Compressive Axial Behavior of Short Columns Incorporating Bottom Ash and Reshaped Waste Tyre Rubber

Dr. R. Shanmugam. [1]Dr.M.Harikaran [2], S.Gokulakannan[3] and P. Keerthana Devi[4]

[1]Professor and head, Department of Civil Engineering, Muthayammal Engineering College, Rasipuram, Namakkal District, Tamil Nadu

[2,3&4]Assistant Professor, Department of Civil Engineering, Muthayammal Engineering College, Rasipuram, Namakkal District, Tamil Nadu

Abstract

The modernization developments globally have led to a lot of infrastructure development. This progression leads to numerous problems, like the scarcity of construction resources. On the other hand, increased productivity is thrown away from the industry. The present work aims to use scrap tyre bus rubber by reshaping it as coarse gravel in the concrete by incorporating it by partially replacing it with a percentage of 5 and 10 replacing coarse aggregate in M_{30} concrete. In this work, coarse aggregate of sizes of 20mm and 15mm was used with a proportion of 70:30. Bottom ash was consumed as fine aggregate with manufactured sand in equal proportions. The upshot of this work is that an anchor hole of 15mm in diameter is provided on the surface of the rubber grate, which enables the cement plaster to shape a cylindrical mooring between the ingredients and the concrete as well as bar to the rubber gravel. This increases the withstand power to failure under load, which simultaneously increases the strength. The short column specimen concrete circular beams, 150mm in diameter X 1000mm, were cast and have compressive axial characteristics. The load and axial deformation of short columns were discussed. The cracking strength of 10% RWTRA alternative concrete was established to be superior to standard concrete. The initial and ultimate crack of RWTRA incorporated concrete is higher than standard concrete. It is established that the consequence of coarse aggregate surrogate by RWTRA will augment the performance of the short column.

Keywords- *Bottom ash, Manufactured sand, Anchorage hole, Conventional short circular column, axial deformation, and ultimate crack.*

1. Introduction

In India, multi-use, progressive projects were proposed. It engrosses hefty construction activities of infrastructure like roads, bridges, dams, irrigation schemes, public health engineering, educational buildings, and residential building projects. For all activities, the main material for construction is concrete. In every construction schemes, there is a demand for optimal and proficient use of resources for construction. The availability and cost of river sand, manufactured sand are quickly increasing because of scarce raw resources and the increase in conveying costs owing to the climb in fuel costs and additional contributions. Auxiliary mining at river mouths causes severe ecological damage by lowering the ground water table and causing rock strata to crumble, resulting in landslides and earthquakes. These promising crises obligate contemporary material handling to equilibrate the ecosystem. In this spirit, the plentiful ease of use of waste tyre rubber can be exploited as an effectual replacement for natural aggregate, which will be advantageous forboth conditions. A concrete structure must be sturdy in vigour and pragmatic before it can be accomplished that it has given out its intentional principle. The serviceability and vigour of the structure establish the existence of the structure. Extreme deflection should not have an effect on the vigour as well as the aesthetics of the structure.

Given these waste issues, scrap tyre rubber could be used as a partial coarse aggregate replacement in concrete. It is to be mentioned that the cast-off tyre rubber waste is an optimal material in the on the increase industry of construction and the distinctive rationale for this is the frivolous nature of concrete. It creates the tyre rubber consisting of coarse aggregate and is one of the ingredients facing discriminating scarcity. Hence, the need to search for a novel and feasible option is significant for the preservation of instinctive resources and a reduction in production costs. This has the other benefit of preserving the instinctive aggregate used for concrete production. In this work, tests were carried out to optimize the use of the tyre rubber as an additional coarse aggregate. This will be constructive for the prospect of the innate coarse gravel in the concrete. This investigational study optimises and furnishes the effects of partial replacement of coarse gravel by scrap tyre rubber on the compressive vigour of concrete.

