IMPACT OF REPLACEMENT OF AGGREGATES BY SCRAP RUBBER TYRE AND USE OF SILICA FUME ON CONCRETE

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Abstract: In this research paper, study of crumb rubber replacement and Silica fume with fine aggregate and cement respectively were been studied with various percentage It contributes to a decrease in cost and emission while strengthening concrete. There have been several studies that had info about various concrete construction which had encouraged to develop the civil industry, Development in different types of component of concrete like strength, weight, binders, and mechanical property of material. In this case study the result of silica fume (SF) in the mix design with different quantity and different test were been perform for the result, so specimens were made according to IS code mix design and were been design for replacement of 0%, 5%, 10% of crumb rubber with fine aggregate only. The tests were conducted for compressive strength as cement concrete is most useful material used in construction industry throughout the world. Nowadays crumb rubber is being used as replacement material with F.A. as crumb rubber is becoming harmful for the environment and will affect human life in future because it does not decompose easily, so instead of treating it as waste we can use it as replacement material and which will also help in reducing cost. The specimen (150mm x150mm x150mm) were cast for testing as per IS code mix design and cement was replaced by silica fume 0%, 5%, 10% and 15% to increase the strength. As silica fume improved the strength of both concrete with replaced rubber and non-rubber or plain concrete.
Keywords: Crumb rubber, Fine aggregate, Silica fume, cement, compressive strength, Concrete, Rubber aggregates.

1. Introduction

A large no of different waste materials is being produced daily, which can be reused, recycled, and reduced. One of the them is crumb rubber and is valuable also. Some of this are harmful to environment and by RRR method (reuse, reduce, recycle) Will be beneficial to construction industry. Some case studies had present that rubber obtained from waste/scrapped is consider as the most waste material obtained in waste. As the rubber industry is growing day by day (e.g.- MRF share price; 1share= 98k). In US production of 3.6 million tons of rubber is produced, in Iran 100000 ton, in Malaysia 200000 ton per year this is due to increase in vehicle production and maintain.

Investing and testing in rubber (crumb rubber) material does not decompose under environmental conditions which is hazardous for nature. Burning is solution to decomposition but the flames become smoke and it is one of the air pollution. So solution on this is rubber can be used as replacement material in concrete with fine aggregate. Actually in real life it is difficult to manage waste produced in nature and that to rubber waste because production is at vast and that is not easy to handle.

After replacement the density of replaced aggregate concrete and ordinary concrete was less

respectively. Lower the toughness of concrete which means higher the strength. Elasticity was found to be less after replacement.
Actually fact
1- When the rubber was replaced with F.A. it showed less compressive strength compared with ordinary concrete.
2- IT is a recommenced the use Silica Fume in rubber concrete which helps in increasing the compressive strength.

1.1 Objectives

The objective of the study is: -

1. To reduce cost and use rubber from waste and replace it with F.A. and use Silica Fume as admixture to have the required amount of strength.
2. To prepare lightweight concrete by using scrap rubber tyre as aggregates.
3. To investigate the effect of addition of rubber aggregates in concrete.

2. Experimental Methods

The mix design is formed when the qualities of the various components are determined.

2.1 Material Used

Cement:
It was constructed using regular Portland cement, grade 53, in accordance with IS 12269-1987. The following specifications apply to this material: fineness of 96.7%, soundness of 2 mm, specific gravity of 2.74, standard consistency of 29%, initial setting time of 45 minutes, and final setting time of 540 minutes.

Fine Aggregate:
A 4.75 mm IS sieve is the primary filter used to remove fine aggregate. The specific gravity is 2.74, the fineness modulus is 2.56, and the water absorption rate is 0.8%. Aggregate used in a concrete pass through a 1.18 mm IS sieve but is left on a 600 micron IS sieve.

