Study of Reuse of Tyre Waste As An Alternative Material in Manufacturing Paver Blocks

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***Abstract*— Due to rapid growth in the automobile industry, the use and manufacturing of tires are increasing day by day and there is no reuse of the same, the decomposition and disposing of tire waste is harmful to the environment. On 4th August the world's biggest tire graveyard in Kuwait, Sulaibya was on fire and has now become an environmental hazard. Tire disposal is one of the greatest challenges that waste management experts face today.**

The research is analytical research looking at an alternative way of recycling tires by incorporating them into concrete construction, the study aims to introduce an environmentally friendly technology also to investigate the optimal use of waste tires as coarse aggregate in concrete composition, and thus studying the alternative methods which can be used to create a better bond between cement and rubber. The research will focus on finding ways to treat the rubber aggregate physically and chemically before using it to create better adhesion between rubber and cement paste. Also, evaluate the use of synthetic rubber adhesives and polytan Crete super plasticizing concrete admixture to increase the compressive strength of rubberized concrete. The research aims to work towards designing/creating a paver block that is not only eco-friendly but also aesthetically pleasing.

Keywords*— *Tyre Rubber, Rubberized Concrete, Compressive Strength, synthetic rubber adhesives, polytan Crete super plasticizing admixture

I. INTRODUCTION

The development in the automobile industry is rising thus the production of vehicle's had increased similarly production of the tire had also increased which result in the larger amount of waste tire generation every year, different investigations have shown that materials used to produce tires are non-biodegradable, the only easiest and cheapest way to decompose tire waste is to burn them, which gives away harmful gasses and results in global warming. Biodegradation of waste tires is harmful to our environment hence it becomes necessary to found out an alternative way to reuse tires. On the other hand, concrete is the widely used material for construction, it's a mix composed of cement, sand, aggregate, and water, when those components are properly mixed and cured, the concrete thus formed may last for centuries. As concrete has high demand but it uses natural resources like aggregate and sand, Concrete has high compressive strength but low tensile strength, low ductility, and low energy absorption similarly rubber has high tensile strength, high shock, and energy absorption, and high compression set. Thus, chipped rubber or crumb rubber can be used as coarse or fine aggregate in concrete which will save our natural resources as well as help in reusing waste tires. Developing this technology will surely open doors for sustainable and eco-friendly construction, in times to come. Various studies carried on rubberized concrete concluded that the percentage of rubber used, the form of rubber aggregate, and surface treatment on them have highly influenced the compressive strength of concrete, at the same time using rubber as aggregate increases resilience and decreases density which is not good for construction use, but we can use these properties to design a concrete mix for paver blocks. It is clear that the rubber surface is hydrophobic and cannot create a stronger bond with concrete. In the present study, efforts have been done to find out ways that can help us to increase the bond within them and achieve minimum requirements of compressive strength required for paving blocks.

II. RESEARCH SCOPE

Study shows that combining recycled rubber and concrete aggregates for making concrete was an innovative idea, it was found that the resulting rubberized concrete had lower strength, and this was not preferable especially for structural applications. However, rubberized concrete has been found to be preferable for paving applications, where a lower range of strengths is included in the design. Using rubber as aggregate in concrete has both positive and negative effects on concrete, it reduces its compressive strength at the same time increases its deformation capacity. According to the literature, size of rubber aggregates highly affects the compressive strength of rubberized concrete. For this research, we will consider both coarse rubber aggregate size up to 20mm and crumb rubber aggregate size up to 1-4mm. The main reason behind for reduction in compressive strength is the weak bond between rubber and concrete in this research we will study physical treatments on rubber surfaces and the use of adhesives and admixtures to increase their bonding.

III. RESEARCH OBJECTIVES

Although many researches are already done on the concept of using recycled rubber in cementitious composites, very limited studies have been performed on the application of crumb rubber concrete (CRC) for pavements. The term of rubberized concrete is a general term, which involves all the types and sizes of recycled rubber. This research aims to study synthetic rubber adhesives and polytan Crete super plasticizing admixture as additives to the rubberized concrete mix.

- Providing required information about crumb rubber, synthetic rubber adhesive, and polytan Crete super

plasticizing admixture and how they help in achieving higher compressive strength and a stronger bond between rubber and cement.

- Integrating the past and existing study on rubberized concrete.

