Analyzing the Comparison between Shredded Tyre used Concrete & Plain Concrete

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***Abstract* - The material replacement in the concrete is the method of enhancing or achieving the same strength. In this research, waste tyre aggregate (shredded) which is hazardous material for the environment has been used as a replacement material of natural coarse aggregate in M20 grade concrete. The objective of this study is to make a comparison of compressive strength between 0% replacement concrete i.e. plain concrete and shredded tyre used concrete with different percentage of replacement. These plain and replaced concrete specimens were tested under the compressive axial load monotonically. Results of research work have shown that 5% replacement of shredded tyre in concrete gives the same strength as we achieve in plain concrete. Waste tyre used concrete is not a cost-effective material than other replacing material. This research work also gives the comparison of strength efficiency with respect to additional cost of replaced concrete.**

***Index Terms* - Replacement, Shredded tyre Aggregate, Compressive axial load.**

INTRODUCTION

Concrete is an artificial construction material and has exceptional quality makes more popular among other constructional materials because of plastic state at the time of usage. Concrete is the most widely used man-made construction material all around the globe because of its superior specialty of being cast in any desirable shape. It has synonymous with strength and longevity, hence emerged as the dominant construction material for the infrastructure needs of the present situation. Cement and aggregate, which are the most important constituents used in concrete production, are the vital materials needed for the construction industry. This inevitably led to a continuous and increasing demand on natural materials used for their production. Parallel to the need for utilization of natural resources emerges a growing concern for protecting the environment and a need to conserve natural resources, such as aggregate, by using unconventional materials that are either recycled or discarded as a waste. The open burning and discharge of waste tyre is expensive and hazardous to the environment and continuously decreasing numbers of landfills generates significant pressure to the local authorities identifying the potential application for this waste products. One of the largest potential routes is in construction, but usage of waste tyres in civil engineering is currently very low.

Zunaithur Rahman D. et. al. (2016), this research aims to use of waste rubber tyre as partial replacement of coarse aggregate to produce rubberize concrete in M20 grade of mix. Different partial replacements of rubber chips (0, 10, 20 and 30%) by volume of coarse aggregates are casted and tested for compressive strength in water as well as in acid curing on 14 and 28 days. The results show that, 10% of rubber waste gives higher compressive strength and durability performance and so considered as light weight concrete. It is recommended to use the rubberized concrete for nonstructural applications. Gregory Marvin Garric (2001), experiments were conducted to determine how the properties of concrete were affected by the inclusion of waste tires. Waste tires were used in the form of chips and fibers. The fibers were further divided into batches with different lengths to determine the effect of length has on the properties of concrete. There was a noticeable decline in the compressive strength of the concrete; however there was an increase in the toughness of the concrete. It was concluded that waste tire fibers were more suitable as additives than waste tire chips since they produced the highest toughness.

Muhammad B. Waris et.al. (2016), has studied the possible use of recycled tire in concrete for partial fine aggregate replacement to provide possible solution for tire waste management as well as aggregate resource conservation. Commercially produced tire crumbs of size ranging between 0.80 to 4.0 mm were used for partial replacement of fine aggregates in concrete. Three fractions of 20%, 40% and 60% replacement were considered in addition to a control mix. A lean mix proportion of 1:2:4 with water-cement ratio of 0.50 was used in this study. In the fresh state, workability improved with increase in replacement percentage of tire crumbs. In hardened concrete, the compressive strength, tensile strength and flexural strength decreased with increase in fraction of tire crumbs. The apparent density was only slight changed while voids and water absorption decreased because of increase in workability.

MATRIAL USED

Cement

Using Ordinary Portland Cement (grade 43) of specific gravity 3.14 conforming to IS 8112:2013, "ORDINARY PORTLAND CEMENT-SPECIFICATION", has been used.

Aggregates

Fine aggregates conforming to IS383:1970, "SPECIFICATIONS FOR COARSE AND FINE AGGREGATES FROM NATURAL SOURCES FOR CONCRETE" has been used.