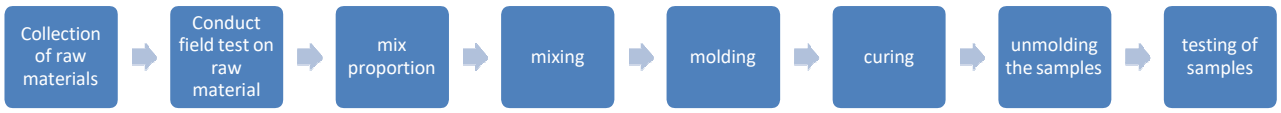
Silica fume:
Concrete made with silica fumes is often exceptionally durable and strong. The specific gravity of silica fume is 2.2, the fineness modulus is 1.5, and the colour is grey, per the test findings that were acquired from that company.

Coarse Aggregate:
Coarse aggregates include, but are not limited to, gravel, crushed stone, sand and other unreactive components used in concrete. The nominal size of the aggregates was 20 mm. a coarse aggregate that passed through a 4.75 mm IS sieve. The specific gravity is 2.82, the fine modulus is 5.71, and the moisture content is 0.45.


Fig 1: Rubber aggregate


Fig 2: silica Fume

1.2 Methodology



1.2 Experimental Procedure

After calculation of mix design, Quantity of sand, cement, course aggregate, crumb rubber and silica fume is taken, which is calculated through mix design. All the materials were mixed in proper proportion. The The required water was then slowly poured using a water-can, rotating the entire mixture repeatedly until the pile had a consistent color and consistency. The concrete which was prepared with the help of concrete mixer was then poured into the 150 mm x 150 mm x 150 mm casting mould, and the mould was tamped. The cubes were then put on the surface that vibrated to condense them. The cubes were taken out of the mould after 24 hours and allowed to cure for the predetermined time. Then, on the compression testing machine, compressive strength tests were performed, and ultimate loads were recorded. Samples were tested on 7^{th} and 28^{th} days.

The following table lists the quantity of components needed to create the required mix of grade M25:

sample	Rubber aggregate %	Silica fume %	cement	Fine aggregate	Course aggregate
S1	0	0	394	639.06	1186.38
		5	374.3	639.06	1186.38
		10	354.6	639.06	1186.38
		15	334.9	639.06	1186.38
S2	5	0	394	607.11	1186.38
		5	374.3	607.11	1186.38
		10	354.6	607.11	1186.38
		15	334.9	607.11	1186.38
S3	10	0	394	575.15	1186.38
		5	374.3	575.15	1186.38
		10	354.6	575.15	1186.38
		15	334.9	575.15	1186.38

For each amount of rubber crumb (0%, 5%, or 10%), 24 cube moulds (150 mm x 150 mm x 150 mm) were prepared means total 72 cube moulds (i.e., for 0%, 5%, 10%, and 15% silica fume added for each percent of rubber aggregate) were prepared for testing. As a result, the compressive strength of concrete mixtures was assessed after 7 and 28 days of curing. Compressive testing machine (CTM) were used to examine the compression strength of cube specimens.

Experimental Results: -

Figures show below are the result of experiment conducted. Figure 3 and 4 represents the compressive strength of concrete with 0% rubber aggregate at 7^{th} and 28^{th} curing day, from which it was clearly known that the strength was increased by addition of silica fume up to 10% with replacement cement, and then started decreasing. From the below graph, the maximum strength of 30.6 N/mm2 was obtained at 10%, then started decreasing. Hence, 10% replacement was considered as the optimum percentage of crumb rubber. From the below graph, the maximum strength of 30.6 N/mm2 was obtained at 10%, then started decreasing. Hence,

10% replacement was considered as the optimum percentage of crumb rubber. Figure 6 represents that; the maximum compressive strength was achieved at 10% replacement of silica fume in rubberized concrete (with 5% of optimum crumb rubber) at 28th curing day. Improvement in the strength is up to 10% due to replacement of silica fume inside the crumb rubber concrete and after is it start dropping down (decreasing) it can be seen in the graph. As, it can be seen from the result that crumb rubber and silica fume % used in concrete has their own limitation depending on their own properties. It should be used in limited % to have good strength beyond the limit the strength will decrease or there will be reduction in strength. So, the cement which is been replaced by silica fume is so for only to improve the compressive strength of the crumb rubber concrete.

