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Effect of Partial Replacement of Coarse Aggregates in Concrete by Waste Tyre Rubber Aggregates with NAOH Solution in Rigid Pavements

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ABSTRACT- This study was intended to research the partial replacement of coarse aggregate with shredded rubber. The rubber used in the study was kept in three conditions. The shredded rubber was either untreated, treated with NAOH and treated with cement paste before being used in concrete. M20 mix of concrete was used in this study. The compressive strength, flexural strength and split tensile strength of concrete after 28 days of curing for replacement of rubber in the percentages of 5%,10% and 15% was done. The results show that there is a decrease in workability as the percentage of rubber is increased for all of the conditions of the shredded rubber treatment. The compressive strength test result show that there is a decrease in strength as the percentage of rubber is increased. However, when treated rubber is introduced the value of compressive strength improves. The flexural strength test results show that the maximum value of flexural strength is obtained at 5% replacement of rubber for treatment with NAOH. The results indicate that treated rubber specimens have more flexural strength when compared with the values of untreated rubber specimens. The split tensile strength shows that the value of split tensile is maximum for 15% replacement of rubber and for treatment with NAOH. The value of split tensile decreases as the percentage of rubber is increased however an improvement is seen as treated rubber is used to replace coarse aggregate.

KEYWORDS- Coarse Aggregate, Waste Tyre Rubber Aggregates,NAOH Solution, Rigid Pavements

I. INTRODUCTION

Concrete is one of the most commonly and continually used construction materials in the world, with cement and aggregates being the most important elements [1]. Furthermore, these aggregates have traditionally been viewed as inert filler in concrete, however aggregates are not truly inert, as their physical, thermal, and sometimes chemical qualities influence the concrete [2]. Because of the high demand for concrete as a construction material in society, it is necessary to protect natural coarse aggregates by employing alternative materials derived from recycled or waste materials [3].

The usage of waste tires or used tires of automobiles has long been a major environmental issue in Western countries, but as a result of modernization and industrialization, this problem is also being felt in various Asian countries, particularly India and China. India has begun to combat this threat, albeit slowly and ineffectively in comparison to its western peers [4].

As India transitions from a developing to a developed country, the number of vehicles on the road per year is rapidly increasing, as is the quantity of tyres [5]. An increase in the number of tyres manufactured or used per year results in an increase in the number of waste tyres created at the end of the year, which results in an increase in the number of landfills or seashores that are hazardous to the environment. Burning these tyres is also not suggested due to the formation of a variety of harmful gases, which is still another major environmental issue [6]. Due to rising automotive production, the tyre business in India has grown by roughly 12% during the last five fiscal years, from 2010 to 2015. This increase is thought to be very positive for the nation's economy and industrialization, but from an environmental standpoint, it has been viewed as a challenge and a growing concern.

Different areas for the use of recycled tyre rubber have been identified from time to time, and much research is being conducted for its better use, but due to the unique physical and chemical properties of rubber, as well as the quantity produced, it is extremely difficult to use it entirely in a specific area or field [7].

Construction is one of the applications of leftover tyre rubber to solve its environmental concern. It has demonstrated significant promise in the building business, where it can be employed with cement concrete pavements. Several studies have been undertaken to successfully use leftover rubber in concrete, with encouraging results. Certain qualities of rubber, such as greater flexibility and light weight, are thought to be the primary reasons for its increasing use in the building sector. Waste rubber has been effectively used as an aggregate replacement in cement construction [8]. We substituted some of the typical coarse aggregates with shredded rubber aggregates produced by cutting worn tyres out of concern for the environment and to save natural rock aggregates.

II. OBJECTIVES

- The main purpose of this study is to examine the effect of addition of shredded rubber aggregates into the Portland cement concrete in three different proportions i.e., 5%, 10% and 15% by mass of coarse aggregates

and evaluate the initial and final setting time of rubberized concrete properties.
- Another objective of this experimental study is to investigate the effect of surface treatment of rubber on various properties of rubberized concrete. Two different treatments will be given to the rubber aggregates.
- Treatment by coating the rubber aggregates with cement paste.
- Treated by washing the rubber aggregates with NaOH solution.
- To prepare lightweight concrete by using waste rubber as partial replacement of coarse aggregate.
- Utilization of waste rubber in the concrete construction sector, hence eliminating the need of land fill disposal of this non-bio-degradable waste.

III. LITERATURE REVIEW

A. Waste Tyre Rubber

Waste rubber tyres are one of the most serious environmental issues facing the globe today. As automobile production increases, massive amounts of waste tyres must be disposed of. Many nations have outlawed the disposal of waste rubber tyres in landfills due to the rapid depletion of accessible waste disposal sites.

B. Waste Tyre Rubber Use in Construction

Waste tyres have been utilised to supplement aggregates in concrete. Rubberized concrete has low compressive and tensile strengths. They do, however, have excellent deformation properties. The set deformations of concrete containing tyre rubber waste are greater than those of non-rubberized concrete. Concrete with tyre rubber waste admixture has higher ultimate strains on failure load. As a result, rubberized concrete has a great impact resistance.

