Replacement of artificial sand and recycled aggregate by using of crumb and shredded rubber

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ABSTRACT-*According to various research papers, it has been found that replacement of natural sand and aggregate by using artificial sand and recycled aggregate at various proportion (5%,10%etc.).In this paper the study of compressive and flexural strength of concrete by partial Replacement of artificial sand and recycled aggregate by using of crumb and shredded rubber.*

Keywords- artificial sand, Recucled aggregate, crumb, shredded rubber.

I. INTRODUCTION

Demolition of old and deteriorated building and traffic infrastructure and their substitution with new ones, is a frequent phenomenon today in most of the part of world. The main reason for this situation are changes of purpose, structural deterioration, rearrangement of city, expansion of traffic directions and increase of traffic load, natural disasters like earthquake, flood fire etc. As per Times of India, Dec 6, 2010 states that according to JNNURM report India generates 10-12 million tons of C& D waste annually. And 50% of it is Concrete and Masonry which is not recycled in India. The most common methods of disposing this material are land filling. In these way large amounts of construction waste is generated, consequently becoming a problem a special problem of human environment. For this similar reason in developing countries, laws have been bought into practice to restrict this waste in the form of prohibitions or special taxes existing for creating waste areas. To take care of the C& D waste in India Ministry of Environment and forests has mandated environmental clearance for all large construction projects. The figure 1.1 and figure 1.2 below shows the C&D Waste and Concrete Rebar which are the main source for recycled concrete aggregates.

Fig: 1.1 Demolished Waste

Fig: 1.2 Concrete Rebar

In short the concrete industry, which uses 12.6 billion tons of raw materials each year, is the largest user of natural resources in the world. It's the world's most widely used construction material. But at the same time it is not an environmentally friendly material too.

1.1 RECYCLED AGGREGATES:

Recycled aggregate is generally produced by two stages crushing of demolished concrete, screening and removal of contaminants such as reinforcement, wood, plastic etc. Concrete made with such aggregates is called as Recycled aggregate Concrete.

Figure no. 1.5 Recycled Aggregate.

Advantages: Environmental gain, Save Energy Cost: , Sustainability, Wide Market.

Limitations: Hard to have permit, Lack of specification or guideline, Properties of Recycled aggregate.

1.2 SHREDDED RUBBER AND CRUMB RUBBER:

1.2.1 Crumb Rubber:

Crumb rubbers are obtained by grinding. Crumb rubber- 30 mesh is produced by passing rubber tires through a screen with 30 holes per inch resulting in rubber granulate that is slightly less than 1/30th of an inch.

Fig: 1.6 Crumb Rubbers

1.2.2 Shredded Rubber:

This fine grade reclaim rubber product is manufactured from whole tyre scrap. These are the used tires from passenger car used tyres, primary shred size of pieces from 30cm and below, the shred is the primary cut of used tires produced by elden primary chopper, container 40 ft load with 25 tons

Fig: 1.7 Shredded Rubber

1.3 OBJECTIVES

- Reusing waste material
- Evaluate possible advantages of using crumb rubber in concrete including
- To find out the percentage of replacement of Develop test information that may aid in the eventual goal of drafting a practical rubber in concrete.
- rubber in concrete to get design strength
- Reducing the production costs of building materials in terms of natural resources.
- Enhance the understanding on crumb rubber concrete material properties through laboratory testing.

II. LITERATURE REVIEW

2.1 El-Gamely, A., A.K. Abtel - Gawad, Y. El- Sherbani and A. Shalaby, **'**COMPRESSIVE STRENGTH OF CONCRETE UTILIZING WASTE TIRE RUBBER', Journal of emerging trends in Engineering and applied science (JETEAS) I (1) : 96:99. In this paper the density and compressive strength of concrete utilizing waster tire rubber has been investigated. Recycled waste tire rubber has been used in this study to replace the fine and coarse aggregate by weight using different percentages. The results of this paper shows that although, there was a significant reduction in the compressive strength of concrete utilizing waste tire rubber than normal concrete, concrete utilizing waste tire rubber demonstrated a ductile, plastic failure rather than brittle failure.