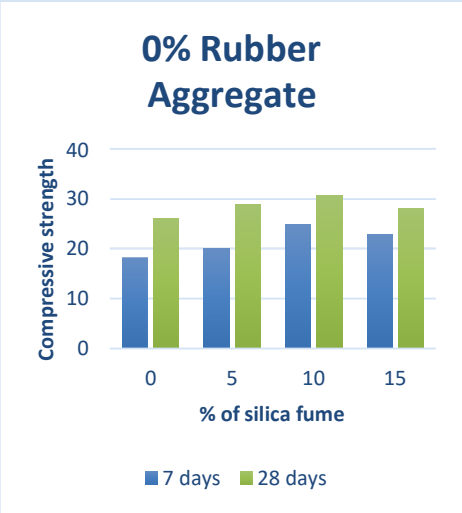


Fig 5: - compressive strength of sample 1 (S1)

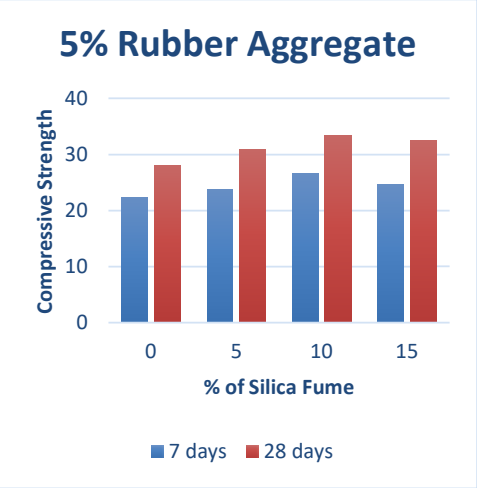


Fig 6: - compressive strength of sample 2 (S2)

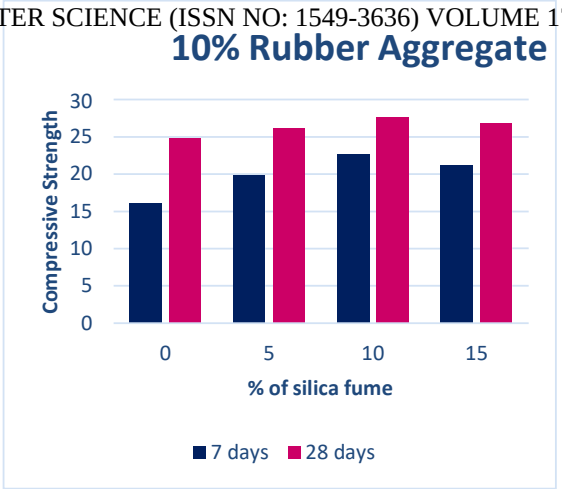


Fig 7: - compressive strength of sample 3 (S3)

Conclusion

Any other investigation to use waste tyre rubber in place of cement and aggregate in concrete may vary depending on alterations to the qualities of the materials, the proportions of components in the mixture, the curing method, and the use of admixtures & additives. The average M25 rubberized concrete's compressive strength is raised by the addition of 5% crumb rubber and 10% silica fume before starting to decline. When silica fume and rubber aggregate are substituted for 10% and 5% of the cement and aggregate, respectively, in concrete, the maximal compressive strength at the 28th day of curing is 33.4 MPa. Therefore, 5% is the ideal rubber aggregate percentage, while 10% is the ideal silica fume percentage. Therefore, it is currently advised to employ an additive to reduce cracks and boost strength, which occur inversely proportionally as silica fume with crumb rubber concrete. As a result, it is advised to utilize silica fume up to 10% and crumb rubber up to 5% in concrete.

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