INVESTIGATION OF CRUMB RUBBER PARTIALLY REPLACED WITH COARSE AGGREGATE IN CONCRETE

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ABSTRACT: In this paper investigation of crumb rubber partially replaced with coarse aggregate in concrete is done. The main intent of this study is to analyse the concrete by applying various properties of crumb rubber. In the concrete mix replacement of crumb rubber is done over aggregates. By using the scraps of tyres preparation of crumb rubber is done. There is reduction in the environment pollution and cost of structure because of replacement over coarse aggregates. Depend on the Indian Standards compression strength and flexural strength tests were conducted based on the evaluation of various combinations of crumb rubber with traditional coarse aggregate. Workability of concrete is determined when tests are carried out. Compared with ordinary mixes, treated concrete is more effective. Hence in concrete mix 0.5% and 1.00% of crumb rubber of 20mm size is replaced as coarse aggregate. Coarse aggregate replacement is done with same percentages (0.5% and 1% treated crumb rubber) by Reinforced concrete. To investigate the behavior of untreated Crumb Rubber Concrete and optimized treated Crumb Rubber Concrete, mixes are compared with traditional concrete mix. Hence in construction, study the behavior of CRC and multi-layers concrete beams is done to carry out the Analysis of Reinforced Concrete (RC) beams.

KEY WORDS: Reinforced Concrete (RC), Crumb Rubber Concrete (CRC), Concrete, Coarse Aggregate, Crumb Rubber (CR).

I.INTRODUCTION

The most challenging field in present generation is waste material management from industrial growth. There is huge environmental impact. There is shortage of construction material because of rapid growth in the field of construction. Hence for the purpose of construction another material is utilized. Based on the scrumb tyre crumb rubber is obtained which is also known as a waste material. Natural aggregate depletion is prevented with the help of fine aggregate. Environmental problems are mostly avoided. Degradable and non degradable categories are obtained from the developmental procedures. These developmental procedures consists of a lot of waste [1].

In the world most widely used building material is concrete with annual consumption of 12.6 billion which is based on the natural resources. So this research has selected that was based on

concrete and this research is about rubber concrete. Materials used were cement, fine aggregate, coarse aggregate, rubber powder, fly ash, glass fiber, super plasticizer. Hence in this research it is aimed to study effectiveness of rubber as substitute of fine aggregate and Utilization of Fly ash & Glass fiber were included for economical and increasing the strength of the concrete [2].

In the formative methods a ton of waste is being delivered in which there lies two classifications degradable and non-degradable methods. While the elastic tires falls in the non-degradable classification hence they can't be disintegrated without any problem. Individuals anyway attempt to disintegrate this material by unloading them in the ground yet this technique turns out just for a restricted term at some point they emerge from the landfills and get on the highest point of the outer layer of land while certain individuals attempt to decay them by consuming which is even most terrible as they produce a ton of carbon while consuming this brings about the expanded air contamination [3]. So it is smarter to put them for the reuse, one of the most outstanding method for reusing them by involving them in development ventures as a structure material. They can be blended with cement to fabricate different designs which will make the removal of elastic tires simple as well as useful.
Based on the automotive and truck scrap tires, crumb rubber is recycled in the field of automotive. Based on the granular consistency, in tire rubber, steel and fluff is removed from the process of recycling. Particle size is reduced from the process of granulator in the cracker mill with the aid of cryogenics or mechanical [4]. Depend on the color (black or white) the particle size is classified [5].

The below shows the objectives of the study:

- To study the strength developments hardened concrete with waste Rubber tyre crumb.
- To determine the effect of various percentage of waste rubber tyre crumb as partial coarse.
- The main object of investigation is to study the strength behaviors of crumb rubber concrete with economical basis.
- Partially replacement of cement.
- To investigate the use of crumb rubber in conventional concrete.
- Find The Split Tensile strength of concrete cylinder
- Find The Flexural strength of concrete beam.
- Comparisons of all the above resultswith Conventional concrete

II. LITERATURE SURVEY

O. Youssf & M. A. ElGawady.et.al [6]

Rubber treated concrete is a traditional cement including scrap tire elastic as a halfway replacement for mineral totals. Utilizing reused tire elastic in substantial development will lessen how much broken down tires that are being discarded to landfill destinations. This composition talks about the qualities of new and solidified rubber treated concrete. Specifically, the impacts of elastic substance and size on substantial unit weight, droop, ensnared air, compressive strength, parting rigidity, modulus of crack, and modulus of flexibility, extreme strain, and gooey damping proportion are examined. This survey uncovered that analysts supplanted various proportions, went from 5 to 100 percent, by volume of mineral fine total or potentially mineral coarse total with elastic. Such substitution brought about strength misfortunes went from 0.0 to 85% relying upon the size of elastic particles and the elastic substance. Involving synthetic

medicines for elastic prior to blending in concrete fundamentally work on the substantial mechanical attributes. At last, expanding the elastic substance brought about additional damping proportion contrasted with regular cement. Rubber treated concrete had the option to arrive at an extreme strain and gooey damping proportion 16 and 120% higher than customary cement, separately.

