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A Study on Concrete with Waste Rubber Tyre as Partial Replacement to Coarse Aggregate

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***Abstract* - This experimental study is conducted to analyze the behaviour characteristics of rubberized concrete where rubber tyre is partially replaced with coarse aggregate.M30 grade concrete has been chosen as the reference concrete specimen. This will not only allow the sustainable use of aggregates available to us but also provide an effective and mass management of waste rubber tyre. This waste rubber tyre aggregate is added as 5%, 10%, 15% to replace the coarse aggregate. In this study compressive strength and split tensile of rubberized concrete was evaluated to investigate the optimal use of crumb rubber as coarse aggregate in concrete.**

***Key Words:* Cement, Aggregates, Waste Tubber Tyre (WRT)**

1. INTRODUCTION:

Concrete is a widely used construction material due to its strength and durability. However, the production of concrete requires a significant amount of natural resources, such as coarse aggregates like gravel and sand.

A very large amounts of used rubber tyres cumulate in the world every year out of which 275 million in the India and around 180 million in European Union. One of the most popular methods to get rid of this waste rubber is to pile these tyres in landfills, and since they have low density and poor degradation, we cannot burry them as landfills. These tyres are also placed in a dump or disposed of by simply piling them in large holes in the ground.

However, this rubber waste's higher amounts can be utilized as fuel, pigment soot, in bitumen, roof and floor covers etc. One of such applications that could use old rubber tyres effectively is rubberized concrete. Concrete can be made cheaper by replacing a fixed percentage of coarse aggregate with waste rubber tyre.

Partial replacement of rubber tyre aggregates in concrete has the additional advantage of saving in natural aggregates used in the production of concrete which are becoming increasingly scarce. Waste tyre rubber mixture is more workable compare to normal concrete and it is useful in making light weight concrete.

2. LITERATURE REVIEW:

Various researches for the partial replacement of coarse aggregate with waste rubber tyre, which are related to my work, are as under:

Muthusamy et al. (2014) Exploratory Study of Rubber Seed Shell as Partial Coarse Aggregate Replacement in Concrete. Total of five mixes consisting various content of crushed rubber seed shell as partial coarse aggregate replacement ranging from 0, 5, 10, 15 and 20%, respectively were prepared in form of cubes. All the specimens were water cured before tested at 7 and 28 days.

Shelke, et al., (2014) The characteristic properties of concrete such as compressive strength, flexural strength, impact resistance, bond strength & split tensile strength using the mix made by replacing coarse aggregate with crushed coconut shell aggregate were reviewed in the present work.

Umapathy, et al., (2014) The results indicated effectiveness of tiles as coarse aggregate by partial replacement of conventional concrete by 20 %, 30%, 50%and cement as rice husk ash with 10%,15% and 20% without affecting the design strength.

Ishwariya (2016) An experimental study on partial replacement of coarse aggregate by crumb rubber. In this study we use to find out the compressive strength of concrete by the replacement of coarse aggregate by crumb rubber in normal concrete in grade of M25 and M30 Finally a comparative study is mode among the normal conventional beam over to the rubcrete beam.

Ashwini, (2016) An experimental study is made on the utilization of E-waste particles as fine and coarse aggregates in concrete with a percentage replacement ranging from 0 %, 20% to 30% i.e. (0%, 10%, 20% and 30%) on the strength criteria of M20 Concrete.

Chandran (2017) This study reviews the feasibility of using waste tires in the form of chips with different sizes in concrete to improve the strength as well as protecting the environment.

Paul Sibiyone et al. (2017) Experimental study on replacing waste rubber as coarse aggregate. Different partial replacements of flap rubber (10, 20,30 and 40%) by volume of coarse aggregate are cast and test for compressive strength, flexural strength and split tensile strength.

Shahid Rasool Tarry (2018) Effect of partial replacement of coarse aggregates in concrete by untreated and treated tyre rubber aggregates. In this research work, emphasis is given on the pre-treating of the rubber particles and then using them as

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the partial replacement of the conventional rock aggregates. To get the best results, the rubber aggregates used are surface treated by sodium hydroxide and cement paste before using them in the concrete M20 grade concrete is used.