2. MATERIALS AND METHOD:

Cement

The cement used in this work was ordinary Portland cement of 53 grade as per IS12269 and confirms the ASTM standard. The primary reason for using OPC 53 is that it is the most commonly used type of cement and is extremely suitable for use in common concrete works everywhere at the moment.

Coarse Aggregates

Coarse aggregate with sizes of 20 mm and 15 mm (70:30 proportioning) was used in this work. Tests were performed to find out the physical properties of the aggregate, including specific gravity, sieve analysis.

Fine Aggregate

Bottom ash and M-sand were used in equal proportion in this work. M sand and bottom ash were used locally and were collected from nearby sources.ASTM C33 (2004) specification for fine aggregate for concrete has a minimum grain size of 2.36 mm and passes sieve no.4. As per IS 383-1970, the grading limit comes under zone III for the tested fine aggregate.

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DESCRIPTION	FA		CA	
	M. Sand	Bottom ash	20mm	15mm
Specific gravity	2.67	2.29	2.81	2.80
Fineness modulus	2.62	2.73	6.27	6.20
Bulk density	1540 kg/m^3	2515 kg/m^3	combined	1690kg/m^3

Table 1. Properties of Aggregate

Reshape Tyre Rubber:

The bus tyres contain strands of rubber that were torn to obtain the rubber chips**.**The waste tyres were sliced to form tiny cubes of 25x25x10 mm dimension. A 15mm diameter bore was prepared on the rubber aggregate's surface. Table 2 shows the physical characteristics of the rubber fragment

PROPERTIES	CA
Specific gravity	1.27
Bulk density	420 kg/m3

Table 2. Mechanical Characteristics of Rubber fragments

Fig.1.Unmodified rubber chips

Fig.2. 15 mm diameter hole on the face of The remodelled tyre rubber

2. Experiment methodology:

In this work, tests were carried out on short columns under axial loading for concrete using reshaped waste tyre rubber as a partial replacement of coarse aggregate. The vigour of the column can be explored by varying coarse aggregate replacement by 0% , 5% ,and 10% of RWTRA for M_{30} . Specimen columns were cast with three standard RCC columns, three standard RCC columns with 5% and three RCC columns with 10% reshaped waste tyre rubber as partial replacement of coarse aggregate .On assessment tests for short column performance with circular section 150mm in diameter x 1000 mm sizes of M_{30} mixes and partial replacement of coarse aggregate by RWTRA (0%, 5%, and 10%) were carried out These specimens had a short column and were tested on a 1000 kN UTM .Specimens were loaded till they fails. Observations were noted at regular intervals and loading was done on specimen short columns gradually is shown in figure 4.

