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Improving the Compressive Strength of Rubber Modified Concrete Using Synthetic Resin

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ABSTRACT

It has been realized that the generation of solid waste and the disposal problem related to it is a standout amongst the most vital issues which our human progress is confronting in present era. The generation of non-biodegradable and hazardous waste alongside the consumer population growth has brought waste disposal crisis. Solid waste can be arranged into various sorts relying upon their source: a) Household, b) Industrial (toxic and hazardous) and c) Bio-medical (infectious), Among industrial wastes, the tyre rubber wastes or scrap tyres are one of the hazardous wastes which are being generated and accumulated on very large scale worldwide every year. India's waste tyres represent around 6-7% of the worldwide aggregate. The waste rubber tyres in India are rising with the 12% per annum growth in the local tyre industry. At global scale a lot of research has been carried out on the use of waste rubber tyres in concrete. Countries like USA and France has made it mandatory to utilize crumb rubber in highway construction. The rubberized concrete was first introduced and checked for its application in engineering works in early 1990s .Waste rubber tyres can be incorporated..

Introduction

At global scale a lot of research has been carried out on the use of waste rubber tyres in concrete . Countries like USA and France has made it mandatory to utilise crumb rubber in highway construction. The rubberized concrete was first introduced and checked for its application in engineering works in early 1990s .Waste rubber tyres can be incorporated. in concrete either as coarse aggregates or fine aggregates. Waste rubber aggregates have been categorized in to four types based upon their particle size. This includes, 1) shredded fibers, 2) shredded/chipped tyres (approximately 2 to 20mm), 3) ground rubber (100% passing 0.425mm), and 4) crumb rubber (4.75-0.425mm). Crumb waste rubber is a material derived by reducing/shredding scrap tires or other rubber into uniform granules. The source of scrap tyres are: passenger car tires, truck tires and off-the-road tires. On average, about 10 to 12 pounds of waste crumb rubber can be manufactured from one passenger tire. Overall, a typical scrap/waste tire consist (by weight); 1) 70 % recoverable rubber, 2) 15 % steel, 3) 3 % fibre, and 4) 12 % extraneous material like inert fillers

Crumb rubber properties

a) Moisture absorption: rubber tyre aggregates has good resistance to water absorption.

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b) Thermal Insulation: Waste rubber aggregates provide high thermal insulation than natural soil or aggregate.
c) Acoustic Insulation: Waste rubber tyre aggregates have high sound insulation.
d) Density: It has low density as compared to natural aggregates thus imparting light weight characteristic to the concrete.

Application of rubberised cement concrete

Extensive investigations and studies have been done in the field of rubberized concrete and its application in the construction activities as a green material. Rubberized concrete can find its successful application in non-structural components such as:-

1. crash barriers, pavement blocks,
2. Sidewalks,
3. Culverts in road construction,
4. Precast roofs for green buildings and roofing tiles with lighter weight.

Improvement of rubber modified concrete

Almost all of the Previous investigations and researches shows that the partial replacement of natural aggregates (fine or coarse)with the waste rubber tyre particles have negative impact on the mechanical properties of the concrete. It was found that there is a significant reduction in the compressive strength and tensile strength of rubber concrete with the increasing tyre content; moreover, significant loss of static stiffness was reported. Therefore, the percentage of waste tyre into the concrete should be limited and optimized. This reduction in strength of rubberized concrete may occur due to different reasons as investigated by experts, such as:-

1) high difference in specific gravity of waste rubber aggregate and other constituent materials of concrete,
2) Compaction of rubber modified concrete without special care, causing effecting cohesiveness and homogeneity of the mix,
3) Rubber particles when introduced in concrete entraps air due to its hydrophobic nature, causing increase in air content, this leads to the reduction of concrete strength and decrease in unit weight
4) Difference between the elastic modulus of rubber and other constituent materials of concrete causes loss of strength,
5) Low adhesion or week bond between the cement matrix and the rubber particles, which results in the acceleration of crack propagation through rubber-cement paste interface, when load acts upon the concrete
6) Rubber aggregates are more softer than natural aggregates, thus reducing the rubber concrete stiffness.

