Comparative Study on Strength Aspects of Light Weight Concrete by Replacing Coarse Aggregate with Shredded Tyre Waste

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doi: https://doi.org/10.21467/proceedings.160.5

ABSTRACT

The need for automobiles is increasing each day and the usage of these vehicles also increased the waste production. Rubber tyre is the one of the main wastes generatedwhen it comes to automobiles. Since rubber is an elastomeric material, it is hard to recycle. So, the accumulating tyre waste is a matter of concern and it leads to various ecological properties. Incorporating a percentage of shredded tyre in concrete to coarse aggregates can reduce the waste accumulation. Since shredded tyre is a light weight material its addition in concrete can reduce the weight of concrete. This study compares the strength characteristics of normal concrete with lighter-weight concrete in which tyre trash is used in place of the coarse aggregate.

Keywords: Waste tyre rubber, Rubber aggregate, Environmental degradation

1 Introduction

The automobile sector in India has a huge role in the development of the country. Historically, the health of the Indian economy has been well reflected in the state of the automobile sector. We all know that the need for automobilesis increasing rapidly. This increased demand also increased production. The increasing waste accumulation associated with automobile production is a serious matter of concern. Burning this material may produce harmful products that are harmful for the environment and cause pollution. All rubber tyres have a fabric composition. To enhance the performance, chemicals will be added. Tyre rubber contains styrene, which is a dangerous substance for living organisms. The chemicals found in tyres also protect them from damage at high temperatures and prevent them from cracking at low temperatures. Due to all these reasons, dumping or accumulation of these tyre waste materials should be avoided.

Concrete is a construction material whose demand is increasing all the time. Concreting can be made economical and effective by replacing conventional aggregates with advanced materials. Shredded scrap tyres can be used as a replacement for both coarse and fine aggregates. Lowered carbon dioxide emissions, reduced demand for natural materials, etc. are the advantages of incorporating tyre rubber in concrete. American Concrete Institute Committee 213 defines lightweight concrete as being composed of light-weight coarse aggregates, light-weight fine particles, and possibly some normal-weight fine aggregates. All lightweight concrete refers to concrete that uses lightweight fine and coarse particles. The unit weight of such concrete, which is typically between 1400 and 1800 kg/m^3, should not be more than 1840 kg/m^3. The weight of the concrete can be reduced to a specific range by replacing coarse aggregates with shredded waste tyres. Primary and secondary shredding are both involved in tyre shreds or chips. The primary shredding operation can yield tyre shreds of dimensions ranging from 300 mm to 460 mm long and 100mm to 230 mm wide.

Automobile sales are in higher demand every day. Therefore, it is obvious that there will be a buildup of waste tyres in thecoming days. Because they contaminate groundwater and soil, used tyres at landfills and

Proceedings DOI: 10.21467/proceedings.160; Series: AIJR Proceedings; ISSN: 2582-3922; ISBN: 978-81-965621-9-9

scrap yards have a direct impact on human health. Used tyres maybe secondhand as aggregates in concrete, the second most used material in the experience, that is an effective method to incompletely immobilize trash. The goal of this project is to reduce the environmental degradation and pollution caused by the accumulation of tyre waste and to partially replace coarse aggregates with rubber tyres so that the demand for natural aggregates and the weight of the concrete will be reduced.

2 Properties of Shredded Tyre

Typically, any two of the following two processes are used tocreate rubber aggregates from used tyres:
The first procedure involves grinding the material mechanically at ambient temperature or at glass transition temperature, where it can be grinded cryogenically. The procedure of cooling or chilling a material and subsequently reducing it to a small grain size is known as cryogenic grinding, often referred to as freezer grinding, freezer milling, or cryo milling. In order to replace coarse aggregates, the first stage results in chipped rubber. Contrarily, the second method typically leads to the production of crumb rubber. They could take the place of fine aggregate. Figure 1 displays the experiment's shredded tyre waste, with a maximum particle size of 20 mm. The specific gravity of tyre aggregate was lower than that of natural aggregate. To increase the bonding of tyre aggregate with other constituentsof concrete, the aggregate was immersed for 30 minutes in a sodium hydroxide solution. Since this situation of tyres increases the connecting in hardened, it again leads to a bettering in the substance characteristics of hardenedconcrete. Kashani *et al.* [1] found that for better compressive strength and split tensile strength, coarse rubber aggregate offered more suitability than fine rubber aggregate. Youssf *et al.* [2] stated that dipping the rubber aggregates in sodium hydroxide solution for more than 30 minutes was not as effective as immersion for 30 minutes. Additionally, they noted that treated tyre aggregates in concrete had compressive strengths that were 40% higher than those of untreated tyre trash.

Figure 1: *Shredded tyre waste*

3 Experimental Study

3.1 Materials

Cement – Ordinary Portland cement of grade 53 was employed as the experiment's binder ingredient. It was madesure that the cement adheres in accordance with IS: 12269:1987.
Fine aggregate: The fine aggregate utilized was manufactured sand.
Coarse aggregate: 20-mm-sized crushed granite was used asthe coarse aggregate for the experimental work.
Water: water having properties similar to that of drinking water was used.
Tyre: To replace coarse material, shredded recycled tyreswith a maximum thickness of 20 mm were employed.

Proceedings DOI: 10.21467/proceedings.160
ISBN: 978-81-965621-9-9

Series: AIJR Proceedings
ISSN: 2582-3922

3.2 Mix proportioning

The compressive clout, split stiffness, and flexural strength for M30 grade was determined and compared at various replacement rates with respect to standard concrete. The percentages of 3, 4, 5 & 6 were replaced with that of the nominal coarse aggregate. The mix ratio was 1: 1.89: 3.48 with a water content of 0.5. The specimens were tested after 7, 14 & 28 days of curing. Slump test, compaction factor testand vee bee consistometer test was administered on fresh concrete to decide the workability.