IV. RESEARCH SIGNIFICANCE

Here, already researched rubberized concrete is reviewed and all the difficulties associated with using waste rubber tire as aggregate is studied; this paper aims to address these difficulties by providing some solutions to overcome them. The following points elaborate on the significance of the research.

- Determining the form of rubber which can be used in rubberized concrete and physical treatment which can be done on it to increase the grip thus making the bond with cement particles stronger.
- Introducing adhesive and admixtures which can help in increasing the strength of rubberized concrete.
- Maximizing the amount of rubber tire waste aggregate replacement in concrete to come up with more sustainable and green construction technology, also to reduce to overuse of natural aggregate and save our limited natural resources.

V. RESEARCH INNOVATION

An only a limited number of studies are available, where techniques to increase the compressive strength of rubberized concrete are discussed. The solutions discussed here to create concrete shows promise for becoming an additional solution for using waste rubber tires in pavement blocks.

VI. LITERATURE REVIEW

1. ***Neela Deshpande, S. S. Kulkarni et al.*** In this paper an attempt is made to design concrete of 25Mpa using artificial sand, Shredded rubber, and Crumb rubber as a source of aggregate is made using IS 10262:2009 also, the shredded rubber particles were coated with NaOH solution and use the same in concrete. The paper concluded after various lab tests that the 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. The tests were done on hardened concrete show that the use of rubber aggregate in concrete mixes produces a significant reduction in concrete compressive strength with increasing rubber aggregate content. The use of NaOH to coat the shredded rubber contributes to a slightly higher compressive strength which can be thought about for potential use in structural applications. However, the use of CR in concrete is not advisable and thus can be used only for minor jobs. [5]

2. Sukhada R H, Prof. Suhas R et al. In the present study effort has been done to use the industrial rubber waste in the experimental study on the Rubber Paver Blocks. The work carried out aims to produce sustainable, eco-friendly, low cost, and low maintenance paver blocks which can sustain heavy vehicular loads. Here they had replaced fine aggregate with crumb rubber in 5%, 10%,15%, and 20% after conducting various lab tests the paper concludes that as the percentage of rubber increases the slump value increases which means that workability increases at the same time compressive strength decreases. So, the conclusion drawn from the present study is, full replacement of the rubber is not possible. But partially replacement of the rubber is possible up to certain percentages. [9]

3. Me. Neeraj Kumar Gupta, Dr. Ajay Swarup et al. In this research scrap tire is used in powder form, the objective was to partially replace fine aggregate with rubber powder in concrete. The study includes experimenting with different mixes and conducting tests on the specimen. The replacement was done as 10%,20%, and 30%, for 10% replacement the compression test result was obtained after 28 days of curing which shows a result of 35.13N/mm2. Thus, the paper concluded that replacing 10% of fine aggregate with rubber powder can satisfy the requirement of the concrete mix as per IS specification.[4]

VII. PHYSICAL TREATMENT

Fig 1.1 Crumb rubber aggregate.

Fig 1.2 Coarse rubber aggregate <20mm

The surface of the rubber is highly hydrophobic hence it cannot create a stronger bond with cement, thus smaller the surface area exposed to cement it will create a comparatively stronger bond. Hence the powdered form of rubber or crumb rubber shows greater compressive strength than coarse rubber aggregate. But if we treat the exposed surface of coarse aggregate physically or chemically so that the outer surface becomes rough it will help the coarse rubber aggregate to create a better bond with cement. Highly acidic and alkaline materials like H2SO4 and NaOH can diffuse through the rubber and cause degradation of its structure which leads to deterioration of rubber properties and makes the outer surface of rubber rough which can create a grip for cement molecules to bond with it. Whereas physically treating the surface with

sharp objects can also roughen the surface. Immersing the crumb rubber or Coarse rubber in Bleach for 24hr will help to remove all the organic impurities stuck to the waste rubber surface which will again help in bonding with cement.

