Experimental Study on Mechanical Properties of Concrete Using Chipped Rubber Aggregates and Silica Fume

Liayaqat Ali Khan[1], Mr. Sourabh Lalotra[2,] Shivani bhardwaj[3]

[1]M.tech Student, Sri Sai Group of Institute Badhani, Pathankot, India

[2,3]Assistant Professor, Sri Sai Group of Institute Badhani, Pathankot, India

Abstract: **Concrete plays a main role and is widely used construction material for the construction of civil engineering works. It basically consists of aggregates which are bonded together by cement and water. Use of these aggregates or raw materials in concrete causes depletion of natural resources. Both fine and coarse aggregates that are used for making concrete has become expensive due to its scarcity. So it is required to use alternative materials for making concrete that can be a suitable substitute of aggregates. It has been found from research that rubber which is generated in large quantities as waste doesn't have useful disposal till now and threatens the environment. In the present experimental work M35 concrete mix was designed as per IS 10262-2009 with partial replacement of cement by silica fume and coarse aggregates by chipped rubber. Cement was replaced by Silica fume with percentage replacement of 0%,5%,10% & 15% and Coarse aggregates was replaced by chipped crumb rubber with percentage replacement of 0%,2.5%,5% & 10%. The concrete mixes with varying percentage of silica fume and chipped rubber was tested for compressive strength, split tensile strength and Flexural resistance test. It was concluded from results that by introducing silica fume in concrete increases the mechanical properties of concrete up to 10% replacement of cement but with increasing percentage replacement of chipped rubber mechanical properties decreases. The optimum strength was obtained by using 10% silica fume as cement replacement and 2.5% chipped rubber as coarse aggregates replacement.**

Keywords: **Concrete, Chipped Rubber Aggregates, Silica Fume**

I. INTRODUCTION

India has done a major leap on developing the infrastructures such as buildings construction, express highways, power projects and industrial structures, dams, etc. to meet the requirements of globalization. For the construction of civil engineering works, concrete play main role and a large quantum of concrete is being utilized. Both coarse aggregate and fine aggregate is a major constitute used for making conventional concrete, has become highly expensive and also scarce. In the backdrop, there is large demand for alternative materials from wastes. Waste tyres management is a serious global concern. Millions of waste tyres are generated and dumped or burned every year, often in an uncontrolled manner, causing a major environmental and health problem (Stephan A et el2012). Tyres and durable and not naturally biodegradable. Waste tyres will remain in dump sites with little degradation for a long time, leads to environmental hazard.

The use of recycled rubber as partial aggregate in concrete has great potential to positively affect the properties of concrete in a wide spectrum. Concrete is one of the most popular construction materials. Due to this fact, the construction industry is always trying to increase its uses and applications and improving its properties, while reducing cost. In general, concrete has low tensile strength, low ductility, and low energy absorption. Concrete also tends to shrink and crack during the hardening and curing process.. One such method may be the introduction of rubber to the concrete mix. It is a perfect way to modify the properties of concrete and recycle rubber tires flaps at the same time.

II. CHIPPED RUBBER

Management of Chipped rubber is very difficult for municipalities to handle because the waste chipped rubber is not easily biodegradable even after long-period of landfill treatment. However, recycling of waste tire rubber is an alternative. Recycled chipped rubbers have been used in different application. It has been used as a fuel for cement kiln, as feedstock for making carbon black, and as artificial reefs in marine environment. It has also been used as a playground matt, erosion control, highway crash barriers, guard rail posts, noise barriers, and in asphalt pavement mixtures. In the last past two decades, research had been performed to study the availability of using waste tire rubber in concrete mixes. Recycled waste tyre rubber is a promising material in the construction industry due to its lightweight, elasticity, energy absorption, sound and heat insulating properties. In this paper the compressive strength of concrete utilizing waster tire rubber has been investigated. Recycled waste tyre rubber has been used in this study to replace the fine and course aggregate by weight using different percentages. But in this project only course aggregate can be replace.

