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A Study on Enhancement the Strength of Conventional Concrete by Replacement of Fine Aggregate with Waste Rubber Tire

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Abstract: ***The paper presents the experimental study on waste rubber tire concrete and the parallel to the need for protecting the environment and to preserve natural aggregate by using alternative materials which are recycled or waste materials of the mechanical and durability properties of concrete with composition of crumb rubber replacing part of the fine aggregate and cement with silica fume were investigated for M-25 grade concrete as per IS10262- 2009.Compressive strength, flexural strength and split tensile strength has been conducted for each sample and the test results indicated that there was a reduction in compressive and split tensile strength and increase in flexural strength when the rubber content increase and the design target strength level to be achieved by addition of silica fume and rubber in the concrete as compared to the addition of rubber without silica fume.***

Key Words: waste rubber, Compressive strength, flexural strength, split tensile strength, M-25 grade concrete

I. INTRODUCTION

One of the most crucial environmental issues all around the world is the disposal of the waste materials. Accumulations of discarded waste tires have been a major concern because the waste rubber is not easily biodegradable even after a long-period landfill treatment. However materials and energy are alternatives to disposal of the waste rubber. Some people propose to use it as fuel material or as raw materials of rubber goods. On the other hand a wide variety of waste materials has been suggested as additives to cement based materials. Other construction products are also based on rubber powder obtained from the cryogenic milling of tires mixed with asphalt or bituminous materials. Unfortunately not much attention has been paid to use the waste tires in Portland cement concrete mixtures particularly for highway use. Limited work was done by researchers to investigate the potential use of rubber tires in conventional concrete. The literature about the use of tire rubber particles in cement-based materials focuses on the use of tire rubber as an aggregate in concrete. Most of the research as mentioned above has shown a remarkable decrease in the mechanical properties of concrete after addition of tire rubber particles as aggregate. The use of only coarse rubber particles affects the properties more negatively than do only fine particles. However, very limited studies have been conducted on the use of coarse and fine rubber particles together in the concrete mixture. However, it is reported that ultrafine mineral admixtures, such as silica fume, increase the homogeneity and decrease the number of the large pores in cement paste both of which would lead to a higher strength material. There is also ample evidence that the use of silica fume results in a denser interface between cement paste and coarse aggregates. Hence, the use of silica fume might be an alternative way to improve the properties of the rubberized concrete for the structural applications

Fig.1- waste rubber tire material

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II. MATERIAL INVESTIGATION

A. Cement Used

Cement is the binding material in concrete which is used for all building elements. OPC (Ordinary Portland Cement) 43 grades was used throughout the project. Specific gravity of cement is 3.15.

B. Fine Aggregate

Sand used for the experimental program was locally available material and conformed to Indian Standard Specifications IS: 383-1970. Sand used was river sand with specific gravity 2.6 the fine aggregate was in zone II. The water absorption of fine aggregate is 1%.

C. Coarse Aggregate

The coarse aggregate was crushed angular with a maximum size of 20mm. the specific gravity of coarse aggregate is 2.67. Water absorption of coarse aggregate is 0.5%.

D. Crumb Rubber (CR)

The source of the rubber aggregate was recycled tires which were collected from the tire recycle plant located in Vellore named as gennext hi Tec rubber. For uniformity of the concrete production and convenience, all the tires collected were from those which were originally produced from Tire factory. This study has concentrated on the performance of a single gradation of crumb rubber prepared by machine grinding. The maximum size of the rubber aggregate was 30 mesh (0.9mm).Specific gravity of crumb rubber is 1.07. Below table shows terminology for recycle tire rubber and from the table our project material is underground rubber.

Table 1 ASTM D-6270 terminology for recycled tire

Term name	Upper limit in mm	Lower limit in mm
Rough shred	(50x50x50)	(762×50×100)
Tire derived aggregate	305	12
Tire shreds	305	50
Tire chips	50	12
Granulated rubber	12	0.425
Ground rubber	<12	0.425
Powdered rubber	-	≤ 0.425

E. Silica Fume (SF)

Silica fume or micro silica collected from moon trader supplier of pozzolanic material located in Madurai. Net weight of bag contain 50kg of powder. Silica fume also referred as micro silica or condensed silica fume is another material that is used as an artificial pozzolanic admixture. It is a product resulting from reduction of high purity quartz with coal inan electric arc furnace in the manufacture of silicon or ferrosilicon alloy. Specificgravity of silica fume is 2.2

Table 2 Physical properties of materials

Materials used	Specific gravity
Cement OPC 43 grade	3.15
Fine aggregate – river sand	2.6
Coarse aggregate	2.67
Crumb rubber	1.07
Silica fume	2.2

III. EXPERIMENTAL PROGRAMME

In this work an experimental study was conducted on the development of the rubberized concrete mixtures with silica fume and the basic engineering properties were investigated. Totally 5 designated mix contain 5, 10,15 and 20 % of partial replacement of crumb rubber with fine aggregate and 5, 10,15 and 20 % of partial replacement of silica fume with cement finally compared with conventional concrete.