Onyeka (2019) The compressive strength of concrete with 100% granite at 28 days is 26N/mm2, while that of concrete gave 25.04 N/mm2 strengths, 24.37N/mm2, 22.22 N/mm2 and 21.55N/mm2, for 15%, 25%, 35% and 45% replacement of granite with glass respectively.

Bharani, et al., (2020) The partial replacement of M- sand by steel slag with 10%, 20% and 30% to find the optimum percentage of replacement. Using optimum percentage as constant, the Coarse Aggregate is replaced with certain percentage by E-Waste.

Priyadharshini (2020) The partial replacement of the coarse aggregate in the proportion of 10%,20% and 30% replacement. the specific gravity of the shell was analyzed and 16mm shell were selected for the experiment.

Jaydeo Phadtare et al. (2022) Study of partial replacement of coarse aggregate in concrete by different proportions of Un-Treated waste tyre rubber. Our clear focus is to study the behaviour and properties of concrete in fresh as well in harden condition when its natural coarse aggregates is replaced by 5% & 15% waste tyre rubber with the help of compressive test, spilt tensile test and flexural test for hardened properties of concrete.

Beiram et al. (2022) Effect of using waste rubber as partial replacement of coarse aggregate on torsional strength of square reinforced concrete beam. The study focused on the effect of the partial replacement of coarse aggregates with waste rubber chips of different proportions 10%, 20%, and 30% in volume on the beams ultimate torque, and rotation, as well as the ductility index, stiffness, cracking hinque, and failure modes.

Jeevana et al. (2023) Partial replacement of coarse aggregate with crumb rubber chips in the preparation of concrete. This crumb tyre aggregate is added as 5%, 10%, 15% to replace the coarse aggregate. In this study, workability and compressive of rubberized concrete was evaluated to investigate the optimal use of crumb rubber as coarse aggregate in concrete.

3. EXPERIMENTAL STUDY

3.1 CEMENT: Cement when mixed with minerals fragments and water, binds the particles into a whole compact. Cement is the most important and costliest ingredient of concrete. Portland Pozzolana cement of 53 grade.

Table-1 Tests Results of Cement

S.NO	PROPERTIES	RESULT
1	Normal Consistency	30 %
2	Initial Setting Time & Final Setting Time	40 min & 330 min
3	Fineness	3.34 %
4	Specific Gravity	3.05

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3.2 FINE AGGREGATE: As per IS 383-2016, Fine aggregate is defined as material that will pass a 4.75mm sieve. For increased workability and for economy as reflected by use of less cement, the fine aggregate should have a rounded shape.

TABLE:2 Tests Results Of Fine Aggregate:

S.NO	PROPERTIES	RESULTS
1	Specific Gravity	2.67
2	Fineness Modulus	2.55
3	Bulking	34 %
4	ZONE	II

3.3 Coarse aggregate: As per IS 383-2016, Coarse aggregates can be defined as irregular broken stone or naturally-occurring rounded gravel used for making concrete. Coarse aggregatesare retained on the sieve of mesh size 4.75mm. It acts as volume increasing component and is responsible for strength, hardness and durability of concrete.

TABLE: 3 Tests Results Of Coarse Aggregate

S.NO	PROPERTIES	RESULTS
1	Specific Gravity	2.71
2	Fineness Modulus	7.2
3	Aggregate Impact Value	26.67 %
4	Aggregate Crushing Value	21.06 %

3.3.1 WASTE RUBBER TYRE (WRT): It is cut down manually to the size coarse aggregates. The size of the rubber aggregates is kept around 20mm.

Figure 1: Waste Rubber Tyre

4. RESULTS AND DISCUSSIONS:

4.1 COMPRESSIVE STRENGTH VALUES: The strength in compression has a definite relationship with all other properties of concrete In India cubical moulds of size 150mm *150mm*150mm had casted and tested for 7days,14 days and 28days. The test results are tabulated below.