Disposal of waste tire rubber is one of the major concerns for all over the world. With the increase of automobiles in India from past few years the demand of tyres has gone up very high. As we know light weight concrete is widely used on various architectural works. In India more than 33 million vehicles use roads from 2007 to 2010, about 80 million tyres have hit the roads - these include two, three, four and six wheelers. A typical tyre contains 24-28% of carbon black, 40-48% of natural rubber and 24- 36% of synthetic rubber including styrene butadiene rubbers (SBR) and butyl rubber (BR), which all are ingredient used for tyre manufacturing. Worldwide more than 981 million tires are thrown away each and every year and even less than 7% are recycled, 11% are burned for fuel, and 5% are exported

III. SILICA FUME

Silica fume is an ultrafine material with spherical particles less than 1 μm in diameter, the average being about 0.15 μm. This makes it approximately 100 times smaller than the average cement particle.[1] The bulk density of silica fume depends on the degree of densification in the silo and varies from 130 (undensified) to 600 kg/m^3. The specific gravity of silica fume is generally in the range of 2.2 to 2.3. The specific surface area of silica fume can be measured with the BET method or nitrogen adsorption method. It typically ranges from 15,000 to 30,000 m^2/kg.

Silica fume is added to Portland cement concrete to improve its properties, in particular its compressive strength, bond strength, and abrasion resistance. These improvements stem from both the mechanical improvements resulting from addition of a very fine powder to the cement paste mix as well as from the pozzolanic reactions between the silica fume and free calcium hydroxide in the paste. Addition of silica fume also reduces the permeability of concrete to chloride ions, which protects the reinforcing steel of concrete from corrosion, especially in chloride-rich environments such as coastal regions and those of humid continental roadways and runways (because of the use of deicing salts) and saltwater bridges. Prior to the mid-1970s, nearly all silica fumes were discharged into the atmosphere

IV. REVIEW OF LITERATURE

Toutanji (1996) investigated the effect of the replacement of mineral coarse aggregate by rubber tire aggregate. Four different volume contents of rubber tire chips were used : 25, 50, 75 and 100%. The incorporation of these rubber tire chips in concrete exhibited a reduction in compressive and flexural strengths, the reduction in compressive strength was approximately twice the reduction of the flexural strength. The specimens which contained rubber tire aggregate exhibited ductile failure and underwent significant displacement before fracture. The toughness of flexural specimens was evaluated for plain and rubber tire concrete specimens. The test revealed that high toughness was displayed by specimens containing rubber tire chips as compared to control specimens.

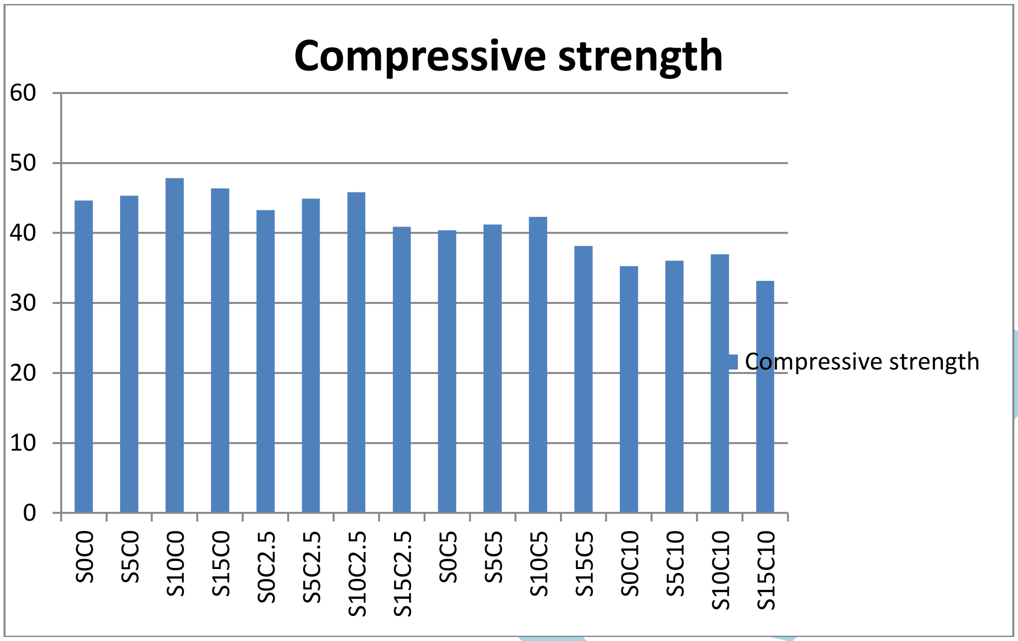
Beukering and Janssen (2001) stated that the used tyres can be directly reused for their original intended purpose. If they do not have the minimum remaining tread depth, they have to be retreaded or regrooved (for truck tyres only) before being reused. The minimum remaining tread depth for some countries is 1.6 mm for part-worn tyres to be sold for further use. With retreading or regrooving, it is evident that tyre utilization is maximized. Around 80% of original material can be reused and if the process of regrooving is carried out correctly, the life of a truck tyre can be increased up to 30% for only 2.5% of the cost of anew tyre.

