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EFFECT ON COMPRESSIVE STRENGTH OF CONCRETE BY USING WASTE RUBBER AS PARTIAL REPLACEMENT OF FINE AGGREGATE: A Review

Aniruddh[1], Mr. Abhishek Kumar[2], Mohd. Afaque Khan[3]

[1]*Post Graduate Student, Babu Banarasi Das University, Uttar Pradesh, India*
[2]*Asst. Professor, Babu Banarasi Das University, Uttar Pradesh, India*
[3]*Asst. Professor, Babu Banarasi Das University, Uttar Pradesh, India*

Abstract – *This research represents the collection of data from various previous studies done on the compressive strength testing of concrete incorporating waste tire rubber (crumb rubber) as a part of aggregate material replacement is mostly done volumetrically. Using such rubber is essentially a method to manage the waste tire problem widespread in India and the world. Some studies also include testing other properties like ductility, toughness and fire resistance of this modified mix and comparing it to the control mixes.*

Key Words: Rubberized Concrete, Crumb Rubber, Tire, Rubcrete, Compressive Strength, Waste Management, Enviornmental Engineering, Fire Resistance.

1. INTRODUCTION

According to the Centre for Monitoring Indian Economy, car registrations in India increased to 236761 Cars in December from 228267 Cars in November of 2015. Car Registrations in India averaged 100437.09 Cars from 1991 until 2015, reaching an all time high of 304900 Cars in March of 2012.
With the ever increasing number of cars, there is a major environmental issue rising with it caused by the improper management of discarded tires. Tires represent a serious environmental concern on several fronts. Part of the risk lies with their chemical makeup. Toxins released from tire decomposition, incineration or accidental fires can pollute the water, air and soil. Scrap tires are considered harmful waste because they:

1. Leach harmful toxins into the environment
2. Are a home for mosquitoes, rats & snakes
3. Have the potential to create harmful fires
4. Emit significant amounts of CO2 & dioxins when burned as fuel

In virtually all environmentally responsible countries, burying tires or tire shred in landfills is now against the law. Similarly, several countries and many state and provincial governments have banned the use of tires or tire derived fuel (tire shred) for use as fuel in cement kilns and paper mills. In 2007 the European Union banned tire shred from landfill and yet 50% of all scrap tires produced in the EU are still land filled as engineering cover. There are very few economic uses for scrap tires, with crumb rubber being the primary product but of little mass market use.
In India there are about 100 crore tires which are thrown away every year.
Using these waster tires in some form in the concrete mix can be beneficial in many ways, it can reduce the environmental issues caused by the thrown away tires and it can also impart some unique properties to the concrete mix.

2. Literature Review

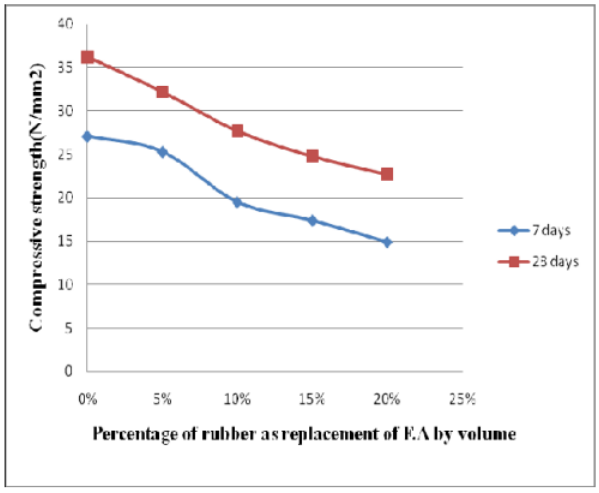
Neil N. Aldin and **Ahmed B. Seouci, 1993** [1], in their paper observed that, accumulations of worn-out automobile tires create fire and health hazards. As a possible solution to the problem of scrap-tire disposal, he conducted an experimental study to examine the potential of using tire chips and crumb rubber as aggregate in portland-cement concrete. they examined the strength and toughness properties of concrete in which different amounts of rubber-tire particles of several sizes were used as aggregate. they observed that the concrete mixtures exhibited lower compressive and splitting-tensile strength than did normal concrete. However, these mixtures did not demonstrate brittle failure, but rather a ductile, plastic failure, and had the ability to absorb a large amount of plastic energy under compressive and tensile loads. A mathematical model was used to describe the effects of rubber aggregate on the compressive and tensile strength reduction of concrete.