Coarse aggregates conforming to IS383:1970, "SPECIFICATIONS FOR COARSE AND FINE AGGREGATES FROM NATURAL SOURCES FOR CONCRETE" has been used

Water

Normal portable water fit for drinking purpose has been used to prepare fresh concrete. Specification confirming to IS 456:2000.

Concrete

The concrete is mixture of four main constituents: cement, water, coarse aggregate, and fine aggregate. The concrete was prepared of M20 for a characteristic compressive strength of 20MPa in 28 days from manufacturing.

Shredded Tyre Aggregate

Rubber is related to thermo-plastic-elastic materials and is turned to thermosetting on vulcanization during manufacturing of rubber products or tires. It can be composed of various composites of rubber material – the most common being styrene-butadiene copolymer – with other chemical compound such as silica and carbon black. Sizes of waste tyre rubber were used in this study of 10mm to 20mm.

EXPERIMENTAL SETUP

A. *Specimen layout*

A total of 39 concrete specimens were prepared and tested in the experimental program having the size of 150mm×150mm×150mm. M20 grade of concrete has been used as per the requirement for axial load design. Each cube specimen consists of a 150 mm square cross section and a depth of 150 mm. 9 plain concrete specimens (no replacement) were prepared and 27 shredded tyre used concrete with different percentage of replacement were prepared. These specimens were prepared for 7, 14 and 28 days of curing respectively. The specimens were numbered as PC_{11}, TC_{11}, TC_{12} and so on, where the letter "P" indicates Plain, and "T" and "C" are indicating waste Tyre and Concrete respectively. "C" indicates concrete which is the second word in abbreviation and the numeric value indicates the sequence in which they were tested in different group.

Figure 1: Shredded Tyre

In this study, the shredded tyre aggregates were mixed homogeneously in the concrete mixture where they were integrated into the cube to form a full composite action. The first step in the strengthening process involved sizing, shaping, dressing, cleaning and removal of moisture from the surface of shredded tyre aggregate. During mixing we ensured the uniform distribution and angular shape of shredded tyre aggregate. Accurate percentage weight has been taken during the preparation of specimens. These all parameters have been maintained in every specimen preparation.

Figure 2: Shaping & Sizing of Shredded Tyre

Figure 3: Uniform Distribution of Shredded Tyre

B. *Testing Programme*

These specimens were subjected to axial compressive load using compressive testing machine of 2000KN capacity. The surface area of each specimen was 22500mm^2. Ultimate load readings were taken to study the compression performance of the specimens. Prior to testing, all specimens were wiped off the water by a cloth and cleaned the surfaces of concrete and leave them at the room temperature for drying. After all these actions, putting the specimen by possessed a thick layer of paper fixed at the top and bottom surface of the column in order to ensure that the contact surface remained parallel and that the applied load remained concentric. The results of tested specimens were tabulated below, these results were recorded in ultimate loads at which the failures of specimens occurred and further these loads are converted in ultimate stress that is ultimate load divided by cross sectional (surface area) area in which the load was applied.

Figure 4: Arrangement & Failure of Specimen

EXPERIMENTAL RESULT

Table 1: Results obtained for concrete specimen

7 Days Curing

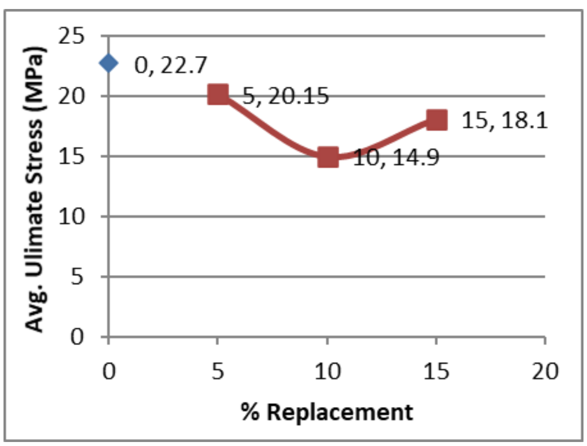
Specimen Name	Percentage Replacement	No. of Cube	P_{ult}(KN)	σult(Pult/A)(MPa)
Plain Concrete(PC) $(PC_{11}+PC_{12}+PC_{13})/3$	0	3	504	22.7
Tyre Used Concrete(TC_{11})	5	3	454	20.15
Tyre Used Concrete (TC_{12})	10	3	407	14.96
Tyre Used Concrete (TC_{13})	15	3	337	18.07

