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An Experimental Study on Rubberized Concrete

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ABSTRACT: About 1 crore 10 lakhs all types of new vehicles are added each year to the Indian roads. The increase of about 3 crores discarded tyres each year poses a potential threat to the environment. The best way to overcome this is to find alternate aggregates for construction. The proposed work presents an experimental study of effect of the use of solid waste material like crumb rubber in concrete by weight variation of crumb rubber. Crumb rubber usually consists of particles ranging in size from 4.75 mm to less than 0.075 mm. Most processes that incorporate crumb rubber as an asphalt modifier use particles ranging in size from 0.6 mm to 0.15 mm. In order to prevent the environmental problem from growing, recycling tyre is an innovative idea or way in this case. Recycling Tyre is the processes of recycling vehicles tyres that are no longer suitable for use on vehicles due to wear or irreparable damage such as punctures. The cracker mill process tears apart or reduces the size of tyre rubber by passing the material between rotating corrugated steel drums. By this process an irregularly shaped torn particles having large surface area are produced and this particles are commonly known as crumb rubber.

KEYWORDS: Crumb rubber, rubberized concrete, compressive strength, split tensile strength

I. INTRODUCTION

Concrete is one of the most widely used construction materials in the world. Cement and aggregate, which are the most important constituents used in concrete production, this inevitably lead to a continuous and increasing demand of natural materials used for their production. Parallel to the need for the utilization of the natural resources emerges a growing concern for protecting the environment and a need to preserve natural resources (such as aggregates) by using alternative materials which are recycled or waste materials.

Almost 1000 million waste tyres are generated in the world annually. By the year 2030, this number is expected to reach 1200 million. The production of tyre increases due to increase of automobile industry, it is very difficult to dispose the waste tyre. Large amount of waste tyre rubber is accumulated every year, and the easy process to decompose the rubber is by burning but because of burning of rubber a large amount of smoke and pollution is generated and another method to dispose waste rubber is by landfill, but nowadays availability and capacity of land fill places decreases.

This is dangerous not only due to potential environmental threat, but also from fire hazards and provide breeding grounds for rats, mice, vermin's and mosquitoes. Since the disposal of tyres has become one of the serious problems in environments. Land filling is becoming unacceptable because of the rapid depletion of available sites for waste disposal. In order to prevent the environmental problem from growing, recycling tyre is an innovative idea or way in this case. Recycling tyre is the processes of recycling vehicles tyres that are no longer suitable for use on vehicles due to wear or irreparable damage.

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The best way to overcome this is to find alternate aggregates for construction. The generation of such waste tyres far exceeds than that which are now being recycled. Waste rubber tyres cause serious environment problems all around the globe. Thus, this accumulated waste material can be used for the civil engineering construction.

Earlier studies have been performed on the use of worn out tyres in the asphalt mixes which were found to be very promising. Although, not much attention has been given to the use of rubber (obtained from scrap tyres) in Portland cement concrete.

II. MATERIALS USED

1. CEMENT:

Ordinary Portland Cement of 43 grade was used in this work. It was tested as per IS 8112-1989 recommendation. The properties of the cement are given below:

A. Specific Gravity = 3.13
B. Normal Consistency = 33 %
C. Initial Setting Time = 40 minutes
D. Final Setting Time = 460 minutes

2. FINE AGGREGATE:

NaturalsandconfirmingtoIS383-1970ofZoneIwasused.Specificgravity andsieve analysisoffineaggregatewerecalculatedaccordingtotheprocedureconfirmingtoIS383-1970. The properties of the fine aggregate are given below:

A. Specific Gravity = 2.60
B. Fineness Modulus = 2.8 %
C. Water Absorption = 1.0

3. COARSE AGGREGATE:

Locally availablecrushedaggregatesconfirming toIS:383–1970wereusedinthis study.The physicalpropertiesof coarseaggregatesaregivenbelow:

A. Specific Gravity = 2.66
B. Fineness Modulus = 5.9 %
C. Water Absorption = 0.5

4. CRUMB RUBBER:

Crumb rubber is a term usually applied to recycled rubber from automotive and truck scrap tyres. During the recycling process steel and fluff is removed leaving Tyre rubber with a granular consistency. Continued processing with a granulator and/or cracker mill, possibly with the aid of mechanical means, reduces the size of the particles further. The crumb rubber basically consists of particle size ranging from 4.75 mm to 0.075 mm. Crumb rubber of size ranging from 2.36 mm to 0.8 mm is used in the investigation. The physicalpropertiesof crumb rubber aregivenbelow:

