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Experimental Study in Strength of Concrete by using Waste Tyre Rubber as Partial Replacement of Coarse Aggregate

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Abstract - Modifications of construction materials have an important bearing on the building sector. Several attempts have been therefore made in the building material industry to put to use waste material products, e.g., worn-out tyres, into useful and cos effective items. This Waste - Tyre rubber is the significant environmental problems worldwide. With the increase in the automobile production, large amounts of waste tyre need to be disposed. Due the rapid depletion of available sites for waste disposal, many countries banned the disposal of waste tyre rubber in landfills. Research had been in progress for long time to find alternatives to the waste tyre disposal. Among these alternatives is the recycling of waste-tyre rubber. Recycled waste tyre rubber is a most widely used method. Recycle wasted Tyre Rubber is a promising material in the construction industry due to its light weight, elasticity energy absorption, sound and heat insulating properties. Success in this regard will contribute to the reduction of waste material dumping problems by utilizing the waste materials as raw material for other products. The present proposal involves a comprehensive laboratory study for the newer application of this waste material in the preparation of fibrous concrete. The primary objective of investigation is to study the strength behaviour i.e. compressive and flexural strength, of rubberized concrete with different volume of waste- Tyre rubber. Parameter to be varied in Investigation: I. Volume variation of waste rubber. In this the density and compressive strength of concrete utilizing waste tyre rubber has been investigated. The proposed work is aimed to study the effect of volume variation of waste-Tyre rubber on the compressive strength, flexural strength, Slump test & The relationship between stress and strain of the concrete. Recycled waste tyre rubber has been used in this study to replace the coarse aggregate by weight of 15%. The results shows that although, there was a significant reduction in the compressive strength of concrete utilizing waste tyre rubber than normal concrete, concrete utilizing waste tyre rubber demonstrated a ductile, plastic failure rather than brittle failure. In this study we use to find out the compressive strength &flexural strength of concrete by the replacement of coarse aggregate by waste-Tyre rubber in normal concrete in grade of M30.

Key Words*: *Waste tyre rubber, Compressive Strength, Flexural Strength, Workability.

1. INTRODUCTION

Recycled waste tyre rubber is a promising material in the construction industry due to its lightweight, elasticity, energy absorption, sound and heat insulating properties. waste rubber tire is most viable in concrete as a partial replacement to mineral coarse aggregates. The twofold advantage that is, it can prevent the depletion of scarce natural resources and the other will be the prevention of different used materials from their severe threats to the environment. Partial replacing the coarse aggregates of concrete with recycled waste tire aggregates can improve the qualities such as low unit weight, high resistance to abrasion, durability, absorbing the shocks and vibrations, high ductility etc. It was estimated that in India alone, more than 13 millions car and truck tires are being discarded annually which becomes one of the major environmental challenge the world facing because waste rubber is not easily biodegradable even after a long period of landfill treatment. Therefore waste tyre rubber concrete has widely used for the development related projects such as roadways or road intersections, recreational courts and pathways and skid resistant ramps. With this new property, it is projected that these concretes can be used in architectural applications; panels that require low unit weight, rail-roads to fix rails to the ground, roofing tiles etc. Significant problem of rubber tire waste disposal and other side shortage of natural coarse aggregates in construction field then to overcome these issue, it is essence to use recycled waste tires as an aggregate which can provide the solution for two major problems, that is, environmental problem created by waste tires and depletion of natural resources by aggregate production consequently the shortage of natural aggregates in some countries. Shredded rubber reduces weight of the concrete. With the increase in construction activities, there is heavy demand on concrete and consequently on its ingredient like aggregate also. So waste tire rubber can be used as an alternative to this demand. However, our objective of the project is to study and compare the strength behavior of concrete using Waste tyre rubber as a replacement material. In this paper the compressive strength and flexural strength of concrete utilizing waste tyre rubber has been investigated by replacing the coarse aggregate by weight using different percentages.

1.1 Objectives of the Project

- Determine the suitability of waste tyre rubber as partial replacement of coarse aggregate in concrete.
- Find the alternative of basic materials which are used in construction from past many years.
- Manage industrial waste.
- Compare the mechanical properties of waste tyre rubber in concrete with control concrete.
- Study the properties of fresh and hardened concrete when coarse aggregate are partially replaced with waste tyre rubber.
- Produce lightweight rubberized concrete for multi-purpose use.
- Develop suitable mix design

1.2 Significant of the Study:

- To reduce the space required for the landfill of waste worn out tyres
- To diminish the pressure on exploiting the natural resources.
- To introduce the potential of waste tyre rubber as coarse aggregate

2. METHODOLOGY

2.1 MATERIAL USED

a) Cement:

Cement is a well-known building material and has occupied an indispensable place in construction work. There is a variety of cement available in market and each type is used under certain condition due to its special properties such as color and composition of cement. The function of cement is, first to bind the sand and coarse aggregates together, and second to fill the voids. Although cement constitutes only about 10 percentage of the volume of the concrete mix, it is the active portion of the binding medium and the only scientifically controlled ingredient of concrete. Locally available cement is used. Like OPC 53 grade (Ultra Tech-Cement).

b) Fine Aggregate (V.S.I Sand):

Vertical Shaft Impactor (V.S.I.) Sand is also known as Artificial Sand or Crushed Sand. Only sand manufactured by V.S.I. Crusher is cubical and angular in shape. There is standard specification for Fine Aggregates (Sand). It is divided in four gradations Zone-I, Zone-II, Zone-III & Zone-IV. Generally the size of the aggregate lesser than 4.75 mm is considered as Fine Aggregate.

c) Coarse Aggregate:

The broken stone is generally used as a coarse aggregate. Aggregate occupies most of the volume of the concrete. Locally available coarse aggregate having size of more than 12 mm was used. The aggregates were washed to remove dust and dirt and were dried to surface dry condition. Coarse Aggregate used of 20 mm and down size. Testing is done as per Indian Standard Specification IS: 383-1970. The size of the aggregate bigger than 4.75 mm is considered as Coarse Aggregate.

d) Water:

Water is used for mixing, curing purpose should be clan and portable, fresh and free from any bacteria and desire matter confirming to IS 3025-1964 is used for mixing. Water is a key ingredient in the manufacturer of concrete.

e) Waste Tyre Rubber :

Waste Tyre Rubber obtained from Scrap Market. Waste Tyre Rubber is an ideal material for recycling. The use of Waste Tyre Rubber saves lot of energy and the increasing awareness of Waste Tyre Rubber, recycling speeds up focus on the use of Waste Tyre Rubber with different forms in various fields.

2.2 Casting of Specimen

Test specimens of Cubes of size 150mm x 150mm x 150mm, beam with 700mm x 150mm x 150mm will prepared using the standard moulds. The samples are cast. The samples are remoulded after 24hrs of casting and kept in a water tank for 7 and 28 days curing. A total of 54 specimens cast for testing the properties such as compressive strength, and flexural strength.

36 cube samples of size 150mmx150mmx150mm for different percentages of waste Tyre Rubber in partial replacement of coarse aggregate will casted. The concrete mixes are 0%, 5%, 10%, 15% crushed waste Tyre Rubber with partial replacement of coarse aggregate. All cubes will casted in one lift and consolidated using machine vibrator. After final setting of cubes, the cube moulds will be removed and cubes will kept in water tank for curing up to 7 and 28 days.

All specimen beams size 700mm × 150mm × 150mm will casted with optimum compressive strength for the specific mix in single lift and consolidated using tamping rods. After setting, the beams will covered with wet gunny bags. The burlap will be kept for 3days. At the end of the third day, the forms will stripped and beams will kept for curing up to 28 days.

Fig-1 waste Tyre rubber pieces added to Concrete

Specimens casted for investigation purpose are listed in Table-1.

Table -1: Number of Cubes and Beam casted for 7 days and 28 days

% of Waste Tyre Rubber	No. of Cube Cast		No. of Beam Cast for 28 days
	7-Days	28-Days	
0	3	3	3
5	3	3	3
10	3	3	3
15	3	3	3

2.3 Testing of Specimen

After 24 hours, the specimens were removed from the mould and subjected to water curing for 7 days and 28 days. After curing, the specimens were tested for compressive strength and flexural strength. Using a Compression Testing Machine of capacity 2000 KN in accordance with the provision of the Indian Standard specification IS:516-1959, strength of specimens were tested at 7 days and 28 days.

2. WORKABILITY

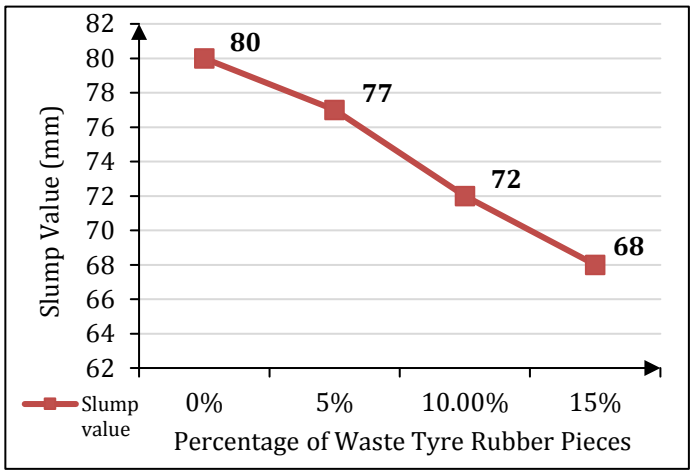
The workability of M30 grade of concrete is measured by widely used empirical test i.e. slump test with w/c ratio 0.40 for addition of different percentage waste Tyre Rubber .