A. Mix Proportions

The mix proportions of different types of percentages of replacement mixes and obtained quantities for mixes were tabulated as below. Table shows the mix proportions for the percentage replacement of fine aggregate with crumb Rubber and cement with Silica fume for the grade of M25. Mix design procedure followed according to IS 10262: 2009. All mix proportions are designed with a slump ranging from 50-75mm, keeping the water content constant at 192 kg/m^3. The water – cement ratio of 0.42 is kept constant for all mixes. Fine aggregate was replaced by crumb rubber varying from 5% to 20% by weight. Cement was replaced by Silica fume varying from 5% to 20% by volume of cement.

Table 3 - Mix proportions for 1m^3 of concrete

Mix	Mix 1	Mix 2	Mix 3	Mix 4	Mix 5
Cement (kg)	475.14	432.28	411.42	388.57	365.71
SF (%)	0	5	10	15	20
SF(kg)	0	22.5	45.71	68.57	91.42
Coarse aggregate (kg)	1115.23	1110.18	1106.82	1100.09	1095.04
Fine aggregate (kg)	637.80	634.92	632.96	629.14	626.26
CR (%)	0	5	10	15	20
CR(kg)	0	13.06	26.05	38.48	51.54

B. Casting of Specimens

In the mixing process the concrete was dry mixed using hand mixing after then water was added gradually and mixed till the homogenous mix obtained. Crumb rubbers mixed with cement and silica fume and then with aggregate finally mix the water. To prevent the crumb rubber initially mixed with aggregate because of low specific gravity of rubber to float at the top of mixture.

C. Fresh Concrete Properties -Slump Test

The slump factor is used to measure the horizontal free flow known as workability of concrete. The test has been carried out for M25 grade concrete and results are shown that it has been identified all the rubber replaced with fine aggregate concrete might behaved low value compared with conventional concrete. Hence it is preferred to make use of workability with 0.42 water cement ratio.

D. Hardened Concrete Properties

1) *A. Compressive Strength:* The purpose of compression test is to determine the crushing strength of hardened concrete. Compression test was carried out on cube of size150mm×150mm×150mm.The strength was recorded at 7, 14 and 28 day. The average reading of 3 specimens was recorded as the strength at respective age of concrete. The compressive strength test is carried out in compression testing machine of 3000 KN capacity. The ultimate strength is recorded after the specimens fail to