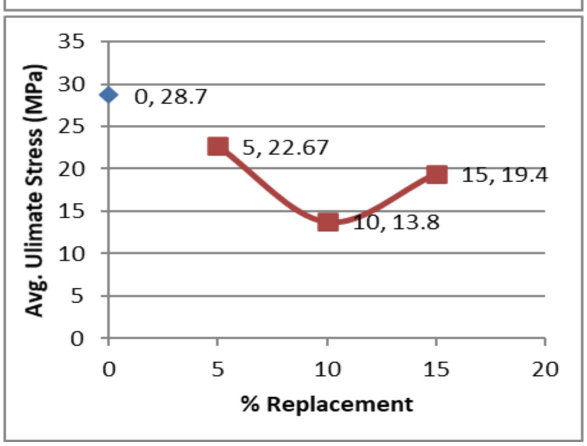
14 Days Curing

Specimen Name	Percentage Replacement	No. of Cube	P_{ult}(KN)	σult(Pult/A)(MPa)
Plain Concrete(PC) $(PC_{21}+PC_{22}+PC_{23})/3$	0	3	647	28.7
Tyre Used Concrete (TC_{21})	5	3	510	22.67
Tyre Used Concrete (TC_{22})	10	3	437	13.78
Tyre Used Concrete (TC_{23})	15	3	310	19.41

28 Days Curing

Specimen Name	Percentage Replacement	No. of Cube	P_{ult}(KN)	σult(Pult/A)(MPa)
Plain Concrete(PC) $(PC_{31}+PC_{32}+PC_{33})$	0	3	854	37.9
Tyre Used Concrete (TC_{31})	5	3	620	27.56
Tyre Used Concrete (TC_{32})	10	3	424	15.26
Tyre Used Concrete (TC_{33})	15	3	344	18.81





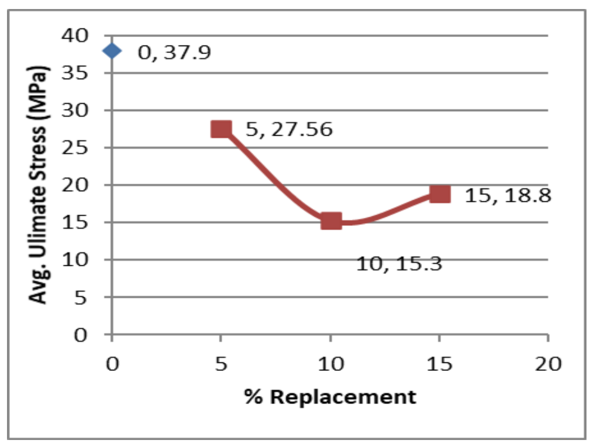


Figure 5: % Replacement VS Ultimate Stress for 7, 14 & 28 Days Cured Concrete

Stresses for Replaced & Without Replaced Concrete

The concrete specimens 5% replaced with waste tyre aggregate records the stress as equal as plain concrete stress. Beyond this limit concrete does not bear the same stress.

CONCLUSION

36 concrete specimens designated as PC11, PC12, TC11, TC11 and so on were tested under axial compressive loading in compression testing machine

of 2000KN capacity having the surface area 22500mm2. Comparative study has been carried out between plain concrete and waste tyre used concrete (PC & TC). This research work shows the following results

- Specimens replaced with waste tyre aggregate, the strength increases as we replace the tyre aggregate by 5%.
- 10% replacement of shredded tyre used aggregate starts fall in strength.
- Further increment of percentage replacement i.e. 15%, concrete strength falls again. So we can conclude that waste tyre aggregate can be replaced up to 5% for higher strength but beyond this limit concrete losses its cohesiveness and strength falls again.

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