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Waste Tyre Crumb Rubber Particle as A Partial Replacement to Fine Aggregate in Concrete

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***Abstract* : Worldwide production of tyre increases due to increase of automobile industry,it is very difficult to dispose the waste tyre as the availability and capacity of landfill spaces decreases. The basic material required in construction of buildings by using concrete are aggregate and cement . In this study, the performance of waste materials crumb rubber as partial replacement for aggregates in M25 grade of concrete mix at different percentages and its effect on concrete properties like compressive strength , fiexural strength and split tensile strength were investigated. The waste tyre crumb rubber particles was used to replace fine aggregate in concrete of size passing through 1.18 mm IS sieve and retaining on 600µ IS sieve at ratios 0.5 % ,1% ,1.5% , 2%, and also in combination with glass fiber at ratios 0.4 %, 0.5% addition to the weight of cement are used to regain the reduced strength of concrete due to the use of waste tyre crumb rubber particle. Result indicated that replacement of waste tyre crumb rubber particles to the fine aggregate in concrete at ratios 0.5 % and 1% there was no effect on the concrete properties would occur, but for replacement ratios 1.5% and 2 % considerable changes were observed as compare to similar normal concrete.**

Keywords: Waste tyre rubber, glass fiber, workability, mechanical properties etc.

I. INTRODUCTION

Large amount of waste tyre rubber accumulate in the world 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. Another method to dispose waste rubber is by landfill, but now days availability and capacity of land fill places decreases, the main objective of this research is to dispose the waste tyre rubber, used in concrete mix as a valuable substitute for aggregate at different percentages to obtain good engineering properties of concrete.

II. RESEARCH OBJECTIVES

Use of waste tyre rubber particle in concrete can gives a efficient way of utilizing rubber and by using rubber in concrete gives better environmental benefits(1) .The waste tyre rubber provides a concrete with good engineering properties by partial replacement of waste tyre crumb rubber particle to the fine aggregate in concrete.

III. CRUMB RUBBER (CR)

Crumb rubber made by shredding process of used waste automobile tyres and in tyre remoulding plant also crumb rubber is generated .

Crumb rubber

crushed rubber

IV. LITERATURE REVIEW

Ki sang son et al [1] investigate the reinforced concrete column with waste tyre rubber particles of different sizes and percentages by considering the concrete compressive strength 24mpa and 28mpa to examine the concrete properties. In this study 600 µ to 1 mm size of rubber particle was used. 27 control specimen were prepared, the result indicated that the rubber filled RC column gives slightly lower compressive strength and

modulus of elasticity . But energy absorption capacity and ductility increases. Therefore this type of concrete is suitable for seismic application .

Esh maiel ganjian et al [2] investigated the concrete mixture by using tyre chipped replaced to coarse aggregates and waste tyre crumb powder replaced to cement at 5%, 7.5% and 10% to examine the concrete properties. The result showed that with increase in percentages of rubber compressive strength reduction was less than 5% and with 7.5% and 10% replacement higher reduction occure modulus of elasticity reduces up to 17-28% for 5 to 10% replacement of chipped rubber to aggregate in concrete, tensile strength and flexural strength reduced with increased percentages of rubber in concrete.

Cammille A Issa, et al [3] have been used recycled crumb rubber as a substitute for fine aggregate in concrete at 0% to 100% replacement to crushed sand in concrete mix. The result showed that 25% Replacement of crushed sand gives good compressive strength and by using crumb rubber up to 25% results in 8% decrease in density of concrete and ductility of concrete increases therefore it is useful in shock resisting element , highway barrier etc. And also damping properties improves.

F pache co- Torgal et al [4] have been studied the effect on fresh and hardened concrete properties by using polymeric waste like tyre rubber and PET bottles in concrete mix. The results of many researchers showed that with increase in rubber content workability (slump) increases, and the properties like compressive strength, split tensile strength , flexural strength and modulus of elasticity decreases. But for higher content of tyre rubber in concrete mix increases the toughness of concrete.

N.J. Azmi, B.S. Mohmmed et al [5] have been investigated the effect of recycled tyre rubber partially replaced to fine aggregate in concrete to examine the properties of concrete like compressive strength splitting tensile strength and flexural strength, they have selected concrete mix with water cement ratios 0.41, 0.57, and 0.68. Total 15 different concrete mixes were cast. The results showed that, there was decrease in strength of tyre rubber concrete mixture, but with increase in rubber content from o to 30% slump values increases. It means that this type of concrete is more workable than normal concrete.