A. Specific Gravity = 1.0
B. Fineness Modulus = 5.6 %
C. Water Absorption = 0.65

III. METHODOLOGY

A. CASTING OF SPECIMENS:

In order to prepare the recycled crumb rubber concrete specimens, fine aggregates were replaced by waste materials of crumb rubber in several percentages (0%, 5%, 10%, 15%, and 20%) in separate concrete mixes. The sand used was cleaned from all inorganic impurities. For each mix, cubes of 150 X 150 X150 mm and cylinders of 150 mm diameter

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by 300 mm height were prepared. All specimens were fabricated and then cured in water for 7 and 28 days in accordance with Indian Standard 10262.

The details of specimens casted in laboratory for compressive and split tensile tests are as shown Table 1.

Proportions	Specimen for compressive strength		Specimen fortensile strength	
	7 days	28 days	7 days	28 days
0% CR (NC)	3	3	3	3
5% CR	3	3	3	3
10% CR	3	3	3	3
15% CR	3	3	3	3
20% CR	3	3	3	3
Total	15	15	15	15

Table 1: Details of specimens casted in laboratory

For each concrete mix, slump tests were performed and recorded at the casting time of the specimens. After 24 hours of casting cubes and cylinders were taken out from the mould and then submerged in water tank for curing.

B. TESTING OF SPECIMENS:

1. Fresh concrete properties -slump test:

The slump factor is used to measure the horizontal free flow known as workability of concrete. The test has been carried out for M25 grade concrete and results are shown that it has been identified all the rubber replaced with fine aggregate concrete might behaved high value compared with conventional concrete. Hence it is preferred to make use of workability with 0.45 water cement ratio.

2. Hardened concrete properties

i. Compressive strength:

The purpose of compression test is todetermine the crushing strength of hardenedconcrete. Compression test was carried out on cubeof size 150mm×150mm×150mm.The strength wasrecorded at 7 and 28 days. The average reading of3 specimens was recorded as the strength atrespective age of concrete. The compressivetest is carried out in compression testingmachine of 3000 KN capacity. The ultimate strengthis recorded after the specimens fail to resist moreloads. The compressive strength can be calculatedby using formulaCompressive strength = failure load / cross sectional area.

ii. Split tensile strength:

Split tensile test was carried out on cylindrical specimens of 150mm diameter and 300mm height at the age of 7 and 28 days. The specimens were tested using compression testing machine of 3000 KN capacity. Split tensile strength = $2P / (\pi \times D \times L)$, Where P = load, D= Diameter, L= Length.

IV. EXPERIMENTAL RESULTS AND DISCUSSION

A. Workability test:

The variation of workability of fresh concrete can be measured interms of different parameters such as slump, compaction factor and vee-beetime. However only slumptestis carried out inview of its simplicite to

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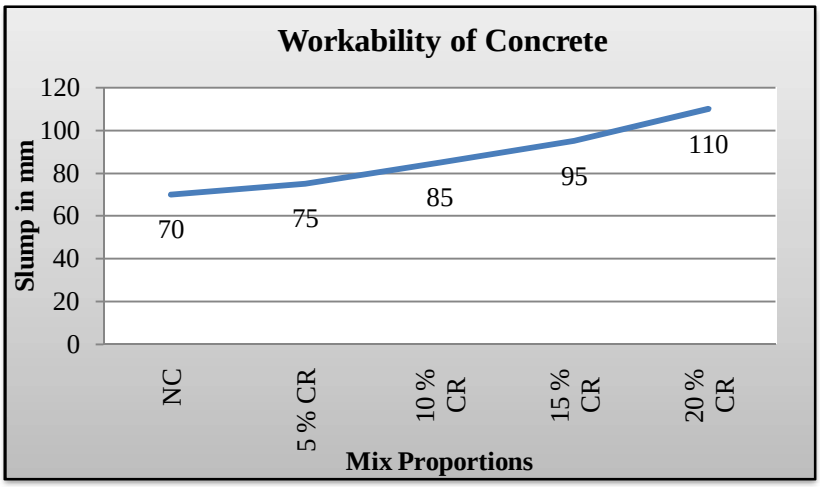
determi1ne the workability of concrete. All the concrete mixes investigated in the study had a constant w/cratio of 0.45.Table 2 and Graph 1 show the workability of concrete for different % replacement of crumb rubber.