2.2 Malek K. batayneh, Iqbal marie, and Ibrahim Asi, 'PROMOTING THE USE OF CRUMB RUBBER CONCRETE IN DEVELOPING COUNTRY' Waste management, 28 (2008) 2171-2176/ www.sciencedirect.com The main objectives of this research were to provide more scientific evidence to support the use of legislation or incentive-based schemes to promote the reuse of accumulated waste tires. This research focused on using crumb tires as a replacement for a percentage of the local fine aggregates used in the concrete mixes in Jordan. Ravindra k.dhir & Kevin A. Paine **'V**ALUE ADDED SUSTAINABLE USE OF RECYCLED & SECONDARY AGGREGATE INCONCRETE', The Indian Concrete Journal, March 2010. This research is helping to create a gradual acceptance of recycled and secondary aggregate for their sustainable use in concrete and concrete product. There is significant potential for growth of recycled and secondary aggregate as an appropriate and green solution to the anticipated increased world-wide construction activity and with it the demand for RSA.

2.3 Gintautas SKRIPKIUNAS, Audrius GRINYS, Benjaminas CERNIUS, 'DEFORMATION PROPERTIES OF CONCRETE WITH RUBBER WASTE ADITIVES' ISSN 1392-1320 Material Science (medziagotyra), vol. 13, No. 3, 2007 The aim of investigation was to study the deformation properties of Portland cement concrete with rubber waste additive. Concrete mixtures with the same compressive strength as concrete without this additive were tested. Used tires rubber wastes were crumbed into fraction 0/1. The rubber additive was used as fine aggregate replacement in concrete mixtures by 3.2 % of aggregates mass.

2.4 A. Mohd Mustafa Al Bakri, S. A. Syed Nuzul Fadli, M. D. Abu Bakar and K. W Leong, **'**COMPARISON OF RUBBER AS AGGREGATE AND AS FILER IN CONCRETE', 1st International Conference on Sustainable Material 2007, ICoMS 2007, 9-11 June 2007, Penang. An experiment will carry out to determine the strength of early age concrete with rubber waste coarse aggregate to compare with the rubber waste as filler in concrete (with crushed stone coarse aggregate and sand fine aggregate).This research will carry out 2 difference type of concrete which are rubberized concrete and rubber filler in concrete. In rubberized concrete, rubbers were used to replace coarse aggregates and river sand as fine aggregate. Furthermore, in rubber filler in concrete, crushed stone was used as coarse aggregate and river sand as fine aggregate. Coarse aggregate usually gravel or crushed stone and shredded rubber as filler in concrete.

2.5 F. A. Aisien, F.K. Hymore and R.O. Ebewele, 'APPLICATION OF GROUND SCRAP TYRE RUBBER IN ASPHALT CONCRETE PAVEMENT', Indian journal of engineering and material sciences, vol.-13, August 2006, appl. 333-338. A laboratory scale evaluation of the feasibility of using ground rubber from scrap tyres in dry process hot-mix asphalt concrete used for road pavement was investigated. The result from the study show that the rubberized asphalt concrete mix has much better mechanical properties that the conventional one. The mechanical properties of rubberized specimens cured in air and those soaked in water were not significantly different.

III. METHODOLOGY.

The methodology for the project work depends on the objectives. This project work which has an objective of achieving M25 grade of concrete with maximum utilization of tyre rubber as aggregate and artificial sand in concrete contains extensive experimental work.

3.1 WORKING METHODOLOGY

THE PROJECT WORK WAS CARRIED OUT IN FOLLOWING PHASES

3.1.1 PHASE I:-Determination of basic properties of available materials

To know the basic properties of available materials. (This exercise was done to have a base to compare the respective properties of conventional materials, and alternative materials.)

Establishing all the Physical and Mechanical properties of Artificial Sand or Machine made sand Shredded rubber.

Various tests carried out:-

To determine the Physical Properties of, Aggregates & Rubber The following tests were carried on materials

i. Specific Gravity of Aggregate
ii. Determination of bulk density.
iii. Fineness modulus and particle size analysis of Aggregate
iv. Surface moisture content in fine aggregate
v. Specific gravity and water absorption of Aggregate.

3.1.2 PHASE II:-Actual Experimentation with mix design & casting

With reference to the above properties various mixes mentioned below were designed with an aim in achieving M25 grade concrete, **Tests performed on concrete:**

1. Fresh Concrete:
   i. Slump test for workability.
2. Hardened Concrete:
   i. Compressive Strength of blocks
   ii. Flexural strength

Concrete Mixes:

Mix design will be done using IS 10262:2009, with M25grate of concrete. (Assumptions of suitable w/c ratio have to be done.)