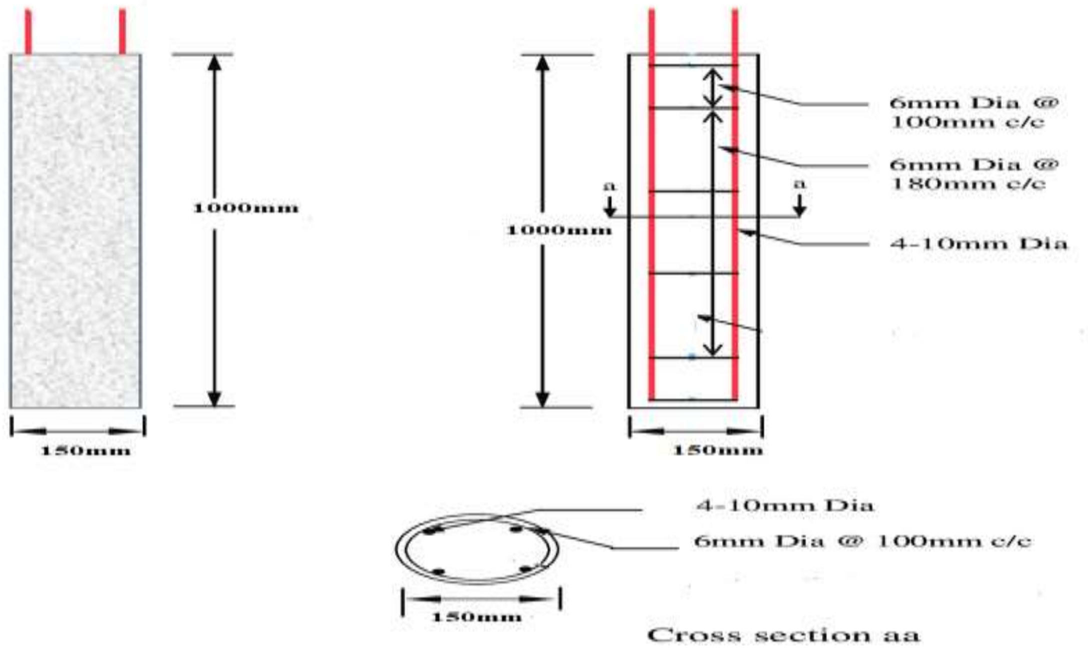

Fig.3 - Reinforcement Details of Short Column

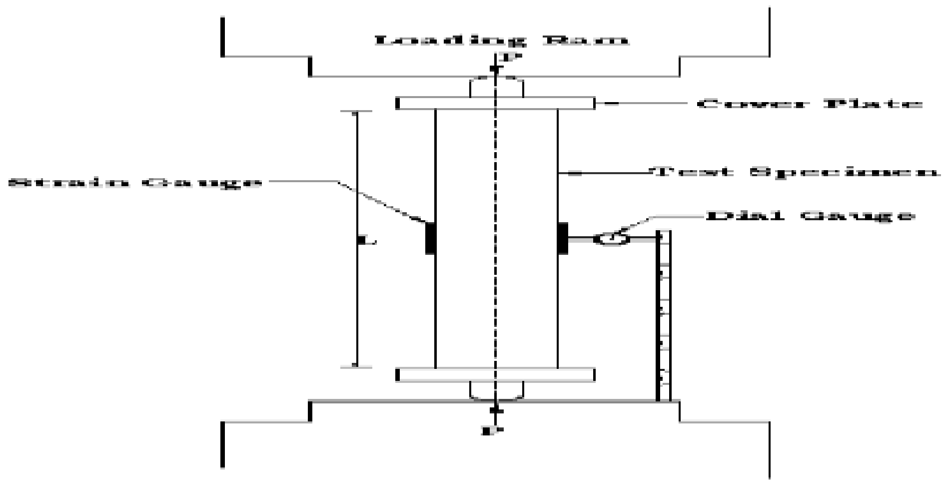

Fig.4-Testing of Short Column

TABLE 3- COMPARISON OF LOAD VS DEFLECTION IN CC, 5% AND 10% RWTRAC

Identification	Specimens	Load (KN)	Axial Deformation (mm)	Remarks
SC (100+ 0%)	SC-1	110	4.12	Initial Crack
		263	5.88	Ultimate Crack
	SC-2	115	4.25	Initial Crack
		258	5.68	Ultimate Crack
	SC-3	108	4.45	Initial Crack
		261	5.88	Ultimate Crack
RWTRAC-1 (95+ 5%)	RWTRAC-11	110	4.12	Initial Crack
		263	5.88	Ultimate Crack
	RWTRAC-12	115	4.25	Initial Crack
		258	5.68	Ultimate Crack
	RWTRAC-13	108	4.45	Initial Crack
		261	5.88	Ultimate Crack
RWTRAC-2 (90+ 10%)	RWTRAC-21	120	4.05	Initial Crack
		266.5	5.80	Ultimate Crack
	RWTRAC-22	110	4.10	Initial Crack
		265	5.78	Ultimate Crack
	RWTRAC-23	125.5	4.25	Initial Crack
		262	5.72	Ultimate Crack

4. STATISTICAL ANALYSIS:

4.1 ANOVA:

An **ANOVA** test is a way out if survey or test results are significant. In other words, it helps you to outline if you need to reject the null assertions or accept the alternate assertions. ANOVA evaluates the main divergence at the heart of various types. It too manages the interface of accompanying aspects as compared to adding cram. In ANOVA, the term "hypothesis" plays a vital role in analyzing the samples. The hypothesis is the term that denotes the proposed justification of limited evidence as a source for further study. There are two kinds of assertions used.

