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Study on Waste Rubber Tyre in Concrete for Eco-friendly Environment

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Abstract

Waste rubber tyre is one of the significant environmental problems worldwide because of increase in auto mobile production huge amounts of waste tyre need to be dispose. Due to rapid depletion of available sites for waste disposal, many countries banned the disposal of waste rubber tyre in landfills. Hence, efforts have been taken to identify the potential application of waste rubber tyre in civil engineering projects. Rubber tyre chips are a waste material that is ideal for use in concrete applications. This has an additional advantage of saving in natural aggregates used in production of concrete which are becoming increasingly scarce. In this essence, our present study 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.

Key word: Coarse aggregate, Rubber tyre chips, Rubberized concrete, Workability, Compressive strength, Acid curing, Durability, Light weight concrete.

Introduction

Major pressures and problems to the local authorities identifying the potential and recycling application for waste products like waste rubber tyres which are expensive and its meets that more problems by decreasing the number of landfills. The disposal of waste tyres to landfill is legally banned in all the countries due to environmental impact. So that

sustainable management of that aforesaid. Waste rubber tyre is a huge task to the industries and public sectors. Decomposing of waste rubber tyre which contains composed of materials and it cause serious contamination for environmental conditions. Another decomposing process is burning and harmful pollutions are causes by that gases exhausted from its [1,2,9,11] burning.

Most of the studies were carried out to recycle and reuse scrap tyres in a variety of rubber products. Generating the electricity or as a fuel for cement clinks as well as in asphalt concrete by incineration [5,6].

For usage waste tyres in civil engineering is currently very low and its one of largest potential routes in construction. Depends on its examinations, another way is using the tyres in concrete. These results in the improvement of energy absorption, ductility and resistance to cracking which undergoes under mechanical and dynamical properties [2,4,10].

When we compared waste rubber mixture is to normal concrete its more workable and also it is useful in making light weighted aerated concretes. Non structural applications are mainly required usage of rubberized concrete [3.8, 9].

In our present investigations were request the rubber aggregate which made by mechanical cutting the tyre into the required sizes. It not easy to handle at initial stage and it's very laborious and time consuming forever at these difficulties can be easily sorted out and proper cutting tools and machinery are made for these particular usage and large scale production is devised. Sources of rubber aggregates is the extracted and discarded tyre that is trucks tyres which is gathered and collected from the local market and rubber tyre coarse aggregates are prepared from aggregate crushing machine [1,7,8,10].

In this study, the rubber aggregates are prepared mechanically by cutting the tyres to maximum nominal size equal to 20 mm and after cleaning with portable water kept for air drying. The specific gravity is obtained from test equal to 1.10 [7].

The main objectives of this study is,

- Observation of some physical properties of concrete mix contained from waste tyre aggregates.

- Compressive strength of concrete mix using different percentage replacement in water and acid curing.
- Comparing and discussion of test results obtained from rubberized concrete with the normal concrete in various mixes.

Materials

Cement - OPC 43 grade used.
Specific gravity 3.12
Fineness 2%
Normal Consistency 33%
Initial setting time 88 mins
Final setting time 215 mins

Fine Aggregate - River sand used.
Specific gravity 2.58
Fineness modulus 3

Coarse Aggregate - Crushed stones used.
Specific gravity 2.88
Fineness modulus 6.96

Water - Portable water used.
pH 7 to 8
Temperature 36°c

Rubber tyre chips - 20mm size used
Specific gravity 1.15
0, 10, 20, 30% replace by CA

Chemical Admixture - 0.5% dilute Hcl and NaOH (acid curing)

Fig. 1. Rubber tyre chips

Methodology

- Define preliminary character of materials
- Calculate mix design of concrete
- Casting of concrete in cubes
- Test on fresh concrete (Workability)
- Determination of compressive strength in water curing at 14 and 28 days
- Determination of compressive strength in acid curing at 28 days
- Determination of density of concrete at 28 days

Experimental Setup

- In this experimental investigation consists of 4 different mix proportions by replace coarse aggregate in 0, 10, 20 and 30% of waste rubber tyre in M20 grade concrete.
- Total numbers of 36 cubes (150x150x150 mm) were casted for durability test as well as optimum compressive strength test. After that cubes were immersed into acid solution until the curing period. Compressive strength test was performed at the age of 14 and 28 days and durability test at age of 28 days curing. Compressive strength calculated using compressive strength machine.
- Density also conducted after 28 days for light weight concrete properties.