Proposed work

Based on the above discussion the proposed work is "IMPROVING THE COMPRESSIVE STRENGTH OF RUBBER MODIFIED CONCRETE USING SYNTHETIC RESIN".
The study is proposed to be conducted in respect of the following parameters:
1) Bulk Density,
2) Workability,
3) Compressive strength and
4) Split Tensile Strength

Objectives of the study

In the view of gaps identified, the objectives of the present research work are as follows:

- To design a concrete mix in accordance to IS 10262:2009 for developing the reference concrete of M35 grade.
- To develop rubberized concrete mix samples by replacing the fine aggregate (sand) with untreated and treated (with synthetic resin) crumb rubber as aggregate at different percentages.

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- To determine the density and slump of rubber modified concrete mix samples having different crumb rubber content.
- To determine the compressive strength for untreated and treated rubber modified concrete.
- To suggest the optimum dosage of crumb rubber aggregates both treated and untreated based on laboratory test results obtained; and draw conclusions for field application

Research methodology

To study the effect of pre-treatment of crumb rubber aggregates with synthetic resin on the strength performance of rubber modified concrete and suggests the optimum dosage of crumb rubber in concrete the research methodology to be proposed by the researcher is as shown in the following steps:-

1. M35 Grade concrete mix design as proposed for control concrete based on "Indian Standard Concrete Mix Proportioning (IS 10262: 2009)" was designed using available natural aggregates.
2. Ordinary Portland cement was used as binder in all the concrete mixes.
3. Crumb rubber tyre aggregates replacing the fine aggregates (sand) in 0, 5, 10 and 15 % by weight were proposed by the researcher to develop different rubber modified concrete mix groups.
4. Compressive and split tensile strength of untreated rubber modified concrete samples having different crumb rubber content was found out.
5. Pre-treatment of crumb rubber aggregates with synthetic resins was done and treated rubber modified concrete mix were prepared at different replacement levels of crumb rubber as specified above.

Experimental programme

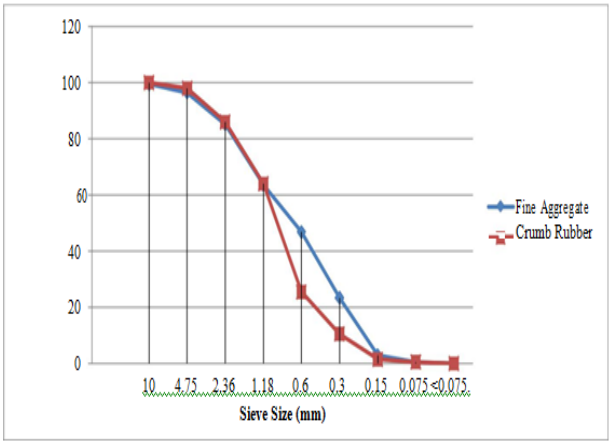
A. Physical Properties of Crumb Rubber

Properties	Test Result
Specific Gravity	1.15
Finess Modulus	3.14
Water Absorption	0.89%

B. Sieve Analysis of Crumb Rubber

IS Sieve Size	Percentage Weight Retained (gm)	Percentage Weight Retained	Cumulative Percent Weight Retained	Percent Passing
10 mm	0	0	0	100
4.75 mm	4	2	2	98
2.36 mm	24	12	14	86
1.18 mm	44	22	36	64
600 Mic	77	38.5	74.5	25.5
300 Mic.	30	15	89.5	10.5
150 Mic.	18	9	98.5	1.5
75 Mic.	2	1	99.5	0.5
<75 Mic.	1	0.5	100	0

*Based on the data obtained from sieve analysis of Crusher sand and crumb rubber, particle size distribution curve has been generated which has been shown



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C. Bulk Density for rubber modified concrete mix