Figure 2: Cube Under Compressive Testing Machine

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TABLE-4 COMPRESSION STRENGTH OF CUBES AT 7,14 AND 28 DAYS

S. NO	% REPLACEMENT OF WRT	COMPRESSIVE STRENGTH (N/mm^2)		
		7 DAYS	14 DAYS	28 DAYS
1	0	40.42	41.35	49.75
2	5	31.55	36.67	46.35
3	10	29.33	35.11	43.65
4	15	25.55	30.55	38.90

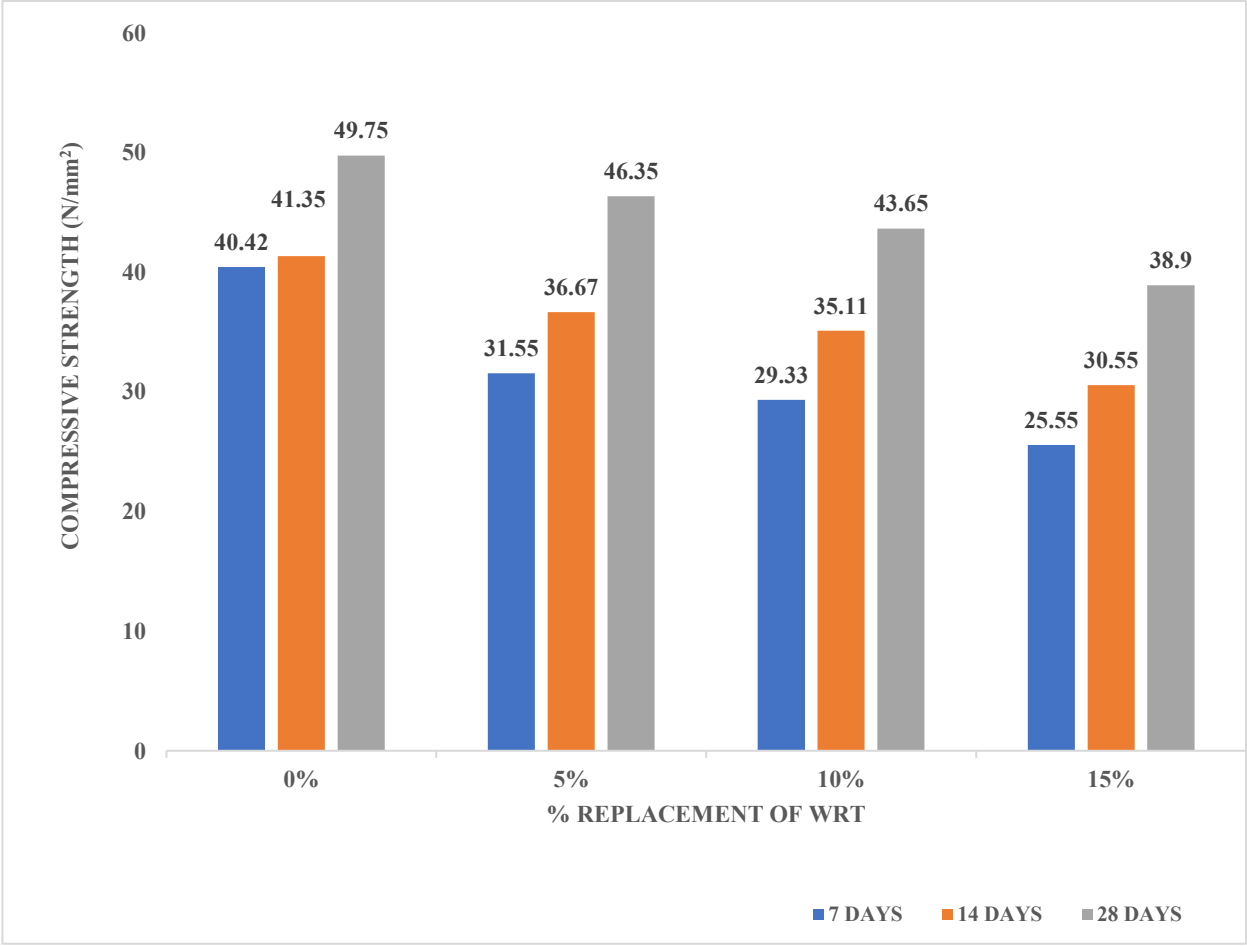

Figure 3: Compressive Strength VS % Replacement of WRT

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4.2 SPLIT TENSILE STRENGTH: The split tensile strength obtained by testing the specimen for M30 grade of concrete to all the mixes designed for various replacement given below.