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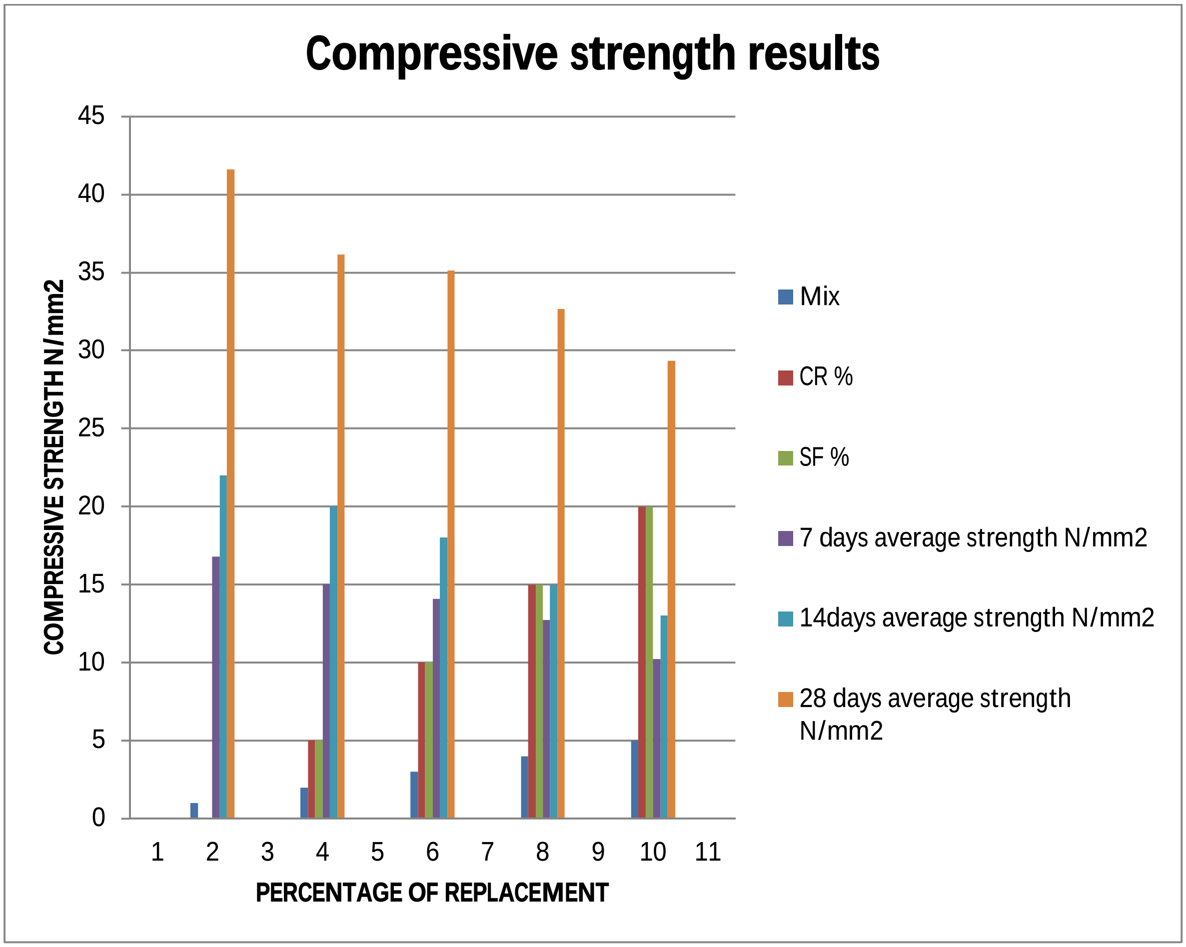
resist more loads. The compressive strength can be calculated by using formulaCompressive strength = failure load/cross sectional area.

Table 4 - Compressive strength results

Mix	CR	SF	7 days average strength	14 days average strength	28 days average strength
	%	%	N/mm^2	N/mm^2	N/mm^2
1	0	0	16.8	22	41.60
2	5	5	15.03	20	36.14
3	10	10	14.10	18	35.11
4	15	15	12.74	15	32.66
5	20	20	10.22	13	29.33