1) Mix 1:-M25 grade of concrete with recycled aggregate-Control mix

2) Mix 2:-M25 grade of concrete with 2% replacement of artificial sand with crumb rubber. 3) Mix 3:- M25 grade of concrete with 4% replacement of artificial sand with crumb rubber. 4) Mix 4:- M25 grade of concrete with 6% replacement of artificial sand with crumb rubber. 5) Mix 5:- M25 grade of concrete with 8% replacement of artificial sand with crumb rubber. 6) Mix 6:- M25 grade of concrete with 10% replacement of artificial sand with crumb rubber. 7) Mix 7:- M25 grade of concrete with 2% replacement of coarse aggregate with shredded rubber. 7) Mix 8:- M25 grade of concrete with 4% replacement of coarse aggregate with shredded rubber. 8) Mix 9:- M25 grade of concrete with 6% replacement of coarse aggregate with shredded rubber. 9) Mix 10:- M25 grade of concrete with 8% replacement of coarse aggregate with shredded rubber. 10) Mix 11:- M25 grade of concrete with 10% replacement of coarse aggregate with shredded rubber.

COMPARISSON

- ompare densities of all the mixes i.e. Mix 1to10 with Mix 'A'
- alculate increase or decrease in weight.
- heck behavior of failure i.e. brittle or ductile
- ompare compressive and flexural strengths of all mixes i.e. Mix 1 to 10 with Mix 'A'

3.1.3 PHASE III: –

To compare the results of each mix stated in Phase III and to determine the optimum percentage of replacement of Crumb Rubber and Shredded Rubber.

Casting of Cubes:

Size of each cube is 15x15x15cm³
Therefore Volume of each cube (3375cm³)
Considering 3 each set for 28 days respectively.

1. Concrete cubes with artificial sand and Recycled Aggregate
2. Concrete cubes with artificial sand and Shredded rubber,

Approximate no of blocks: - 33

Casting of Beams:

Each beam of size (10x10x50) cm³.With volume (5000cm³)

1. With recycled aggregates
2. with relevant replacement
3. with relevant replacement

Approximate no of beams – 33

TOTAL:

Total No. of cubes: 33

Total No. of Beams: 33

IV. CONCRETE MIX DESIGN:

4.1 MIX DESIGN FOR CONTROL MIX [M25 grade concrete] AS PER IS 10262:2009

DATA for MIX DESIGN:

1. Grade of concrete: M25
2. Cement: OPC 53 grade
3. Maximum size of aggregate: 20mm
4. Minimum cement content: 300 kg/ m³
5. Maximum w/c ratio: 0.5
6. Workability of concrete: 75mm slump
7. Admixture: super plasticizer
8. Specific gravity of cement: 3.15
9. Specific gravity of conventional coarse aggregate: 2.89
10. Specific gravity of artificial sand: 2.89

STEP I - TARGET STRENGTH

$$f_t = f_{ck} + k.\, s$$

$$= 25 + 1.65 \times 4 \quad = 31.6\ N/mm^2$$

Where, f_t = target mean compressive strength at 28 days,

f_{ck} = Characteristic compressive strength of concrete at 28 days,

k = usually 1.65 as per IS456-2000

s =standard deviation

STEP II -SELECTION OF WATER/ CEMENT RATIO

Max. Water content = 186 liter for 25 to 50mm slump for 20mm aggt. Water content for 100mm slump =186{(6/100)186} = **197lit.**

STEP III- CEMENT CONTENT

W/C ratio = 0.55 Cement content= (197/0.55)

= **358.18 Kg/m³** > 300Kg/m³ (O.K.)

STEP IV- PROPORTION OF VOLUME OF CRUSHED AGGT. AND FINE A Volume of crushed aggt. = 0.60For W/C ratio = 0.50

Therefore, for 0.55 W/C ratio volume of crushed aggt. = 0.59

Volume of fine aggt. = 1- 0.59 = 0.41

STEP V- MIX CALCULATIONS

a) Volume of concrete = **1 m³**
b) Volume of cement = {(358.18/3.15)x (1/1000)}**= 0.113 m³**
c) Volume of water = {(197/1) x (1/1000)}**= 0.197 m³**
d) Volume of all in aggt. = 1-(0.197+0.113) **= 0.690 m3**
e) Mass of fine aggt.