The slump values were recorded for different W/C ratios at different rubber content replaced to fine aggregate in concrete mix are as follows,

1) w/c ratio = 0.41	slump (mm)
0 % replacement	75
10 % replacement	78
15 % replacement	85
20 % replacement	90
30 % replacement	94
2) w/c ratio = 0.57	slump (mm)
0 % replacement	85
10 % replacement	110
15 % replacement	125
20 % replacement	135
30 % replacement	146
3) w/c ratio = 0.68	slump (mm)
0 % replacement	100
10 % replacement	125
15 % replacement	136
20% replacement	147
30% replacement	158

Piti Sukontasukkul [6] in his study investigated the thermal and sound properties of crumb rubber concrete the waste crumb rubber concrete panels, the waste crumb rubber produced in a local recycling plant was used to replace fine aggregate at percentages 10%, 20% and 30% to examine the properties such as thermal resistance, thermal conductivity, heat transfer, sound absorption and noise reduction. The results showed that the crumb rubber concrete panel was higher sound absorption, light in weight and lower heat transfer properties than normal concrete panel. From the investigation he concluded that the concrete with crumb rubber replaced to fine aggregate gives good thermal and sound properties and the unit weight of concrete also reduced than normal concrete.

V. EXPERIMENTAL STUDY

A) Material

OPC was used throughout , naturally occuring river sand and crushed stone aggregate are used as fine and coarse aggregate respectively, waste tyre crumb rubber particle of size passing through 1.18 mm IS sieve and retaining on 600μ IS sieve are used. The glass fiber 6 mm in length, 12 um diameter and having 2.60 specific gravity are used for the study.

B) NaoH Treatment

The waste tyre rubber particle are immersed into NaoH solution for 20 min and then dried before using in the concrete mix. NaoH treatment to the surface of rubber particle enhances the adhesion between the rubber particle and cement paste.

C) Concrete mix design

The mix design for M25 grade of concrete with target strength 31.6 mpa used for this study.(Table 1) The proportions are given below in kg Worth mentioning here is that at all substitutions of sand by waste tyre crumb rubber , the replacement was done by mass and not by volume.

TABLE 1. CONCRETE MIX DESIGN

Item in mix	**Specific gravity (g/cc)**	**weight(kg/m^3)**
Cement	3.15	383.2
Natural sand	2.70	741.74
Coarse aggregate	2.59	1067.27
Water	1	191.6

TABLE 2. PERCENTAGE OF RUBBER CRUMB REPLACING SAND FOR 1 M3 CONCRETE.

Percentage of rubber crumb	Rubber crumb (kg/m^3)	Sand (kg/m^3)
0.5 %	3.708	738.03
1 %	7.417	734.32
1.5 %	11.126	730.61
2 %	14.834	726.90

TABLE 3. PERCENTAGE OF GLASS FIBER ADDITION TO THE WEIGHT OF CEMENT FOR 1 M3 CONCRETE.

Percentage of Glass fiber	Glass fiber (kg/m^3)	Cement (kg/m^3)
0.4%	1.533	383.2
0.5%	1.916	383.2

VI. EXPERIMENTAL RESULTS AND DISCUSSION

A) workability

In this study for three different w/c ratios at varying rubber content slump values were recorded.

W/C Ratio= 0.43	slump (mm)
0 % replacement	75
0.5 % replacement	76
1.0 % replacement	80
1.5% replacement	82
2.0 % replacement	84

W/C Ratio= 0.45	slump (mm)
0 % replacement	76
0.5 % replacement	78
1.0 % replacement	81
1.5% replacement	83
2.0 % replacement	85

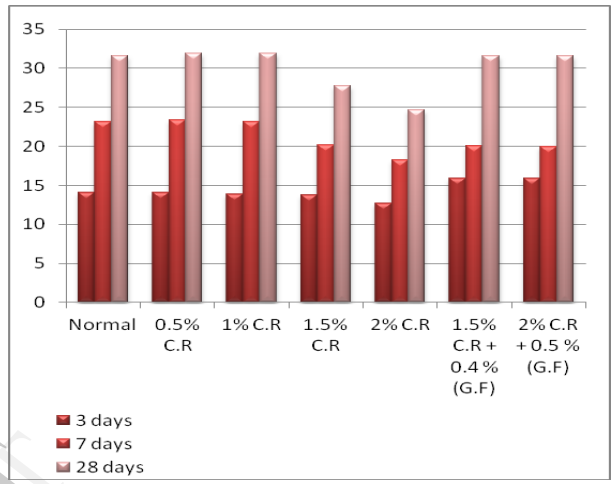
W/C Ratio= 0.50	slump (mm)
0 % replacement	77
0.5 % replacement	78
1.0 % replacement	82
1.5% replacement	86
2.0 % replacement	88

It observed from the above result, for higher rubber content workability of concrete increases.

In this study different concrete batches with varying proportions of crumb rubber replaced to fine aggregate and glass fiber as a addition to the weight of cement were prepared to cast cubes, beams and cylinders. For each proportion 9 cubes (150x150x150), 9 beams (150x150x700) and 9 cylinders of dia. 150 mm and 300 mm length were cast. And test was conducted after 3days, 7days and 28days of curing, to check compressive, split tensile and flexural strength of concrete.