Results and Discussion

A. Workability of concrete

TABLE 1. WORKABILITY OF CONCRETE

% Replacement of waste rubber tyre	Slump value (mm)
Conventional Concrete	80
10%	73
20%	66
30%	43

Table 1 shows that, Slump value of fresh concrete has been decreased due to increase in percentage of waste tyre chips in all replacement of concrete mix.

B. Compressive Strength in Water curing at 14 and 28 days

TABLE 2. COMPRESSIVE STRENGTH IN WATER CURING

% Replacement of waste rubber tyre	Average Compressive Strength (N/mm²)	
	14 Days	28 Days
Conventional Concrete	17.38	20.39
10%	20.19	23.11
20%	18.11	20.84
30%	9.53	13.28

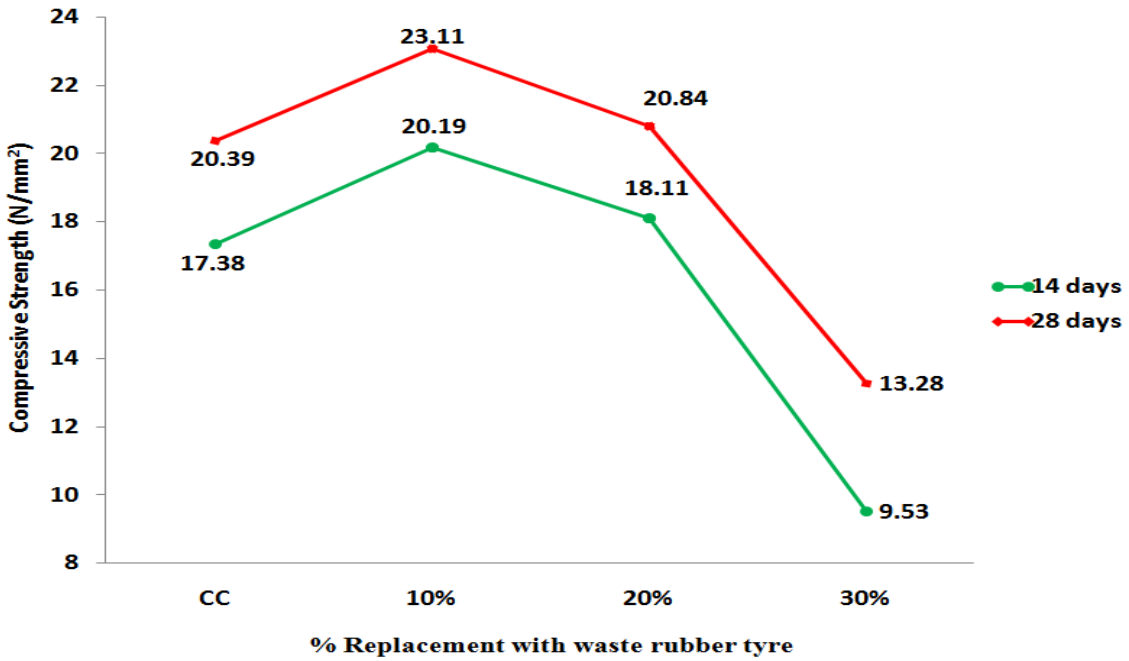

Fig. 2. Compressive strength in Water curing

Fig 2 shows that, 0 to 20% of replacement of waste rubber tyre in concrete increases the strength between 0.5 to 2.5 N/mm^2 at both 14 and 28 days strength in water curing.

C. Compressive Strength in Acid curing (durability test)

TABLE 3. COMPRESSIVE STRENGTH IN ACID CURING

% Replacement of waste rubber tyre	Average Compressive Strength (N/mm^2) at 28 Days
Conventional Concrete	16.69
10%	19.95
20%	17.72
30%	9.73