=0.690x0.41x2.95x1000**=834.56Kg/m3**

f) Mass of coarse aggt. = 0.690 x 0.59 x 2.22 x1000 **= 903.76 Kg/m³**

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4.2 MIX PROPORTIONS:

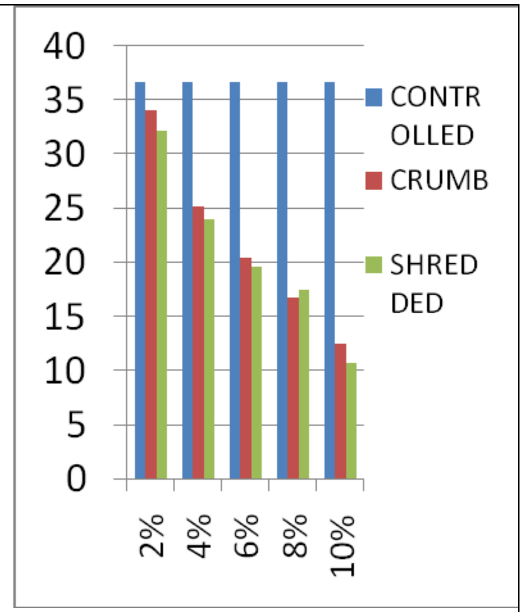
WATER (Lit.)	CEMENT (Kg)	ARTIFICIAL SAND (Kg)	CRUSHED AGGREGATE (Kg)
197	**358.18**	**834.56**	**903.76**
0.55	**1**	**2.33**	**2.52**

V. RESULT

Table and graph: FLEXURAL STRENGTH

SR.NO	% of replacement	Crumb rubber	Shredded rubber
1	Control mix	5.28	5.28
2	2%	3.92	4.54
3	4%	3.36	3.56
4	6%	2.83	2.83
5	8%	2.03	1.56
6	10%	1.11	0.78

Compressive Strength

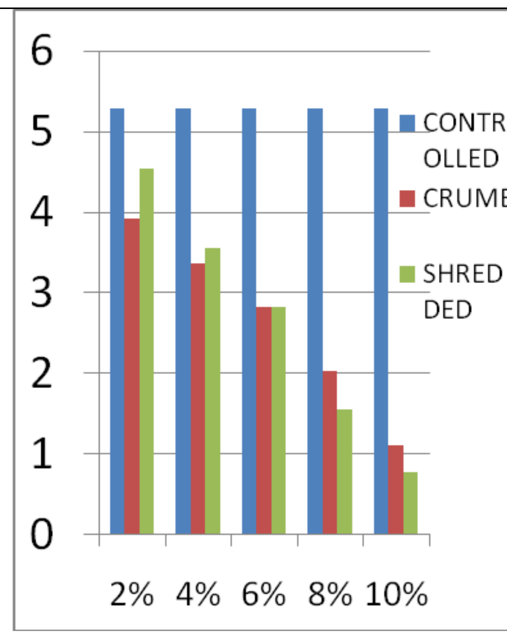


% replacement of rubber

Table and chart: COMPRASSIVE STRENGTH

SR.NO	% of replacement	Crumb rubber	Shredded rubber
1	Control mix	36.7	36.7
2	2%	34.7	32.15
3	4%	25.18	24
4	6%	20.43	19.7
5	8%	16.8	17.55
6	10%	12.60	10.8

Compressive Strength



Comparison of Mix – flexural Strength

VI. CONCLUSIONS

1. The test results show that the use of rubber aggregate in concrete mixes produces a significant reduction in concrete compressive strength which increases with increasing rubber aggregate content. However, if the amount of rubber in the concrete is limited (2% in the project), a normal strength concrete can still be produced.
2. Properties of shredded rubber as compared to the artificial fine aggregate or Conventional coarse aggregate are not very encouraging. However an attempt to use them in concrete as percentage replacement can be done.
3. In the present study, slump is not obtained for the mix. A trend of buckling can also be viewed. However as contrast to the specifications given by IS 10262:2009, all the mixes were easy to work with. It was found that rubberized concrete mixes did not pose any difficulties in term of finishing, casting, or placement, and that a good quality finish can be achieved although additional effort is required to smooth the finish surface. However, increasing the rubber aggregate content reduces the workability of the mix.
4. A typical pattern of failure was also observed in blocks and beams wherein two separate halves were not seen as expected. The interlocking fibers of rubber could held the halves together & avoid flexural cracking. The results also showed an enhancement of concrete flexural strength which could be beneficial in some applications.

5. As seen in table and figures 6.6.1 to 6.6.4 increase in crumb rubber and shredded rubber content in the mix resulted in decrease in unit weight of mixtures. However despite in the decrease in the unit weight of the mix due to lower unit weight of the rubber, the unit weight remained within the acceptable range for the total aggregate volume.

6. The cost analysis shows that with 2 percentage replacements by crumb rubber increases the cost of concrete with 3.10% and by shredded rubber the percentage increase in cost is about 3.25%. From present study it is not feasible to go with such small percentage of replacement as it results in increment in cost of concrete. In future there may be wide scope for study with some chemicals and if possibly increase in strength will reduce the cost by higher percentage

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