crumbed rubber tyre powder produced comes only from passenger car tyres and trucks which use blends of natural rubber and synthetic rubber passing through 4.75mm sieve with a specific gravity of 1.1.

Figure 1: waste rubber tyre
Sources: www.googleimages .com/ rubber tyre

EXPERIMENTAL INVESTIGATION

- **Design Mix**

Mix design was done for M20 grade of concrete. The water cement ratio of 0.5 is used. The cement with coarse aggregate to fine aggregate ratio used is 1: 1.46:3.28. The mix design was prepared based on the guidelines of IS: 10262(1982). The details of mix design and specimens used in experimental program are given in the table 1.

TABLE 1
MIX DETAILS

Mix	Cement (%)	Fine Aggregate	Fine Aggregate	No of specimens	No of specimens
		Sand (%)	Rubber (%)	Cube	Cylinder
M1	100	100	0	9	9
M2	100	97	3	9	9
M3	100	94	6	9	9
M4	100	91	9	9	9

- **Casting and curing of specimens**

Nine cubes each of size cube (150mm x 150mm x 150mm) and cylinder (300mm x 150mm) are prepared and tested at an age of 7, 14 and 28 days. The concrete mix was designed as per code IS 10262 (1982). The constituent materials are weigh batched. The specimens are cast in steel moulds. The specimens are demoulded in the next day. The specimens are cured by immersing in water. Specimens were tested for age of 7, 14 and 28 days. Nine specimens are tested on each day using compression testing machine and tensile testing machine. The compressive strength & split tensile strength is determined and reported in this paper.

- **Testing results**

The test data is given in the table 2, 3. The test results are also given in Fig 2, 3

TABLE 2 COMPRESSIVE STRENGTH OF SPECIMENS

Curing days [1]	Average Compressive strength N/mm²			
	M1	M2	M3	M4
7 days	8.2	9.4	7.9	7.1
14 days	16.5	18.9	20.3	14.0
28 days	23.4	25.89	20.35	19.76

TABLE 3 SPLIT TENSILE STRENGTH OF SPECIMENS

Curing days [2]	Average Split Tensile strength N/mm²			
	M1	M2	M3	M4
7 days	1.31	1.93	1.28	1.02
14 days	2.46	3.10	2.56	2.40
28 days	3.02	3.56	2.89	2.64

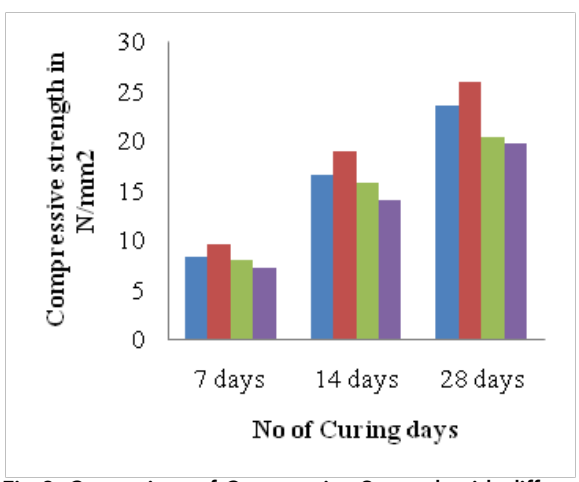

Fig 2: Comparison of Compressive Strength with different ages

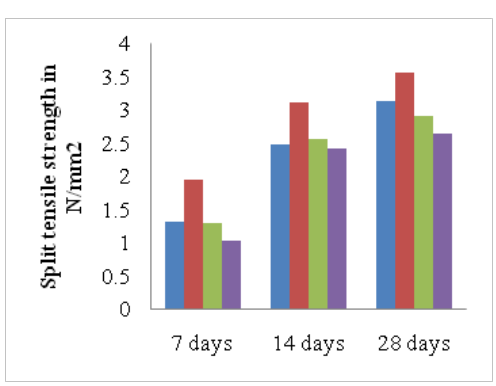

Fig 3: Comparison of Split Tensile Strength with different ages

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RESULT AND DISCUSSION

• Behaviour of concrete specimens in compression strength test

Effect of 3% Rubber tyre waste in concrete
Compressive strength of Partial replacement of fine aggregate with 3% rubber tyre waste in concrete was found to be increased by about 10.48%, 14.18% and 15.48% than control concrete for 7 , 14 and 28 days respectively.

Effect of 6% Rubber tyre waste in concrete
Compressive strength of Partial replacement of fine aggregate with 6% rubber tyre waste in concrete was found to be increased by about -3.29%,-5.2% and -13.22% than control concrete for 7 , 14 and 28 days respectively.

Effect of 9% Rubber tyre waste in concrete
Compressive strength of Partial replacement of fine aggregate with 9% rubber tyre waste in concrete was found to be increased by about -12.8%,-15.17% and -13.22% than control concrete for 7 , 14 and 28 days respectively.

• Behaviour of concrete specimens in split tensile strength test

Effect of 3% Rubber tyre waste in concrete
Split tensile strength of Partial replacement of fine aggregate with 3% rubber tyre waste in concrete was found to be increased by about 8.33%,12.91% and 16.10% than control concrete for 7 , 14 and 28 days respectively.

Effect of 6% Rubber tyre waste in concrete
Split tensile strength of Partial replacement of fine aggregate with 6% rubber tyre waste in concrete was found to be increased by about -2.29%,4.07% and -7.37% than control concrete for 7 , 14 and 28 days respectively.

Effect of 9% Rubber tyre waste in concrete
Split tensile strength of Partial replacement of fine aggregate with 9% rubber tyre waste in concrete was found to be increased by about -22.13%,-2,44% and -15.38% than control concrete for 7 , 14 and 28 days respectively.

CONCLUSIONS

The following conclusions are derived from the present experimental investigation carried out on the strength properties of concrete with rubber tyre waste.

The compressive strength was increased by 10.48%, 14.18 %, 15.48% in 7, 14 and 28days at 3% of rubber tyre waste was added to the control specimen.

Similarly When 3% of rubber tyre waste was added to the concrete the split tensile strength was increased by 8.33%, 12.91% and 16.10% in 7, 14 and 28days than control specimen.

From the test results, it was concluded that 3% rubber tyre waste as partial replacement of fine aggregate was the optimum.

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