Ahmed N. Bdour and Yahia A. Alkhalayleh.et.al [7]

More than 2.5 million piece tires are delivered in Jordan every year. Furthermore, multiple million tires are at present stored all through the country. However, just a single organization has been laid out in the country for the reusing, recuperation and reuse of scrap-tires. Presently, this industry is confronting many difficulties because of absence of help and sponsorships from the public authority. Numerous specialists have researched the utilization of reused tire items in a few customary structural designing materials. This examination is investigating the utilization of steel ropes, a side-effect of the tire reusing process, in substantial blends. Different substantial examples were created and tried in un-axial pressure and parting elasticity.

El-Gammel, A.K.Abdel-Gawad, Y.El Sharbini, A.Shalaby [8]

Waste Tyre elastic is one of the huge ecological issues around the world. With the expansion in the car creation, immense measures of waste tire should be arranged. Because of the quick exhaustion of accessible locales for garbage removal, numerous nations restricted the removal of waste tire elastic in landfills. The consequences of this research shows that despite the fact that, there was a critical decrement in the compressive strength of cement using waste tire elastic than ordinary concrete, concrete using waste tire elastic exhibited a malleable, plastic disappointment as opposed to weak disappointment.

PitiSukontasukkul.et.al [9]

In this review, the thermal and sound properties of piece of elastic substantial board were explored. The scrap elastic from utilized tires, delivered in a nearby reusing plant, was utilized to supplant fine total at proportions of 10%, 20% and 30%. Properties, for example, warm conductivity, warm resistivity, heat move, conductance esteem, sound ingestion at various recurrence and sound decrease were explored. Results showed that scrap elastic substantial board was lighter as well as had higher sound ingestion and lower heat move properties than the regular substantial board.

Radley J. Putman, Serji N Amirshanian.et.al [10]

Crumb rubber has been utilized to upgrade the presentation of hot blend black-top faults since the 1960s by working on the rheological properties of the Crumb Rubber Modified (CRM) folios. A few scientists have recognized the CRM-folio cooperation as dispersion of the lighter fastener portions into the CRM particles. This actual collaboration is depend on two properties: (1) the elastic particles swell and (2) the thickness of the fastener network builds because of expulsion of a piece of the slick portion. While this cooperation has been the significant thought with CRM covers, the impact of the CRM particles going about as fillers has not gotten a lot of consideration. This examination brought about a technique to evaluate both the Interaction Effect (IE) And Particle Effect (PE) of CRM, which add to the expanded rheological properties of CRM fasteners. These impacts were resolved utilizing a rotational viscometer and a Dynamic Shear Rheometer (DSR) to gauge the rheological properties of CRM folios created with three sizes of CRM, two morsel elastic handling strategies (surrounding and cryogenic crushing), two CRM

items, and three cover sources. It was presumed that fastener source essentially affected the IE, trailed by CRM content. The PE was most fundamentally impacted by the CRM content, trailed by the CRM molecule size.

III. STUDY OF MATERIALS

The materials that used in the study are

1) Cement
2) Fine aggregate
3) Coarse aggregate
4) Water
5) Crumb rubber

1) Cement:

Ordinary Portland Cement (OPC) is the essential Portland concrete and is the most ideal for use in everyday substantial development. It is of three kinds 33 grades, 43grade, 53 grade. One of the significant advantages is the quicker pace of improvement of solidarity. Concrete is a fine, dark powder. It is blended with water and materials like sand, rock, and squashed stone to make concrete. The concrete and water structured as glue that binds different materials together as the substantial solidifies. In the current work, 53 grade concrete was utilized for test. Concrete is a usually involved restricting material in the development. The concrete is gotten by consuming a combination of calcareous (calcium) and argillaceous (clay) material concrete at an extremely high temperature and afterward crushing the clinker is created to a fine powder. It was first created by a bricklayer Joseph Aspdin in Britain in 1924. In this trial Standard Portland concrete was utilized and its particular gravity is 3.1.

Fig. 1: ORDINARY PORTLAND CEMENT

2) Fine Aggregates:

Among different attributes, the main one is its reviewing coarse sand might be liked as fine sand builds the water interest of cement and extremely fine sand may not be fundamental as it is normally has bigger substance of slight particles as concrete. The sand particles ought to likewise pack to give least void proportion, higher voids content prompts prerequisite of really mixing water.