B) Compressive strength

From the result it was observed that there was no effect on the strength with replacement of 0.5 % and 1% of crumb rubber to the fine aggregate in concrete. But, compressive strength was reduced by 12.21% and 21.83% with replacement of 1.5% and 2 % of crumb rubber to the fine aggregate in concrete respectively. To gain this reduced strength the glass fiber were added at percentages of 0.4% and 0.5% to the weight of cement. The result of compressive strength test are shown below.

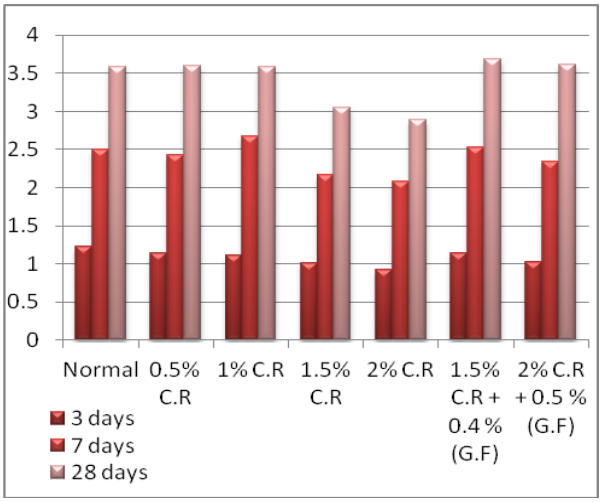


(CR-crumb rubber, GF-glass fiber)

C) Flexural strength

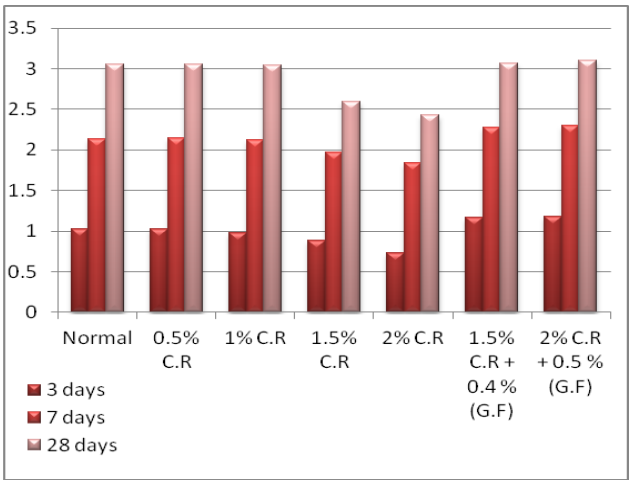
From the result it was observed that by replacing 0.5% and 1.0% crumb rubber to the fine aggregate in concrete there was no effect on flexural strength . But, for the replacement of 1.5 and 2.0% of crumb rubber the flexural strength was reduced by 14.86% and 19.07% resp.

By using glass fiber at 0.4 and 0.5% addition to the weight of cement with 1.5% and 2.0% replacement of crumb rubber resp. flexural strength was increased by 2.79 and 2.80 % resp.



D) Split tensile strength

From the result obtained by split tensile strength test it was observed that for replacement of 0.5% and 1.0% crumb rubber to the fine aggregate in concrete there was no effect on split tensile strength . But for the replacement of 1.5 % and 2.0% of crumb rubber it was reduced by 15.08% and 20.32% resp. By addition of glass fiber at 0.4 and 0.5% addition to the weight of cement with 1.5% and 2.0% replacement of crumb rubber resp. split tensile strength was increased by 0.87 and 1.857 % resp.



COCLUSIONS

This study represents the effect of waste tyre crumb rubber particle of size passing through 1.18mm IS sieve and retained on 600 µ IS sieve used in concrete on compressive, flexural and split tensile strength. From the results obtained during investigation and based on literatures review following conclusions can be drawn:

Higher content of waste tyre crumb rubber particle in concrete increases workability of concrete.

Using waste tyre crumb rubber particle replaced to fine aggregate in concrete at 0.5 % and 1.0% It was observed that, there was no effect on compressive , flexural and split tensile strength of concrete when compare with similar normal concrete mix.

Using waste tyre crumb rubber with 1.5 % and 2.0% replacement affects the hardened concrete properties

The reduced strength was recovered by adding the glass fiber to the weight of cement by 0.4% for 1.5% replacement and 0.5% for 2.0% replacement of crumb rubber to the weight of fine aggregate in concrete.

Higher content of waste tyre crumb rubber produces the light weight concrete.

Further investigation is necessary to improve the hardened properties of rubber filled concrete, to gain the loss strength due to the use of waste tyre crumb rubber at higher content in concrete mix. 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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