Khaloo et al (2008) investigated the feasibility of using elastic and flexible tire-rubber particles as aggregate in concrete. Tire-rubber particles composed of tire chips, crumb rubber, and a combination of tire chips and crumb rubber, were used to replace mineral aggregates in concrete. These particles were used to replace 12.5%, 25%, 37.5%, and 50% of the total mineral aggregate's volume in concrete. Cylindrical shape concrete specimens 15 cm in diameter and 30 cm in height were fabricated and cured. The fresh rubberized concrete exhibited lower unit weight and acceptable work ability compared to plain concrete. The results of a uniaxial compressive strain control test conducted on hardened concrete specimens indicate large reductions in the strength and tangential modulus of elasticity. A significant decrease in the brittle behavior of concrete with increasing rubber content is also demonstrated using nonlinearity indices. The maximum toughness index, indicating the post failure strength of concrete, occurs in concretes with 25% rubber content. Unlike plain concrete, the failure state in rubberized concrete occurs gently and uniformly, and does not cause any separation in the specimen. Crack width and its propagation velocity in rubberized concrete are lower than those of plain concrete. Ultrasonic analysis reveals large reductions in the ultrasonic modulus and high sound absorption for tire-rubber concrete.

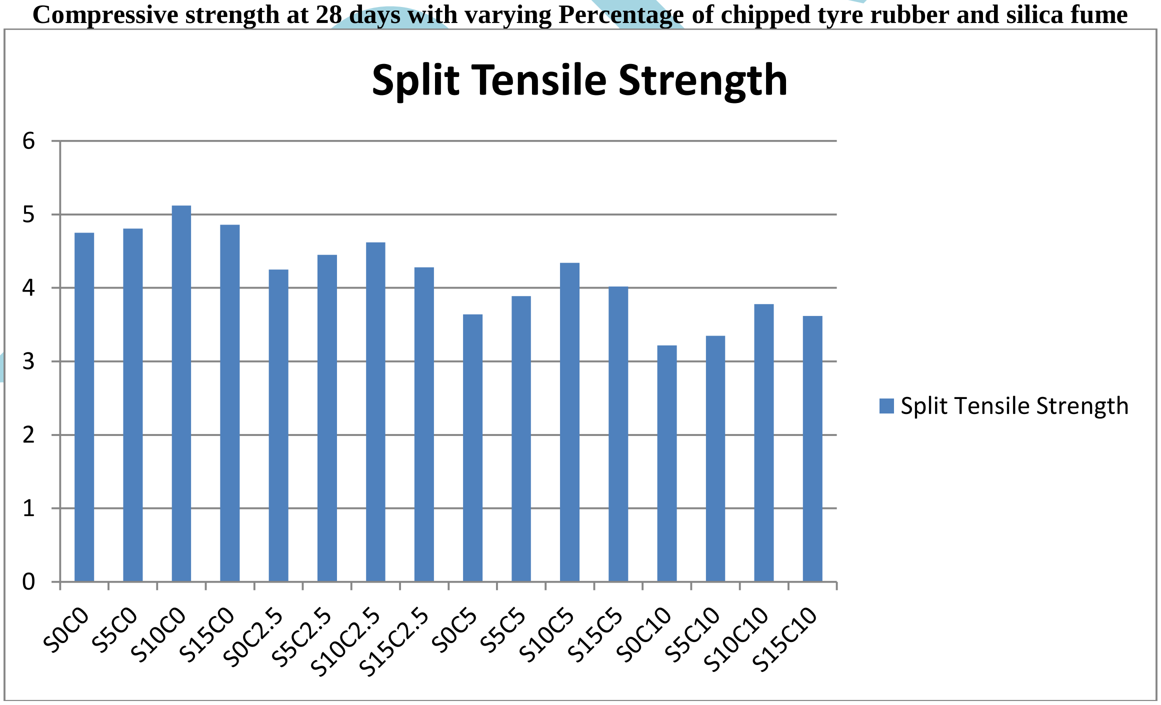
Rostek and Biernat (2013) conducted the study for waste samples of different density polyethylene, polyethylene terephthalate and rubber from waste tires. Gasification process of subjecting the sample was recorded TG and DSC curve, observing changes in mass, temperature and enthalpy. These studies were carried out in order to pre determine the kinetics of thermal decomposition. The study, conducted in an atmosphere of argon/nitrogen (non-oxidizing atmosphere), both in terms of the changes of enthalpy and mass.

Jedidi M. et al (2014) conducted a study to provide more data on the effect of rubber aggregates on the thermo physical properties of self-consolidating concrete (SCC). To this end, four sets of rectangular specimens were prepared by varying the proportion of the rubber aggregates with percentages of

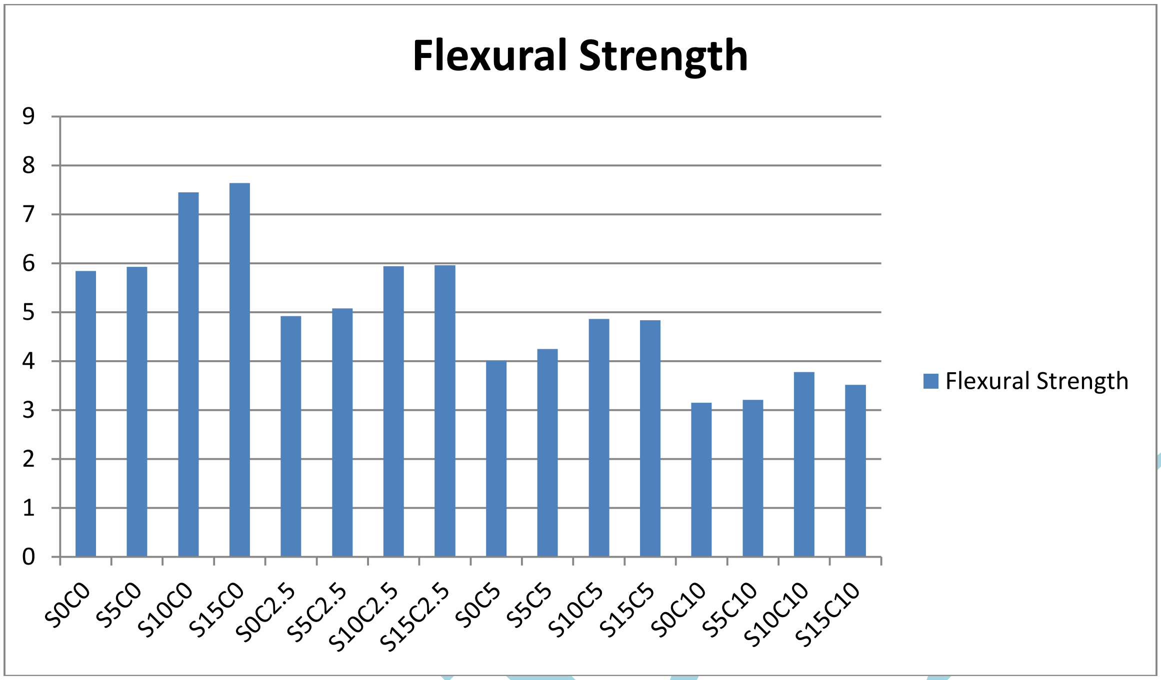
0%, 10%, 20% and 30% of the volume of gravel. Tests on hardened self-consolidating concrete rubber SCCR included measuring the thermal conductivity and the thermal diffusivity were decreased according to the increase of the percentage of rubber aggregates. This decrease was significantly improved thermal performance of the SCCR.