Proportions	Slump Value in mm
NC	70
5 % CR	75
10 % CR	85
15 % CR	95
20 % CR	110

Table 2: Workability of concrete

The results of the slump of concrete with and without inclusion of crumb rubber are shown in Graph 1. The Graph shows the effect of partial replacement of sand with crumb rubber on the slump value of concrete. It can be noted that with increase in the crumb rubber the slump value increases.



Graph 1: Workability of concrete for different proportions of crumb rubber

As seen in Graph, the increase of the crumb rubber content in the mix resulted in an increase in the slump.

B. Compressive Strength:

ThetestresultsforthecompressivestrengthofM25 grade concrete at different ages where fine aggregate was replaced by crumb rubber with a constant replacement level of 5%bymass offine aggregate in the intervals of0, 5, 10, 15 and 20%and compared with normal concrete.

Compressive strength of concrete mixes at different ages is shown in Table3.

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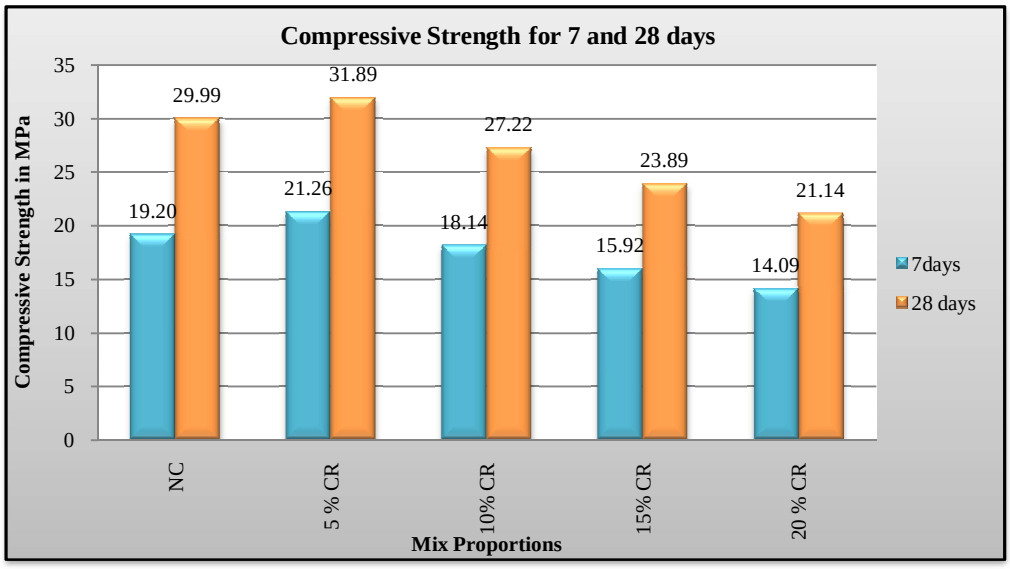
PROPORTIONS	CubeCompressiveStrengthinMPa	
	7 DAYS	28 DAYS
NC	19.20	29.99
5 % CR	21.26	31.89
10% CR	18.14	27.22
15% CR	15.92	23.89
20 % CR	14.09	21.14

Table 3: Compressive strength of concrete mixes at different ages

Itisseenthatcompressivestrengthat7and28daysthestrengthincreases initially and then decreases gradually with increase in crumb rubber percentage. The cube compressive strength for the conventional concrete is 29.99 MPa, while it decreased from 31.89 MPa to 21.14 MPa as replacement increased from 5% to 20%.



Graph 2: Compressive strength of cubes at 7 and 28 days

The cube compressive strength at 5% fine aggregate replacement indicated a slight improvement in strength compared with conventional concrete, which may be because of better compaction as a result of increase in workability.

C. Split Tensile Strength:

The test results for the split tensile strength of M25 grade concreteat different ageswhere fine aggregate was replaced by crumb rubber with a constant replacement level of 5%bymass offine aggregate intheintervals of0, 5, 10, 15 and 20% and compared with normal concrete.

Split tensile strength of concrete mixes at different ages isshown in Table 4.