FIGURE 4: Cylinder Under Split Tensile Testing Machine

Table-5 Split Tensile Strength of Cylinders At 7, 14 & 28 Days of Curing

S. NO	% REPLACEMENT OF WRT	SPLIT TENSILE STRENGTH (N/mm^2)		
		7 DAYS	14 DAYS	28 DAYS
1	0	4.12	4.29	4.35
2	5	3.64	3.88	4.12
3	10	3.54	3.85	3.93
4	15	3.45	3.65	3.87

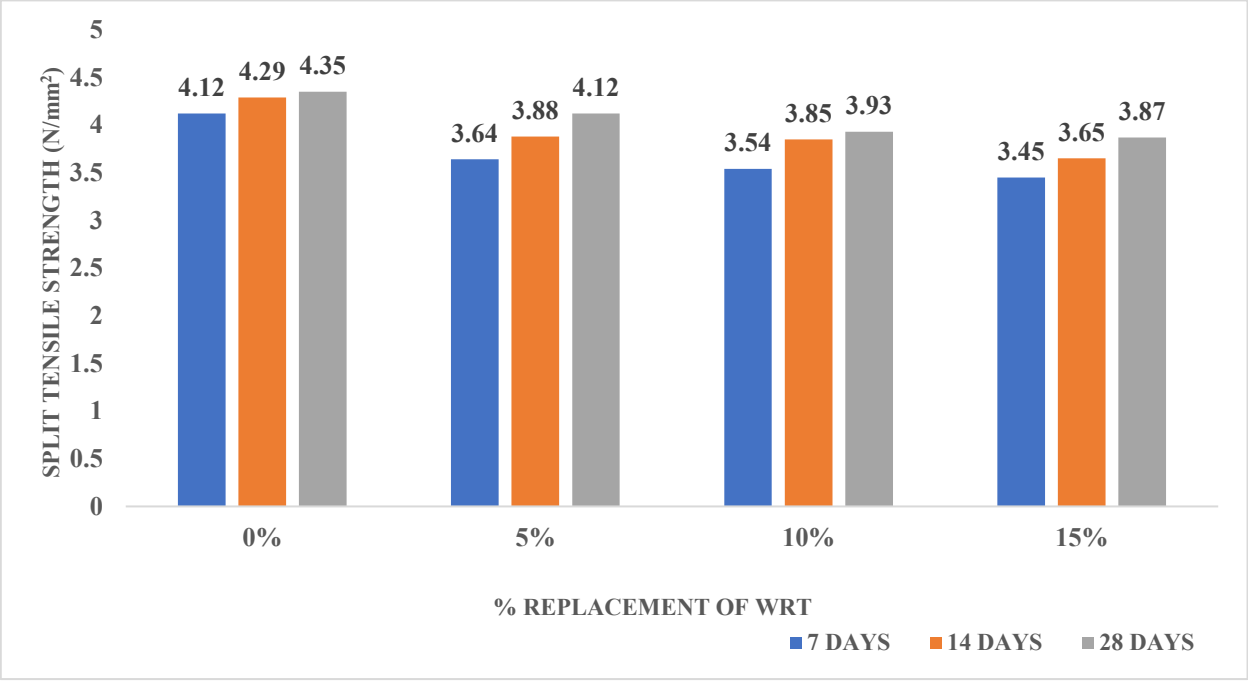

Figure 5: Split Tensile Strength VS % Replacement of WRT

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5. CONCLUSIONS:

Based on the experimental testing, following conclusions were drawn

- From the test results, it is observed 21.18%, 14.11% and 1.61%. improvement in compressive strength when compared with target mean compressive strength of concrete at 5%, 10% and 15% replacement of waste rubber tyre to coarse aggregate.
- From the test results, it is observed 7.57%, 2.61% and 1.04%. improvement in split tensile strength when compared with target mean compressive strength of concrete at 5%, 10% and 15% replacement of waste rubber tyre to coarse aggregate.

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