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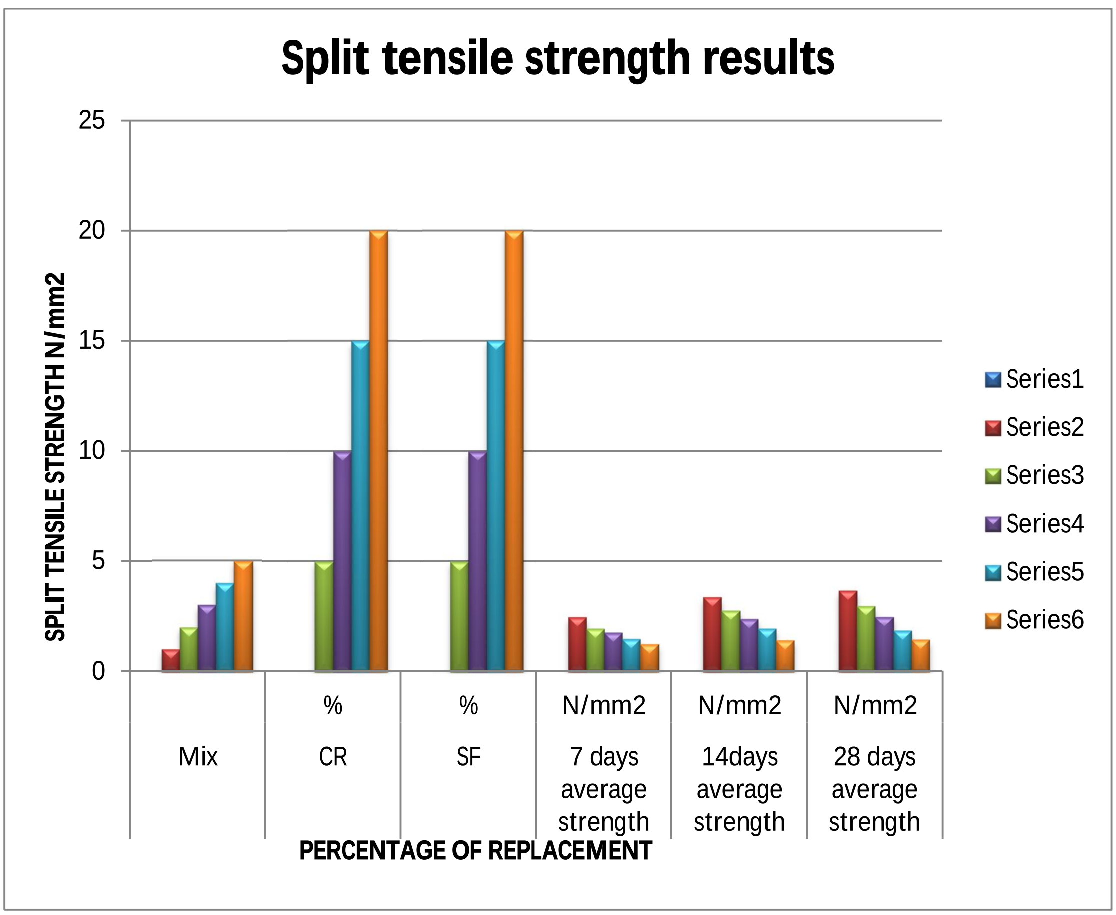
2) *Split Tensile Strength:* Split tensile test was carried out on cylindrical specimens of 150mm diameter and 300mm height at the age of 7, 14 and 28 day. The specimens were tested using compression testing machine of 3000 KN capacity.

$$\text{Split tensile strength} = 2P / (\pi \times D \times L)$$

Where P = load, D= Diameter, L= Length.

Table 4 - Split tensile strength results

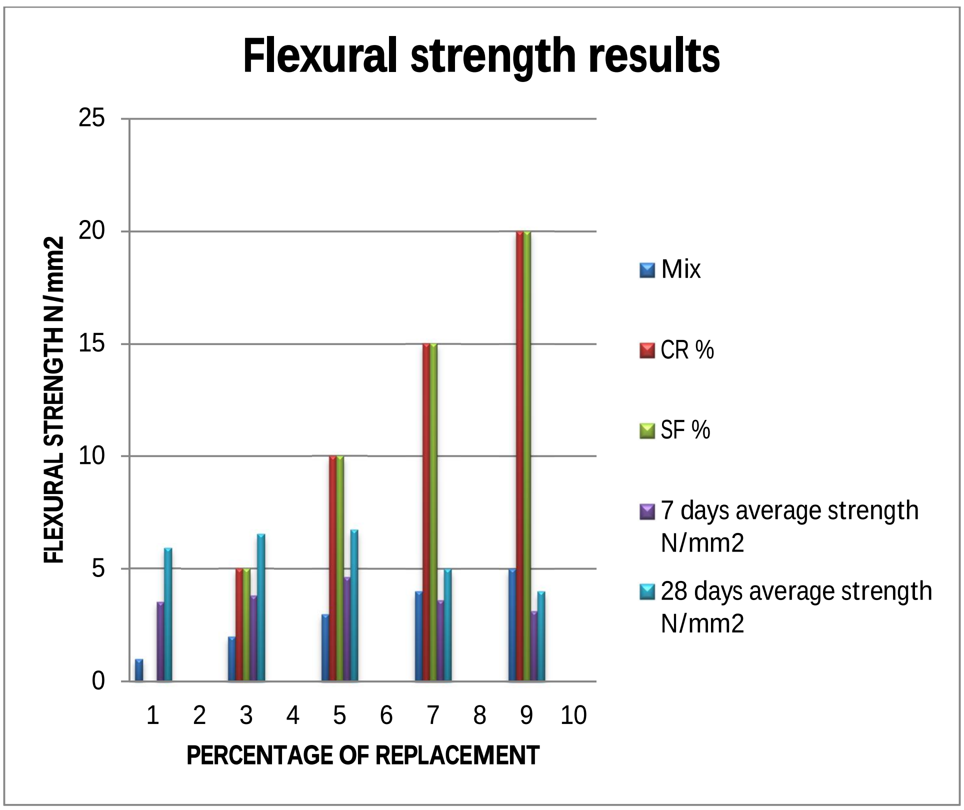
Mix	CR	SF	7 days average strength	14days average strength	28 days average strength
	%	%	N/mm^2	N/mm^2	N/mm^2
1	0	0	2.45	3.36	3.65
2	5	5	1.95	2.76	2.94
3	10	10	1.76	2.38	2.47
4	15	15	1.48	1.95	1.86
5	20	20	1.24	1.41	1.43