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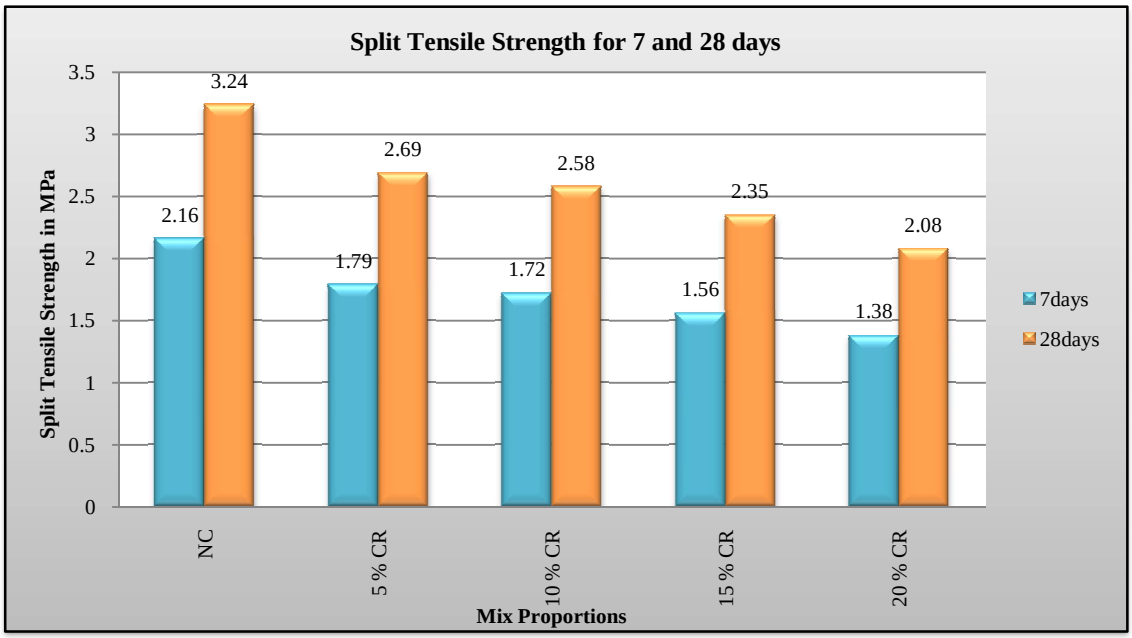
PROPORTIONS	Split Tensile Strengthin MPa	
	7 DAYS	28 DAYS
NC	2.16	3.24
5 % CR	1.79	2.69
10 % CR	1.72	2.58
15 % CR	1.56	2.35
20 % CR	1.38	2.08

Table 4: Split tensile strength of concrete mixes at different ages

The split tensile strength for conventional concrete is 3.24 MPa, while values of 2.69 MPa, 2.58 MPa, 2.35 MPa and 2.08 MPa were observed with replacement of 5%, 10%, 15% and 20 % respectively.



Graph 3: Split tensile strength of cylinders at 7 and 28 days

Itisseenthatsplittensilestrengthat7and28daysthestrengthdecreaseswithincrease in crumb rubber percentage. The decrease in the split tensile strength is due to nonpolar action of the rubber particles which attracts air and repels water.

V. CONCLUSION

The experimental study investigated the use of recycled tyres for partial replacement of fine aggregates in concrete using fraction of 5%, 10%, 15% and 20%. Based on the results, following conclusions may be drawn:

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- The workability of concrete is increased with the increase in the percentage of crumb rubber in the concrete mix. Hence, it can be summarized that the workability is adversely affected by the incorporation of chipped tyre rubber.
- Test results indicates that incorporation of crumb rubbercontentinconcreteresultsin increase in strength at first then it decreases gradually.
- Thecompressivestrengthof the concreteformixcontaining 5% crumb rubbershows higher value when compared to theother mixproportions.
- In split tensile strength, the strength of crumb rubber concrete is lower than the strength of conventional concrete.
- From the test results, it is found that the crumb rubber poses less bonding ability which has affected on the strength of the concrete.
- The Crumb Rubber Concrete has improved thermal resistance and sound insulation properties since, its density is lesser than the conventional concrete.
- It can be concluded that modified crumb rubber would contribute to the disposal of the non-decaying scrap tyres, since the amount being accumulated in third world countries is creating a challenge for proper disposal.
- The use of crumb rubber in concrete mix is very much beneficial to environmental concern and to solve the problem related to disposal of waste tyre rubber throughout the world.

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