Compressive strength at 28 days with varying Percentage of chipped tyre rubber and silica fume



Split Tensile strength at 28 days with varying Percentage of chipped tyre rubber and silica fume



Flexural strength at 28 days with varying Percentage of chipped tyre rubber and silica fume

V. CONCLUSION AND FUTURE SCOPE

The studies show that Gradual reduction in compressive strength, flexural strength and tensile strength was observed with the addition of used chipped rubber aggregate and silica fume. From this study it can be concluded that up to 2.5% of chipped rubber aggregate can be added into concrete mixes without considerable reduction in strength. Utilization of chipped rubber aggregates and silica fume, which is a waste product, in concrete construction is economically viable and environmentally effective.

From the experimental investigations, it can be concluded that:

- An increase in compressive of concrete can be seen at a percentage replacement of 10% of silica fume with cement and 2.5% of rubber aggregate with coarse aggregates.
- Percentage replacement of 10% of silica with cement and 2.5 % of rubber aggregates with coarse aggregates can be used to get optimum split tensile strength of concrete.
- An increase in flexural strength of concrete can be seen at percentage replacement of 15% of silica with cement and 2.5% of rubber aggregates with coarse aggregates.

REFERENCES

[1]. Afroz, S. and Prasad, K.S.B. (2012),"Utilization of waste plastic as a strength modifier in surface course of flexible and rigid pavments", International Journal of Engineering Research and Applications (IJERA), Volume 2 (4), Pages 1185-1191.

[2]. Ali R. Khaloo,M. Dehestani and P. Rahmatabadi (2008), "Mechanical properties of concrete containing a high volume of tire-rubber particles", Waste Management, Volume 28, Issue 12, Pages 2472-2482.

[3]. Bala Raju Teppala, C.B. Mishra, Alok Sinhaad & Dinesh Kumar (2014), "Experimental Assessment of Properties of Crumb Rubber Modified Bitumen Mix (CRMB 55) With and Without Application of Nanotechnology Additive", International Journal of Innovative Research in Science, Engineering and Technology, Volume 03, Pages 16489-16494.

[4]. Beukering, P.J.H.,and Janssen, M.A. (2001) "Trade and recycling of used tyres in Western and Eastern Europe." Resources, Conservation and Recycling, Volume 33, Issue 4, Pages 235-265.

[5]. Boudaoud Z. and Beddar M. (2012) "Effects of Recycled Tires Rubber Aggregates on the Characteristics of Cement Concrete." Open Journal of Civil Engineering, Volume 2, pages 193-197.

[6]. Dumne S M (2013) "An Experimental Study on Performance of Recycled Tyre Rubber-Filled Concrete" International Journal of Engineering Research & Technology (IJERT) Vol. 2 Issue 12, Pages 766-772.

[7]. Eldin, N. N.,and Senouci, A. B. (1992) "Use of scrap tires in road construction." J. Construction Engineering and Management, 118 (3), 561-576.

[8]. Eshmaiel Ganjiana,Morteza Khoramib and Ali Akbar Maghsoudic (2009), "Scrap-tyre-rubber replacement for aggregate and filler in concrete",

Construction and Building Materials, Volume 23, Pages 1828-1836.