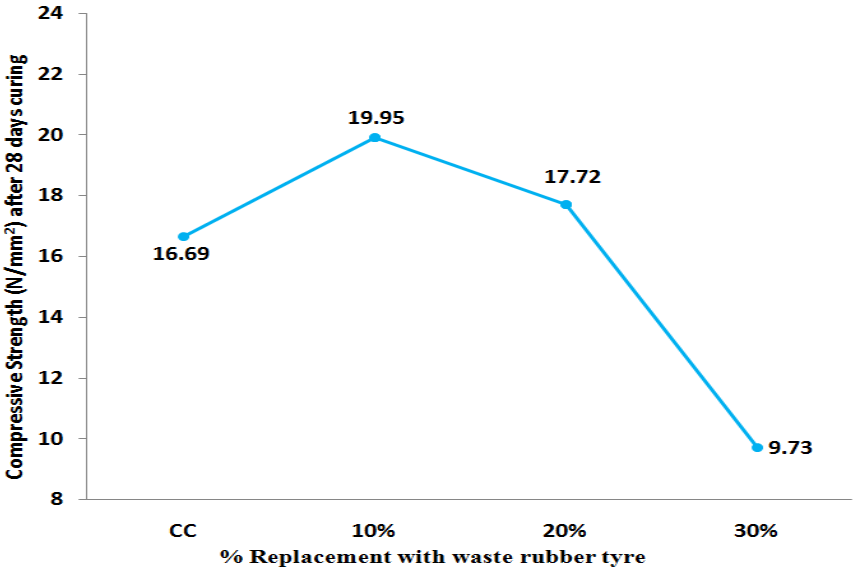

Fig. 3. Compressive strength in Acid curing

Fig 3 shows that, 0 to 20% of replacement of waste rubber tyre in concrete increases the strength between 1 to 3 N/mm^2 at 28 days strength in acid curing.

D. Density test on Concrete

TABLE 4. AVERAGE WEIGHT OF CONCRETE

% Replacement of waste rubber tyre	Average Weight of Concrete (Kg) after 28 Days
Conventional Concrete	8.431
10%	7.624
20%	7.182
30%	6.815

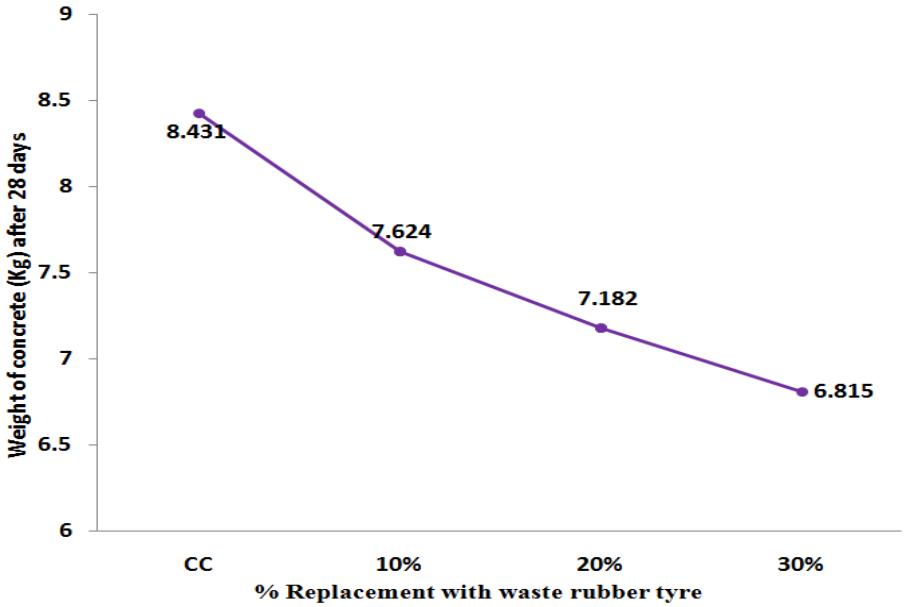

Fig. 4. Average weight of concrete

Fig 4 shows that 0 to 30% of replacement of waste rubber tyre in concrete reduce the weight between 0.8 to 1.6 Kg in 150x150x150 mm cube at 28 days strength.

Conclusion

The various strength tests were conducted for the concrete mix which containing different replacement proportions for waste rubber tyre. Addition of waste rubber tyre into normal concrete mix leads to decrease in workability for the various mix samples.

When 10% coarse aggregate was replaced by waste rubber tyre:

- In water curing, Compressive strength of concrete increases nearly about 15%.
- In acid curing, Compressive strength of concrete increases nearly about 20%.
- Density of concrete decreases nearly about 10%.
- Strength decreases with increasers the waste rubber tyre due to poor bonding strength between cement and waste rubber tyre chips at both 14 and 28 days strength.

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