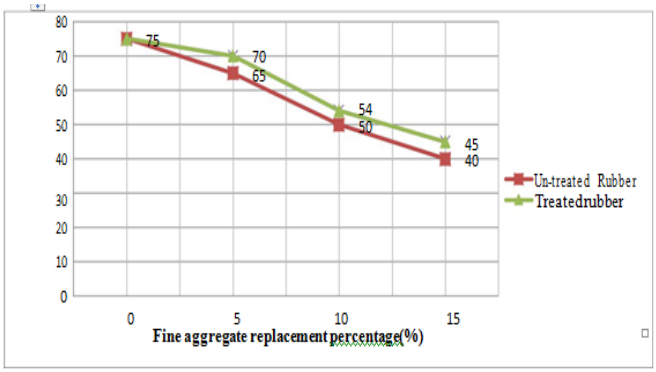
Mix Group Untreated / Treated	Crumb Rubber Replacement (%)	Bulk Density(Kg/m3) Untreated / Treated
C	0	2466
CR5 / TCR5	5	2322.59 / 2322.61
CR10 / TCR10	10	2236.58 / 2236.60
CR15 / TCR15	15	2134.40 / 2134.43
CR15 / TCR15	15	2134.40 2134.43

Results and discussion

A. Effect on Bulk Density

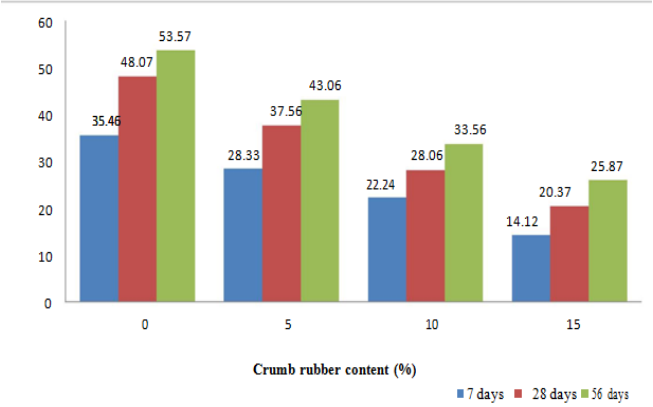
From figure, it can be observed that the reduction in bulk density was increased with the increase in the replacement percentage level. Moreover, for both untreated and treated rubber modified concrete mix the bulk density was approximately same

B. Effect on Workability



From the above Figure, it can be seen that the increment in the content of crumb rubber (treated / un-treated) in concrete mix caused the decrease in the concrete slump.

C. Effect on Compressive strength



The above figure shows the variation in compressive strength The reduction in compressive strength increased with the increase in percentage replacement of fine aggregate with crumb rubber.

Conclusion

A. Replacement of fine aggregate with untreated / treated crumb rubber aggregate by 5, 10 and 15 % weight of fine aggregate in normal concrete resulted in decline of bulk density of concrete mix by approximately 5%, 9.30 % and 13.44% respectively in both the cases.

B. With the increase in untreated / treated crumb rubber aggregate content in the concrete mix, workability decreases. However, the loss of slump in treated rubber modified concrete mix at all replacement levels was slightly less than untreated rubber modified concrete mix. Workable mix was achieved at 5, 10 and 15 % replacement; but both untreated and treated rubber modified concrete mix became little harsh at 15 % replacement level.

C. The strength parameters such as compressive and split tensile strength showed decline in their value when untreated / treated crumb rubber particles

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were added. Reduction in strength increased with increase in the percentage replacement of fine aggregate with crumb rubber particles.

Scope for future work

1. Study of effect of surface pre-treatment with synthetic resin on hydration of cement and durability of rubber modified concrete.
2. Exploring other chemicals for pre-treatment and comparing the results with present study.
3. Studying the effect of using coarse aggregate or coarse + fine aggregates which are pre-treated with synthetic resin, on fresh and hardened properties; and comparing the same with the present research.

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