4 Results

The result of compressive strength test results for concrete cubes of 150 x 150 mm are displayed in Figure 2. After 7, 14, and 28 days of curing, the samples were analysed.

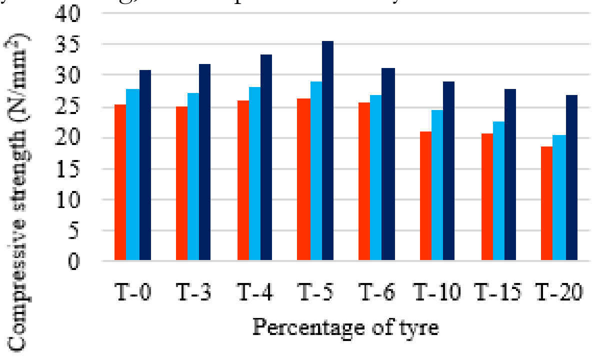

Figure 2: *Results of strength against compressive force*

Figure 3 displays the flexural strength test results for concrete beams with dimensions of 100cm*50cm*50cm. After 7, 14, and 28 days of curing, the samples were analyzed.

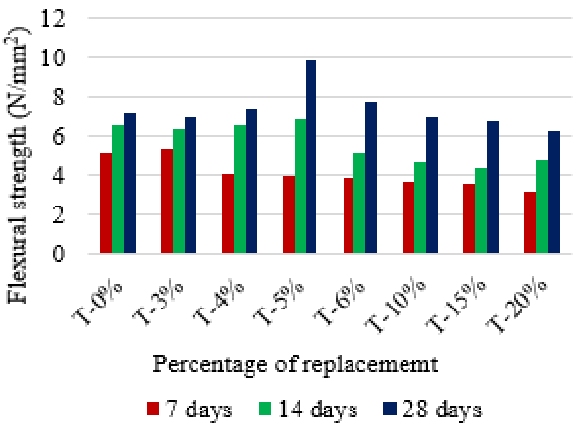

Figure 3: *Results of strength against bending force*

The test results for a concrete circular solid amidst a 150-mm broadness and 300-mm distance are demonstrated in Figure 4. After 7, 14, and 28 days of curing, the samples were analyzed.

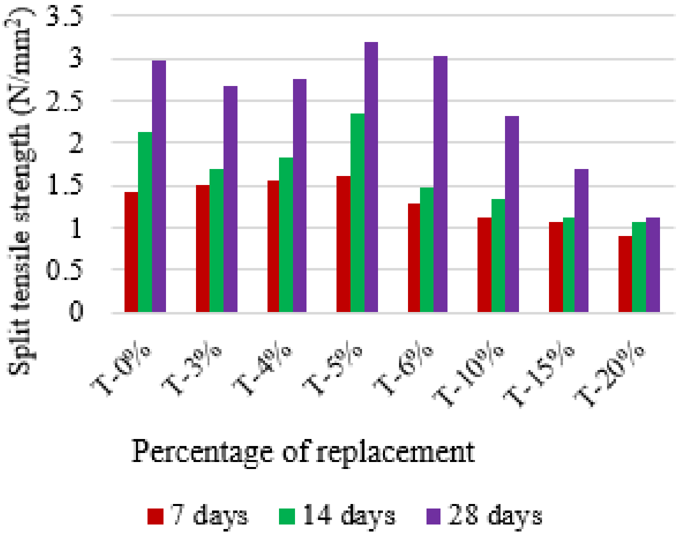

Figure 4: *Results of strength against splitting tensile force*

5 Discussions

- After 28 days of curing, the conventional concrete's compressive, flexural, and split tensile strengths were 31.56 MPa, 2.95 MPa, and 7.2 MPa, respectively. The compressive, flexural, and splittensile strengths of concrete with a tyre as a replacement after 28 days of curing were 64 N/mm^2, 3.18 MPa, and 9.82 MPa, respectively.
- According to test results from the experimental study, concrete's strength increased by 5% when coarse aggregate was substituted with shredded tyres.
- Within the first seven days of curing, the concrete gained 80–85% of its compressive strength.
- On increasing the replacement after 5%, the strengthwas found to be decreasing.

6 Conclusions

- Concrete's strength metrics improved when up to 5% of shredder tyre waste was substituted.
- The substance of the factual was decreased when thesubstitute portion was nurtured over 5%. It was found that the relation between the tyre parts and cement was degrading when aggregate substitute was raised.
- The low specific gravity of the tyre pieces also made them rise to the top of the mould during compaction.
- The tyre fragments were arranged erratically as a result. Concrete's unnatural arrangement decreased its strength as the proportion of tyres increased. As a result, the natural coarse aggregate in concrete can be replaced in part by shredded tyre trash. Without affecting the concrete's strength properties, the replacement of natural coarse aggregate can range upto 5%.

7 Declarations

7.1 Acknowledgment

We would like to express our appreciation to all of the civil engineering department's education and non-education faculty associates that one directly and obliquely supported us in perfecting this paper work.

7.2 Publisher's Note

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How to Cite

Archana *et al.* (2023). Comparative Study on Strength Aspects of Light Weight Concrete by Replacing Coarse Aggregate with Shredded Tyre Waste. *AIJR Proceedings*, 49-53. https://doi.org/10.21467/proceedings.160.5

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