Kamil E. Kaloush et al. 2004 [2], tested various properties of concrete and compared them to concrete with rubber aggregates. they observed that as the rubber content increased, the tensile strength decreased, but the strain at failure increased. Higher tensile strain at failure is indicative of more ductile mixes. He also established that Crumb Rubber Concrete is more resistant to thermal changes.

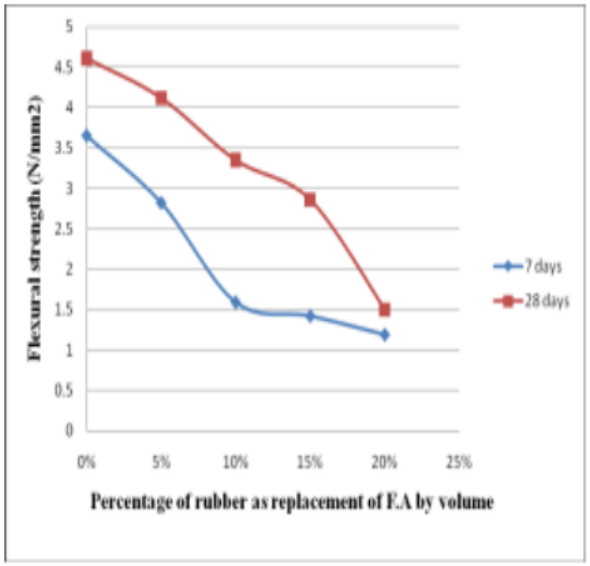
G. Senthil Kumaran et al. 2008 [3], in their study concluded that the reduction of compressive strength and tensile strength can be increased by adding some super

plasticizers and industrial wastes as partial replacement of cement will definitely increase the strength of waste tyre rubber modified concrete. Further study is needed to increase performance against fire.

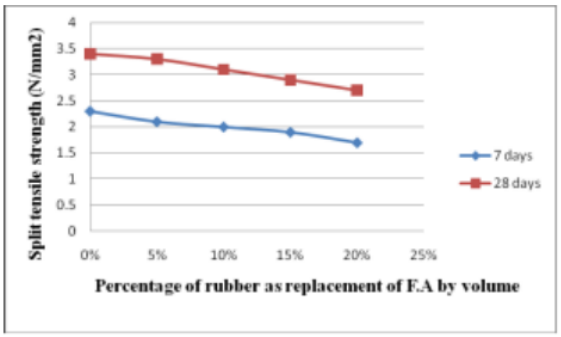
Yogendra Antil, 2014 [4] observed that the Crumb Rubber Concrete can be used where light weight mixes are required.



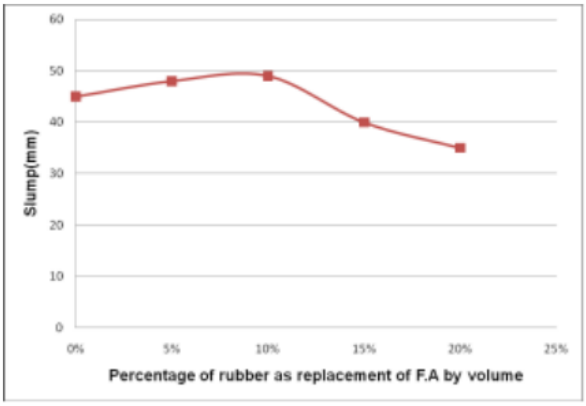
Variation of compressive strength at 7 and 28 days v/s percentage of crumb rubber as replacement for FA



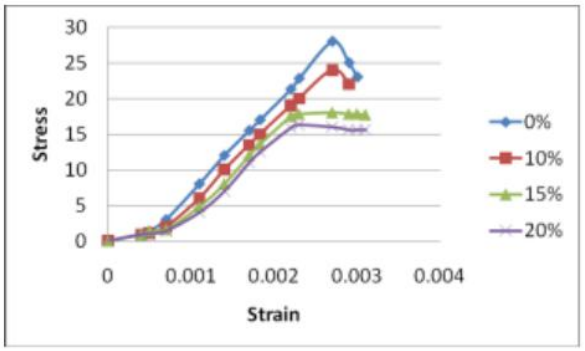
Variation of flexural strength at 7 and 28 days v/s percentage of crumb rubber as replacement for FA



Variation of split tensile strength at 7 and 28 days v/s percentage of crumb rubber as replacement for FA



Variation of slump v/s percentage of crumb rubber as replacement for FA



Relationship between stress and strain for different rubber contents

Slump increases by 1.08 % upto 10% use of rubber, increased content of rubber increases toughness.