1. Null assertions.

2. Alternating assertions.

Null assertions:

During scrutiny the trials were equal and the divergences between the specimens were not significant.

$H_0 = \mu 1 = \mu 2 \ldots .. = \mu L$

Where,

H_0 = Null assertions;

$\mu 1$, $\mu 2$ = Mean of groups 1, 2;

L = number of groups.

Alternate assertions:

During the study one sample varies from the other samples, and there are substantial variations between them.

$$H_1 = \mu 1 = \mu L$$

Where,

H_1 = Alternate assertions;

μ_1 = Mean of group 1;

L = number of groups.

ANOVA analysis can be carried out by the following steps:

Step 1: Data is entered into the spreadsheets in both rows and columns.

Step 2: Click on the "Data Analysis" tab.

Step 3: Select Anova with one-way variance for the analysis.

Step 4: Type the input range in the Range box.

Step 5: Use P 0.05 to determine whether the samples are null or alternate hypothesis.

Step 6: start the analysis of the input data.

Step 7: ANOVA findings will be presented in the spreadsheet.

The trial statistics were evaluated by means of one-way variance scrutiny (ANOVA). The inconsistencies among the groups in a sample were used to evaluate ANOVA should have compassion for any major or trivial disparity among the trials. Using ANOVA technology, the outcomes were gathered and tabulated in table 4.

Analysis of Variance Results:

Descriptive statistics of your k=2 independent treatments:

TABLE 4 - ANOVA OUTCOMES

Treatment →	Initial Crack	Ultimate Crack	Pooled Total
observations N	18	18	36
Sum $\sum x_i$	3,379.0000	90.2200	3,469.2200
mean x	187.7222	5.0122	96.3672
sum of squares $\sum x_i^2$	733,827.5000	463.5430	734,291.0430
sample variance s^2	5,853.7712	0.6671	11,427.7700
sample std. dev. s	76.5099	0.8167	106.9007
std. dev. of mean SE_x	18.0336	0.1925	17.8168

- **One-way ANOVA of your k=2 independent treatments:**

Source	sum of squares SS	degrees of freedom ν	mean square MS	F statistic	p-value
treatment	300,446.4969	1	300,446.4969	102.6389	8.3484e-12
error	99,525.4514	34	2,927.2192		
total	399,971.9483	35			

5. Conclusion:

The present study is necessitated to scrutinize and evaluate the physical distinctiveness of the concrete, which was primed by partially varying the coarse aggregate with in the vicinity of obtainable reshaped rubber chips in various proportions. The following implications were attained as a result of the outcome of the RCC short column tests performed on the concrete specimens.

The following implications were from the outcomes:

➢ For RCC short columns, the compressive vigour of 10% RWTRA replacement concrete is better than a standard column. Replacement concrete has a 5% and 2.73% greater initial and ultimate crack than standard column. It concludes that RWTRA augments the vigour characteristics more than coarse aggregate with standard concrete.

➢ The p-value obtained for column SC-1 and 10 percent RWTRAC-1 from the above findings is 3484e-12, which is less than the significance point of 0.05. The null assertions were rejected if the p-value was less than 0.05, i.e., the experiments were conceded with ample confirmation to validate the alternate assertion. It is achieved that column consistency relies greatly on RWTRA in concrete being surrogated. So there's more significant dissimilarity between standard coarse aggregate rendered by column and RWTRA as partial column replacement.

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