Fig 1.3- Left-Physically treated rubber with sharp object, Right-Non treated sample

VIII SYNTHETIC RUBBER ADHESIVE

Latex cement is a group of water-based adhesives, is made from emulsified elastomers, or rubbers. These types of water-based adhesives are primarily used for bonding rubber, leather, wood, etc., Latex-based adhesives have been also widely used for bonding in the footwear industry. An important area of application of this adhesive concerning our research is that it is used in bonding rubber acoustic tiles to concrete walls or rubber mats to the concrete floor because it acts as a bonding agent to promote adhesion. The synthetic rubber adhesive is a type of Latex adhesive also known as SBR adhesive or simply rubber adhesive is an effective synthetic bonding solution. The water-based synthetic rubber adhesive can be mixed with water while creating the concrete mix using rubber aggregate, it will act as a bonding agent between rubber and cement molecules. The secret to the success of synthetic rubber is in the structure of its chain of molecules. Two hard ends on the outside (Styrene), a flexible, softer, rubbery middle part (Butadiene). So the structure is Styrene-Butadiene-Styrene=SBS as shown in Fig 2.1. The styrene-end segment determines the cohesiveness (internal strength) of the adhesive; the rubbery middle segment determines the adhesiveness.

Fig 2.1 Chemical Structure of Synthetic Rubber adhesive

IX POLYTAN CRETE SUPER PLASTICIZING ADMIXTURES

Polytancrete NGT is a polymeric liquid admixture, useful for increasing the strength of concrete or mortar by reducing the water content of the mix. The effect of Polytan Crete admixture on cement hydration shows that at a very early age in initial retardation of cement hydration is produced. This effect is more pronounced at higher doses of superplasticizer. The use of PC admixtures makes it possible to reduce the water content by up to 40%, producing workable, high performance, and therefore very resistant concrete. Owing to these characteristics, the development and use of such superplasticizers have been related to the preparation and formulation of self-compacting concrete.

The molecular structure of polycarboxylate (PC) superplasticizer admixtures is shown in Fig. 2.2 Their 'comb-type' molecule consists of one main linear chain with lateral carboxylate and ether groups. The carboxylate groups are instrumental in the adsorption of these admixtures to cement particles. Dispersion is due to electrostatic repulsion owing to the carboxylate groups, but primarily to the steric repulsion associated with the long lateral ether chains. The high degree and duration of the fluidity that this admixture affords concrete are related to structural factors; hence, the shorter the main chain and the longer and more numerous the lateral chains, the greater and more long-lasting is the fluidity induced. [2]

Thus, adding some amount of polytan Crete super plasticizing admixtures in the concrete mix having rubber aggregate will increase the strength of concrete by reducing water content in the mix as rubber surfaces are hydrophobic lesser the water required for bonding the stronger will be the bond.

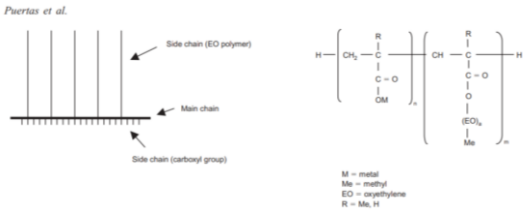

Fig 2.2 Molecular Structure of PC Admixture

DISCUSSION

Reason for the reduction in strength of concrete when rubber is added and reason for increasing strength when adhesives and admixtures are added

- Lack of bonding between rubber particles and cement paste.
- Due to the non-uniform distribution of rubber particles in the concrete, non-homogenous samples are produced, which in turn results in a reduction in concrete strength.
- Despite the reduced compressive strength of rubberized concrete in comparison to conventional concrete, there is a potentially large market for concrete products in which the inclusion of rubber aggregates would be feasible which will utilize the discarded rubber tires the disposal of which is a big problem for the environmental pollution.
- Polycerate super plasticizing admixture and synthetic rubber adhesive will act as the bonding agent between rubber aggregate and cement paste.

CONCLUSION

The overall result of this study and literature review shows that it is possible to use recycled tire waste as aggregate in concrete but as partial replacement to mineral coarse aggregates but it cannot be used in construction however, it can be used in manufacturing paving blocks. It is noted that, the compressive strength of rubberized concrete decreases with the increase of rubber content. This paper suggests that using different methods like using suggested admixtures, adhesives and some physical treatment to rubber aggregate can help to gain straight while replacing a higher percentage of mineral coarse aggregate with rubber.

FUTURE SCOPE FOR RESEARCH

- Experimental research can be conducted using suggested admixtures and adhesives in different quantities while keeping the rubber aggregate quantity as high as 50%.
- Studying the physical and chemical properties of rubber and finding chemical treatments which can convert the hydrophobic surface of rubber into the hydrophilic surface can be done.

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