Fig. 2: FINE AGGREGATE

3) Coarse aggregate:

In the entire experimental work mainly Crush stone aggregate is used based on the sizes of 20

mm and 12.5 mm. 20mm Coarse aggregate was used with 2.912 specific gravity and 12.5 mm Coarse aggregate was used with 2.9 specific gravity.

Fig. 3: COARSE AGGREGATE

4) Water:

Water is a significant element of concrete as it effectively takes part in the substance responses with concrete. The strength of concrete substantial comes predominantly from the limiting activity of the hydration of concrete get the necessity of water ought to be decreased from necessary synthetic response of un-hydrated concrete as the over abundance water would wind up in just development voids or vessels in the solidified concrete glue in concrete. Aside from the strength thought the sturdiness attributes like porosity, level of protection from dissemination of CO_2, $CaSO_4$, mositure, air oxygen, and so it is examined after determination of relieving period.

5) Crumb Rubber:

In complex engineering products are utilized as tyres. Based on the various types of rubber compounds tyres are made. Not only rubber compounds but also they utilize chemicals, clay and silica and minerals. This will permit or accelerate vulcanization while making tyres. Hence in the innovative construction industries waste matter is utilized as rubber tyres in present generation.

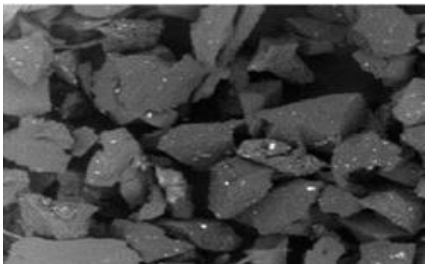

Fig. 4: CRUMB RUBBER

IV. MIX DESIGN FOR M20 GRADE

Details of materials:

1. Grade of concrete- M20
2. Type of cement – OPC 53 grade
3. Maximum nominal size of aggregate – 20mm
4. Exposure condition – Severe
5. Degree of Supervision – good
6. Type of aggregate- Angular aggregate

Test data materials:

1. Specific gravity of cement – 3.1
2. Specific gravity of sand – 2.7

3. Specific gravity of coarse aggregate- 2.9
4. Specific gravity of rubber- 1.2

Sieve analysis:

1. Sand- conforming to zone-III
2. Aggregate 20mm nominal size

V. RESULTS AND DISCUSSION

Concrete is a mixture of cement, fine aggregate, coarse aggregate and water. Normally concrete is strong in compression and weak in tension. In the design of concrete structures, engineers usually refer to the hardened state properties like compression strength, flexural strength, and split tensile strength of concrete.

1. Compressive strength
2. Flexural strength
3. Split tensile strength

1. Compressive Strength:

Table. 1: COMPRESSIVE STRENGTH

Material	Compressive strength(7 days)	Compressive strength(28 days)
Nominal mix	27.96	42.79
0.5% Rubber	25.18	41.52
1% Rubber	28.29	42.9

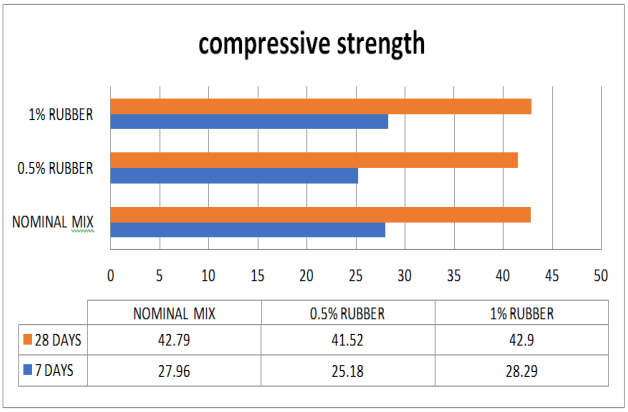

Fig. 5: COMPRESSIVE STRENGTH

Fig. 6: COMPRESSIVE TEST

2. Flexural strength:

Bend strength, modulus of rupture and transverse rupture is also known as Flexural strength. Flexural strength is defined as the material property where the stress in material is yield in flexural test. Higher stress is experienced in flexural strength. Flexural strength is mainly measured in terms of stress. Based on the standards of IS Code 516-1959 Flexural strength of specimen was conducted.

Table. 2: FLEXURAL STRENGTH

Material	Length Of Crack	Flexural Strength
Nominal mix	27.5	7.07
0.5% Rubber	25	7.7
1% Rubber	22	8.04

3. Split tensile strength:

Based on the IS Code 516-1999, Split tensile test was conducted. Because of the brittle nature, tension is very weak in concrete. Hence direct tension is not accepted and resisted in concrete. When it is applied to tensile forces cracks are developed in concrete. Concrete members may crack when load and tensile strength is determined. The main intent is to determine the tensile strength of concrete based on concrete cylinder. Hence split tensile strength is given in below equation:

Split Tensile strength (MPa) = 2P / DL.