IV. MATERIAL & METHODOLOGY

A. Cement

The cement utilized was obtained from a local Khyber Cement Vendor, is of OPC 43 grade and can be seen in figure 1,with a consistency (P) of 27%. With a specific gravity of 3.15, the first setting time is 39 minutes and the final setting time is 586 minutes.

Figure 1: Cement

B. Aggregate

The coarse aggregate was brought from a local crusher facility in Lasjan, Srinagar,as can be seen in figure 2 and the fine aggregate river sand was purchased from the same location from a local seller with a fineness modulus of 2.49, according to Zone II.

Figure 2: Aggregates

C. Water

The water used for testing and curing was drawn from a n earby faucet. In this project, the w/c ratio is held constant at 0.39.

D. Tyre Rubber

For this Project the tyre rubber was collected from a local garage in the Karan Nagar area Srinagar jammu and Kashmir as can be seen in figure 3.
The rubber thus produced was reduced to a size comparab le to coarse aggregate.In the workshop, the resulting rubber was manually chopped do wn to get the desired particle size.

Figure 3: Waste Tyre rubber

E. Sodium Hydroxide (NAOH)

For this Project the Sodium hydroxide was ordered from India mart and can be seen in figure 4. The color and texture of sodium Hydroxide.

Figure 4: Sodium Hydroxide

F. Test Procedure

Table 1: Test Procedure

STEPS	DESCRIPTION
1.	Collection of raw materials to be used which include cement, fine aggregate, coarse aggregate, rubber waste and NAOH.
2.	Proportioning concrete mix according to M 20 mix
3.	Mixing all the ingredients, keeping a water cement ratio of 0.45.
4.	Performing the workability test on concrete.
5.	Placing the concrete in cubes, cylinders and beams.
6.	The moulds are removed after 24 hours before being placed in the curing tank for 7 days and 28 days.
7.	Modifying the mix by replacing the coarse aggregate with shredded rubber.
8.	Performing the workability test on concrete before being placed in moulds.
9.	After 24 hours the moulds are removed and the specimen are placed in curing tank for 7 days and 28 days respectively.
10.	Performing the compressive strength, split tensile and flexural test after the curing periods and comparing values with that of conventional concrete.
11.	Modifying the mix by replacing the coarse aggregate with rubber which has been treated with cement paste.
12.	Performing the workability test on concrete before being placed in moulds.
13.	After 24 hours the moulds are removed and the specimen are placed in curing tank for 7 days and 28 days respectively.
14.	Performing the compressive strength, split tensile and flexural test after the curing periods and comparing values with that of conventional concrete.
15.	Modifying the mix by replacing the coarse aggregate with rubber which has been soaked in NAOH for 20 min.
16.	Performing the workability test on concrete before being placed in moulds.
17.	After 24 hours the moulds are removed and the specimen are placed in curing tank for 7 days and 28 days respectively.
18.	Performing the compressive strength, split tensile and flexural test after the curing periods and comparing values with that of conventional concrete.

V. RESULTS AND DISCUSSION

A. Slump Test

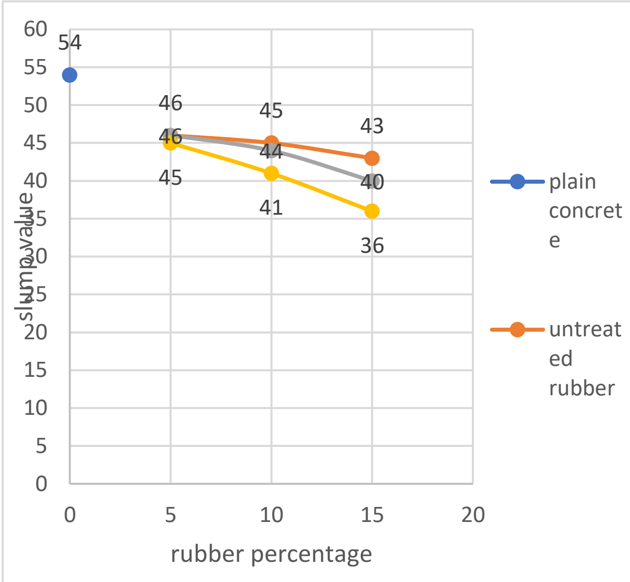

Figure 5: Slump values of different mixes of concrete

Figure 5 is plotted between the slump value and rubber percentage for concrete with untreated rubber, NAOH treated rubber, cement paste treated rubber and conventional concrete. There is a decrease in slump value as the percentage of rubber is increased.