Values obtain for different percentage mix is as show in following

Table -2: Slump values for different percentage of mix

% of Waste Tyre Rubber	Slump value (mm)
0	80
5	77
10	72
15	68

Graph 1: Slump Value



4. EXPERIMENTAL METHODOLOGY

4.1 Compressive Strength Test

The result of compressive strength After 7 days and 28 days are recorded. Result indicate that as we increase percentage of waste Tyre Rubber from 0% to 15% it's compressive strength increases after further increment in percentage of waste Tyre Rubber there is loss in compressive strength. That means we can replace up to 15% natural coarse aggregate by waste Tyre Rubber.

4.2 Flexural Strength Test

Testing of all beam specimens with two points loading for flexural strength. The results of flexural strength were plotted in below table for 28 days. Result indicate that if we increase percentage of waste Tyre Rubber from 0 to 15% will give us good results and help to increase flexural strength of concrete.

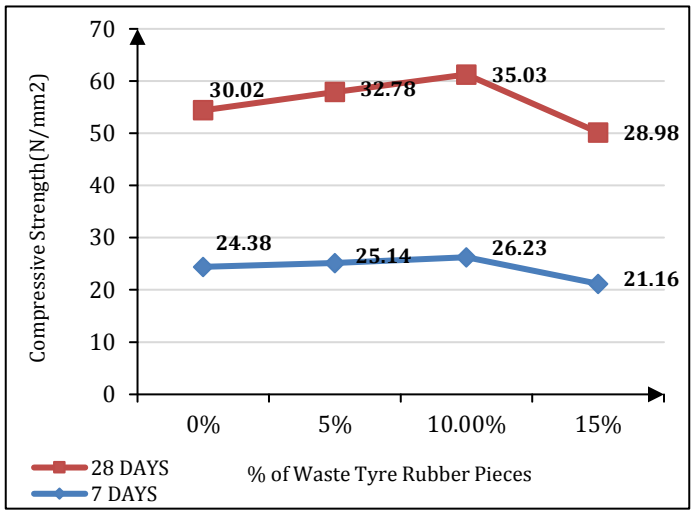
$$F_r = \frac{P \times L}{b \times d^2}$$

5. EXPERIMENTAL RESULTS

5.1 Compressive Strength Test

Table -3: Results of Compressive Strength

% of Waste Tyre Rubber	Compressive Strength (N/mm^2)	
	7-Days	28-Days
0	24.38	30.02
5	25.14	32.78
10	26.23	35.03
15	21.16	28.98

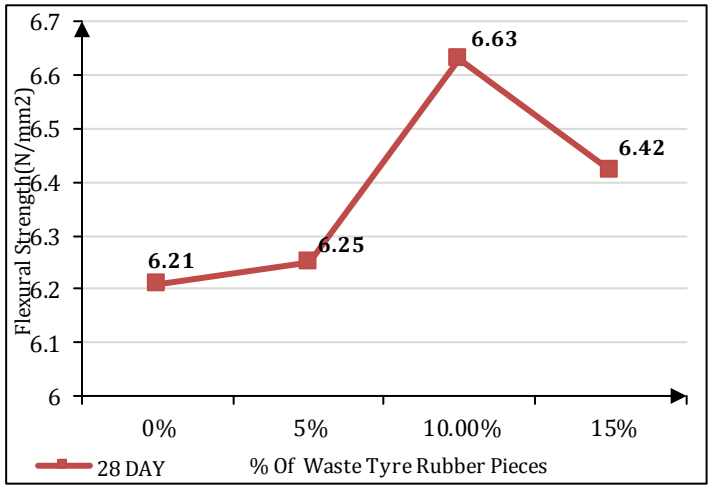


Graph 2: Compressive Strength at 7 and 28 days

5.2 Flexural Strength Test

Table -4: Results of Flexural Strength

% of Waste Tyre Rubber	Flexural Strength (N/mm^2) 28 days
0	6.21
5	6.25
10	6.63
15	6..42



Graph 3: Flexural Strength at 28 days

5. CONCLUSIONS

Based on results and observation made in experimental research study. The following conclusions are drawn.

1. It is observe that with increase in percentage of wast Tyre Rubber e workability decreases..
2. Current study concluded that waste Tyre Rubber can replace coarse aggregate up to 10%
3. 3.12% increment in the compressive strength is found for 5% replacement of coarse aggregate by waste Tyre Rubber and the strength decreases by 19.32% when the 15% of coarse aggregate is replaced by waste Tyre Rubber , by using and water cement ratio (W/C) is 0.40.
4. 0.65% increment in the flexural strength is found for 5% replacement of coarse aggregate by waste Tyre Rubber and the strength decreases by 3.16% when the 15 % of coarse aggregate is replaced by waste Tyre Rubber , by using and water cement ratio (W/C) is 0.40
5. The use of waste Tyre Rubber in concrete is possible to improve its compressive strength, and flexural strength.

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