Table. 3: SPLIT TENSILE STRENGTH

Material	Failure load (KN)	Split Tensile Strength Of Cylinder (N/mm^2)
Nominal mix	215	3.04
0.5% Rubber	230	3.24
1% Rubber	2850	3.49

Fig. 7: SPLIT TENSILE TEST

Fresh properties of conventional concrete

Slump= 75mm

Compaction Factor= 0.92

- **HARDENED PROPERTIES**

Cubes

Compressive strength of concrete for nominal mix (for 7 days) = 28.5 N/mm^2

Compressive strength of concrete for nominal mix (for 28 days) = 42.66 N/mm^2

Cylinders

Split tensile strength for nominal mix = 3.256 N/mm^2

Beam

Flexural strength of beam = 7.58

- **FRESH PROPERTIES OF RUBBERIZED CONCRETE**

For crumb rubber,

Slump= 50mm

Compaction Factor= 0.97

Compressive strength of 0.5% crumb rubber = 41.52N/mm^2

Compressive strength of 1% crumb rubber = 42.81 N/mm^2

VI. CONCLUSION

Below shows the conclusions for crumb rubber partially replaced with coarse aggregate in concrete:

1. Unit weight and Slump are the properties of Fresh concrete which is decreased with the higher replacement levels of rubber
2. After 35% compressive strength is significantly reduced because of increase in rubber content.
3. The rubber is eco-friendly with environment and to be used in the concrete by saving area which is great potential.
4. Transport of heat is prevented by creating discreet thermal insulation based on the air and rubber combined action. Thermal conductivity is increased when these properties are analysed in relation with density and there is reduction of its porosity.
5. There is lower compressive strength compared to the normal condition for rubber concrete which is based on the resistance of Sulphatic attack.

VII.REFERENCES

[1] S.Selvakumar and R.Venkatakrishnaiah (2015) "strength properties of concrete using crumb rubber with partial replacement of fine aggregate", International journal ofInnovation Research in Science, engineering and Technology"Vol. 4, Issue 3, March 2015

[2] Alan Richard Son, Kathryn Coventry, Eli Dias,(2015)'Rubber Crumb used in Concrete to provide Freeze Thaw Protection'Proceeding of EURO ELECS, pp. 1 - 12.

[3] Nitiya P and Portchejian G (2014), "Behaviour of Partial Replacement of Fine Aggregate with Crumb Rubber Concrete", International Journal Of Structure and Civil Engineering Research, Vol.3, No.3, August 2014

[4] Harpalsinh Raol. Abhijit Sinh Parmar, Dhaval Patel, Jitendra Jasswah,(2014)'Effect of the use of Crumb rubber in Conventional Bitumen on the marshall Stability value' International Journal of Research in Engineering and Technology, Vol. 3, Issue .1, pp. 209 – 212.

[5] Nabin Rana Magar,(2014), "Study on the performance of Crumb rubber modified Bitumen by varying the size of Crumb rubber", International Journal of Engineering Trends and Technology, Vol. 14, No.2, pp. 50 – 56.

[6] O. Youssf & M. A. ElGawady, "An overview of sustainable concrete made with scrap rubber", a conference paper, 2012

[7] Ahmed n. Bdour and Yahia A. Alkhalayleh "Innovation Application of Scrap-tire Steel Cords in Concrete Mixes" Jordan Journal of Civil Engineering, Volume 4, No. 1, 2010

[8] El-Gammel.A, A.K.Abdel-Gawad, Y.El Sharbini ,A.Shalaby,(2010)'Compressive Strength of

Concrete utilizing Waste Tyre Rubber', International Journal of Engineering Trends and Technology,1 (1), pp. 96 – 99

[9] PitiSukontasukkul "Use of crumb rubber to improve thermal and sound properties of pre-cast concrete panel", Construction and Buildings 23 (2008)084- 1092.

[10] Radley J. Putman, Serji N. Amirshanian, (2006)'Crumb Rubber modification of Binders Interaction and Practice Effect Road materials and Pavement Design, Vol. 10, No. 10, pp. 1 – 23

[11] Mohammed Reza Sahrabi, Mohammed karbalaie,(2004), "An Experimental Study on compressive strength of concrete containing crumb rubber", International Journal of Civil and Environmental Engineering, Vol. 11, No. 3, pp. 23 – 27.

[12] Bradley J. Putman, Jesse U. Thomson, Serjin,(2002)'High Temperature Properties of Crumb Rubber Modified Binder'Asphalt Rubber Technology, pp. 1 – 9.