B. Compressive Strength Test

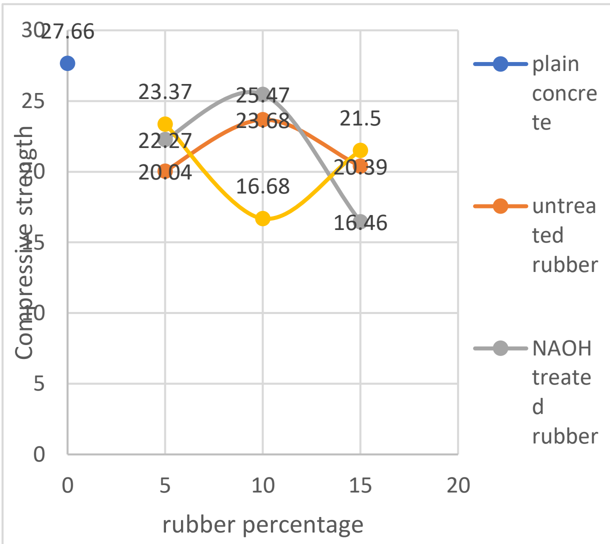

Figure 6: Compressive strength of concrete

Figure 6 is plotted between compressive strength and rubber percentage for concrete with untreated rubber, NAOH treated rubber, cement paste treated rubber and conventional concrete. The graph shows the change in compressive strength in concrete. There is a decrease in compressive strength in concrete when coarse aggregate is replaced with rubber in various percentages. For the mix with 10 % coarse aggregate replaced with NAOH treated rubber saw the least drop in compressive strength.

C. Flexural Strength Test

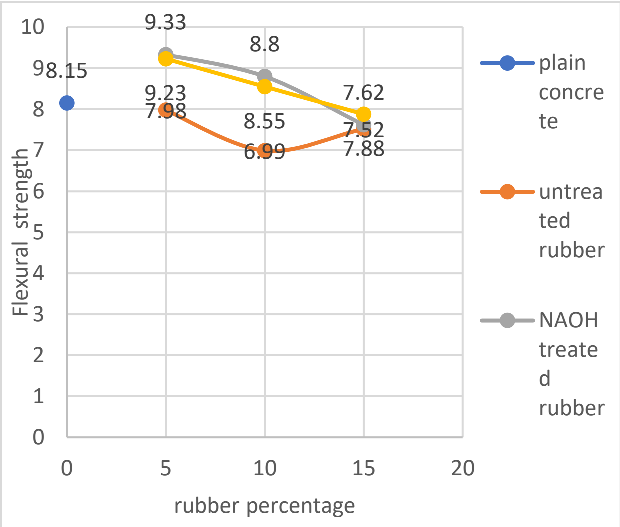

Figure 7: Flexural strength of concrete

Figure 7 is plotted between flexural strength and rubber percentage for concrete with untreated rubber, NAOH treated rubber, cement paste treated rubber and conventional concrete. The graph shows the change in flexural strength in concrete. There is an increase in compressive strength in concrete when coarse aggregate is replaced with rubber in various percentages. For the mix with 5 % coarse aggregate replaced with NAOH treated rubber and cement paste treated rubber saw the most increase in Flexural strength.

D. Split Tensile Strength Test

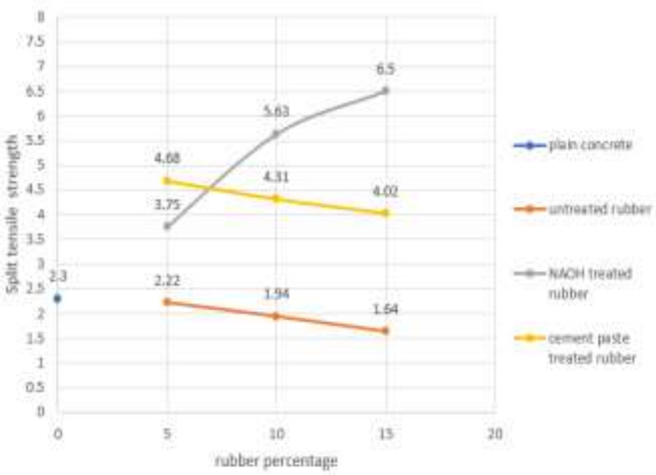

Figure 8: Split tensile strength of concrete

Figure 8 is plotted between split tensile strength and rubber percentage for concrete with untreated rubber, NAOH treated rubber, cement paste treated rubber and conventional concrete. The graph shows the change in split tensile strength in concrete. There is an increase in compressive strength in concrete when coarse aggregate is replaced with rubber in various percentages. For the mix with 15 % coarse aggregate replaced with NAOH treated rubber saw the most increase in split tensile strength.

VI. CONCLUSIONS

In this research the coarse aggregate in concrete is replaced with shredded rubber in the percentages of 5%,10% and 15%. The shredded rubber that are used are either kept untreated, treated with NAOH and treated with cement paste. The specimens of concrete are made for the various conditions of shredded rubber.

Then compressive strength, flexural strength and split tensile test were performed on the specimens. The compressive strength saw a decrease in value as the percentage of rubber in any of the three conditions was increased. The maximum value was obtained for plain concrete as 27.66 N/mm2.

Flexural strength was maximum at percentage replacement of 5% for NAOH treated shredded rubber. The value obtained was 9.33N/mm2. The value of flexural strength decreased as the percentage of rubber was increased.

Split tensile strength was maximum at percentage replacement of 15% for NAOH treated shredded rubber. The value obtained was 6.5 N/mm2.

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