Kotresh K.M and **Mesfin Getahun Belachew 2014** [5], observed that rubberized concrete strength can be improved by improving bond properties of rubber aggregates. The tire recycling factories should supply quality rubber aggregates in 20 -10 mm, 10-4.75mm and 4.75mm down sizes to be used as cement concrete aggregates. The light unit weight

qualities of rubberized concrete may be suitable for architectural application, false facades, stone baking, interior construction, in building as an earthquake shock wave absorber, where vibration damping is required such as in foundation pads for machinery, railway station, where resistance to impact or explosion is required, such as in jersey barrier, railway buffers, bunkers and for trench filling. One of the possible applications of rubcrete may be its application in rendering of roof top surfaces for insulation and waterproofing. With proper Mixed Design a 20 mm thick Rendering on roof top surfaces may be done with 4.75 mm down rubber aggregate

S. F. A. Shah et al. 2014[7], did a study on the thermal properties of rubberized concrete in 2014. The testing was done by incorporating 5, 10 and 15% of scrap rubber as volume replacement for coarse aggregate. Thermal behavior for concrete was examined using hotbox technique. No remarkable changes in concrete properties up to 5% replacement were occurred. Beyond 5% substitution, concrete properties change appreciably. Compressive strength, flexure strength, workability, stiffness and unit weight of rubberized concrete decreased as rubber content increased. While impact resistance, air content and water absorption of rubberized concrete increased with increase in rubber content. Thermal performance of concrete containing rubber aggregate was improved, and promising results were obtained. It was concluded that rubberized concrete could be useful in slabs to improve energy efficiency of building unit.

Haolin Su and **Jian Yang et al. 2015** [8], conducted a study in which three groups of singly-sized rubber particle samples (3 mm, 0.5 mm and 0.3 mm) and one sample of continuous size grading were used to replace 20% of the natural fine aggregate by volume. It was observed that the rubber particle size affects the concrete's workability and water permeability to a greater extent than the fresh density and strength. Concrete with rubber particles of larger size tends to have a higher workability and fresh density than that with smaller particle sizes. However, the rubber aggregates with smaller or continuously graded particle sizes are shown to have higher strengths and lower water permeability.

S.Selvakumar and **R. Venkatakrishnaiah 2015**[9] in their research paper concluded that the compressive strength of crumb rubber concrete with 5% replacement is 38.66 N/mm^2 ; it is higher than the strength of normal concrete (36.73N/mm^2) on 28th day. The compressive strength of crumb rubber concrete with 10% replacement, it gives acceptable strength of 33.47 N/mm In splitting tensile strength the strength of crumb rubber concrete is lower than the strength of normal concrete. In the flexural strength test conducted on crumb rubber concrete it shows a decrease in strength when compared to the strength of normal concrete. From the test results, it is found that the crumb rubber posses less bonding ability which has affected on the strength of the concrete.

Tushar R More et al. 2015 [10], got the conclusions that, addition of recycled crumb rubber aggregates into normal concrete mix leads to decrease in workability for the various mix samples. Flexural strength of concrete decreases about 40% when 3% sand is replaced by crumb rubber aggregates and further decrease in strength with increase of percentage of crumb rubber aggregates. Split tensile strength of concrete decreases about 30% corresponding to 3% sand replaced by crumb rubber and further decreases the strength with increase in percentage of crumb rubber. One of the reasons that splitting tensile strength of rubberized concrete is lower than conventional concrete because of bond strength between cement paste and rubber tire aggregates poor. The rubberized concrete can be used in non-load bearing member's, i.e., lightweight concrete walls, other light architectural units, thus concrete containing fine rubber aggregates could give a viable alternative to where strength is not prime requirements. Experimental results of study show that it is possible to use recycled rubber tyre in terms of aggregates in concrete construction as partial replacement to natural fine aggregates

3. CONCLUSIONS

1. From the various studies mentioned above, it is clear that rubberized concrete and be used in a wide amount of areas.
2. It is evident that the compressive and tensile strengths of rubberized concrete decrease with the increase in rubber content, but some other properties like toughness and ductility of the hardened rubberized mix increases.
3. It is essential to find out the specific areas where this mix can be used.
4. Economically Rubberized concrete is more expensive than the normal mixes.
5. Fire resistance of rubberized concrete is greater than normal mixes

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