Effect of Partial Replacement of Course Aggregates In Concrete by Waste Tyre Rubber Aggregates in Rigid Pavements

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Abstract— Our present study intends to explore the most effective use of the waste tyre rubber as a constituent of concrete mix replacing the coarse aggregate partially. In this research work, emphasis is given on the pre-treating of the rubber particles and then using them as the partial replacement of the conventional rock aggregates. To get the best results, the rubber aggregates used are surface treated by sodium hydroxide and cement paste before using them in the concrete.M20 grade concrete is used. Using untreated rubber aggregates, the compressive strength of the resultant concrete reduced rapidly, but when treated rubber aggregates were introduced, it resulted in the regaining of more than 90% of the 28 day compressive strength of normal concrete which can be considered quite satisfactory considering the easy and cheap availability of the used tyres and the negative impacts it can have on the environment if left unused. This much compressive strength is enough for treated-rubberized concrete for its use in different areas where compressive strength is not much important like in floors and concrete road pavements. Flexural and split tensile strength is found to be higher than that of the normal concrete but only when treatment is given to the rubber aggregates before using them. Workability is decreased. Flexibility gets increased and due to the lower unit weight of the rubber particles, it is also lighter than the normal concrete. These enhanced properties can be helpful in using this concrete in flexible slabs and as light weight concretes. Appreciable compressive strength, more flexural and split tensile strength, light weight, higher impact and toughness resistance which means prolonged and better resistance to formation of cracks, upgraded ductility, etc.

Key words: Rubber Aggregates, Rubberized Concrete, Sodium Hydroxide (NaOH), Cement Paste, Tread

I. INTRODUCTION

Use of waste tyres or used tyres of automobiles has been an inveterate environmental issue in western countries but now due to the modernization and industrialization, this problem has slowly been felt in different Asian countries especially India and China. India has at a very slow pace started to work against this menace, but not effectively when compared to its western counterparts.

As India is on its way from being a developing country to a developed country, rate of vehicles hitting the road per year is increasing very fast and so is the number of tyres. Increasing number of tyres produced or used per year means more number of waste tyres being produced at the end of that year which in turn produces more number of landfills or sea shores that are hazardous to the environment. Burning of these tyres has also not been recommended due to the production of a variety of poisonous gases which is again a big environmental problem.

In the last five fiscal years i.e. 2010 to 2015, the tyre industry in India has shown a growth of about 12% due to increased automobile production. This growth is considered to be very good for the nation's economy and from industrialization point of view but taking into consideration the environmental aspect; it has been seen as a challenge and an emerging threat.

Different areas for the use of recycled tyre rubber have been identified from time to time and a lot of research is being carried out for its better use but due to the unique physical and chemical properties of rubber, and the quantity in which it is produced, it is very difficult to use it wholly in a particular area or field. The different applications of waste tyre rubber where it has been successfully used are:

1) Sports surfaces
2) Automotive industry
3) Construction
4) Geo-technical/asphalt applications
5) Adhesives and sealants
6) Shock absorption and safety products
7) Rubber and plastic products

One of the application of waste tyre rubber to overcome its environmental problem is in the field of construction. It has shown great potential in the construction industry where it can be used with cement concrete pavements. Different researches have been conducted to successfully incorporate waste rubber in concrete and appreciable results have been found. Certain properties of rubber like better flexibility and light weight are considered to be the main reason for its more and more use in the construction industry. Waste rubber has been successfully used as the replacement of the aggregates in the cement concrete. With a great environmental concern and in saving the natural rock aggregates, we have replaced a part of the conventional coarse aggregates by shredded rubber aggregates resulted from cutting worn tyres.

II. LITERATURE REVIEW

Lee et al. (1998) [1] studied the crumb rubber filled concrete and observed its impact and flexural strength. It was found that the flexural and impact strength of the crumb rubber filled concrete is more as compared to the latex modified concrete as well as portland cement concrete. It was concluded that due to the formation of styrene-butadiene rubber (SBR) latex, the interfacial bond between the crumb rubber particles and cement paste becomes much stronger as compared to the conventional bond when there is no SBR latex.

Taha et al. (2003) [2] added various percentages of rubber aggregates having the size range of 5mm to 20 mm. When 100% of aggregates were replaced by the rubber aggregate, a huge reduction of 75% in the compressive

strength of resultant concrete was found which is considered to be extremely poor.

N. J. Azmi et al. (2008) [3] mainly focused on the mechanical properties of the concrete containing crumb rubber as partial replacement of natural fine aggregates with the replacement levels of 10, 15, 20 and 30% by volume. Different water cement ratios of 0.68, 0.57 and 0.41 were used and the testing of specimen was carried for compressive strength, split tensile strength, flexural strength and also for modulus of elasticity. As in other research works, the results depicted that there is a reduction in the compressive strength of the concrete. They also found out that when the crumb rubber content was increased from 0-30%, there was a clear increase in the workability as well. Crumb rubber being more workable than the conventional/normal concrete can thus be very use full in certain conditions where less workability is needed. The replacement of aggregates by crumb rubber also reduced the static modulus of elasticity and increased the deformability. American Concrete Institute mix design methods were used in this research work.

Zeineddine Boudaoud and Miloud Beddar (2012) [4] led to the conclusion that there is a reduction in the mechanical characteristics of the concrete when rubber is added to it. However, even after the reduction in the strength, it still has the potential to be used in many places where not much strength is required like in the road construction industry. It was observed to be more economical, ecological and lighter than the normal concrete.

Akinwonmi et al. (2013) [5] separately replaced the natural aggregates by both shredded rubber as well as by crumb rubber. After testing the specimen which contained different percentages of the crumb rubber and others which contained the different percentage of shredded rubber, it was observed that up to the replacement level of 2.5% by shredded tyre, the compressive strength slightly increased but when the replacement level goes beyond 2.5%, there is a massive decrease in the compressive strength of the concrete. On the other hand the replacement by crumb rubber totally showed negative results and thus was not recommended.

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