3) *Flexural Strength:* The experimental test is to determine the maximum load carrying capacity of beam specimens. The specimen is subjected to two points loading and the load at the failure of the specimen is noted down. Flexural strength was carried out on beam specimen of 100×100×500mm and tested at the age of 7 and 28 days. The specimens were tested using capacity of 100KN flexure machine. The flexure strength can be calculated by using $f_b = (Pl/bd^2)$ Where p is the failure load, l is the length of the specimen, b is the breath and d is the depth

Table 6-Flexural strength results

Mix	CR	SF	7 days average strength	28 days average strength
	%	%	N/mm^2	N/mm^2
1	0	0	3.53	5.92
2	5	5	3.8	6.53
3	10	10	4.64	6.73
4	15	15	3.6	5
5	20	20	3.12	4



4) *Durability Properties:* In crumb rubber concrete most of the research work shows that rubber treated with chemicals like sulphuric acid, hydrochloric acid, and sodium hydroxide etc. gives roughness to the material and are easily bonded with concrete to gain strength. Based upon this point of view durability property with acid curing for 28 days compressive strength is

to be done instead of treatment of rubber with solutions. One of the major concerns of the material is the ingress moisture and aqueous solutions or the contact with an alkaline environment when durability is considered.

a) *Sulphuric Acid And Hydrochloric Acid:* To conduct this test, one litre of sulphuric acid was mixed with 100 litres of ordinary portable water. The specimens were cured for 28 days in Ordinary potable water for 28 days and then immersed in the solution for a period of 28 Days. Compressive strength after curing to be calculated.After testing strength to be compared with conventional concrete and normal portable water curing strength. Procedure to be same as followed for hydrochloric acid

Table 7Compressive strength results (28 days) on acid attack

Mix	CR	SF	Normal curing	Curing with H_2SO_4	Curing with HCL
	%	%	N/mm^2	N/mm^2	N/mm^2
1	0	0	41.6	42.4	41.3
2	5	5	36.14	36.59	37.10
3	10	10	35.11	36.14	36.51
4	15	15	32.27	31.70	30.20
5	20	20	29.33	27.7	28.5

IV. RESULTS AND DISCUSSIONS

A. For rubberized concrete, the test results show that the addition of rubber aggregate resulted in a reduction in concrete compressive strength compared with the control concrete. This reduction increased with increasing percentage of rubber aggregate. Losses in compressive strength ranging from 6.5 % to 64.02 were observed. The reason for the strength reduction is due to lack of adhesion at the boundaries of the rubber aggregate, soft rubber particles behave as voids in the concrete matrix.

B. The results of the splitting tensile strength tests show that, there is a decrease in strength with increasing rubber aggregate content like the reduction observed in the compressive strength tests. However, there was a smaller reduction in splitting tensile strength as compared to the reduction in the compressive strength. The visual observation of the patterns of failure mode shows that the rubberized concrete does not exhibit typical compression failure behavior. The control concrete shows a clean split of the sample into two halves, whereas the rubber aggregate tends to produce a less well defined failure. Moreover, the mode of failure was a gradual type rather than the brittle failure in the control concretes.

C. A significant advantage of increase in flexural strength was achieved by limiting the replacement amount to only 10 % of the fine aggregate. In these two categories of concretes, for rubber aggregate contents of 15 and 20 % a flexural strength reduction was observed compared to the control mixes. The reduction indicates that improvements in flexural strength are limited to relatively small rubber aggregate contents. Since the tendency of the flexural strength test results are a bit different from the other strength test results due to ductile nature of rubber materials.

D. As compared to earlier researchers rubberized concrete shows that loss of mechanical and durability properties without any other replacements like silica fume, fly ash, ggbs etc. In this work rubberized concrete with silica fume shows the results reduction in strength but strength results are controlled and achieved the target strength value of 25Mpa.

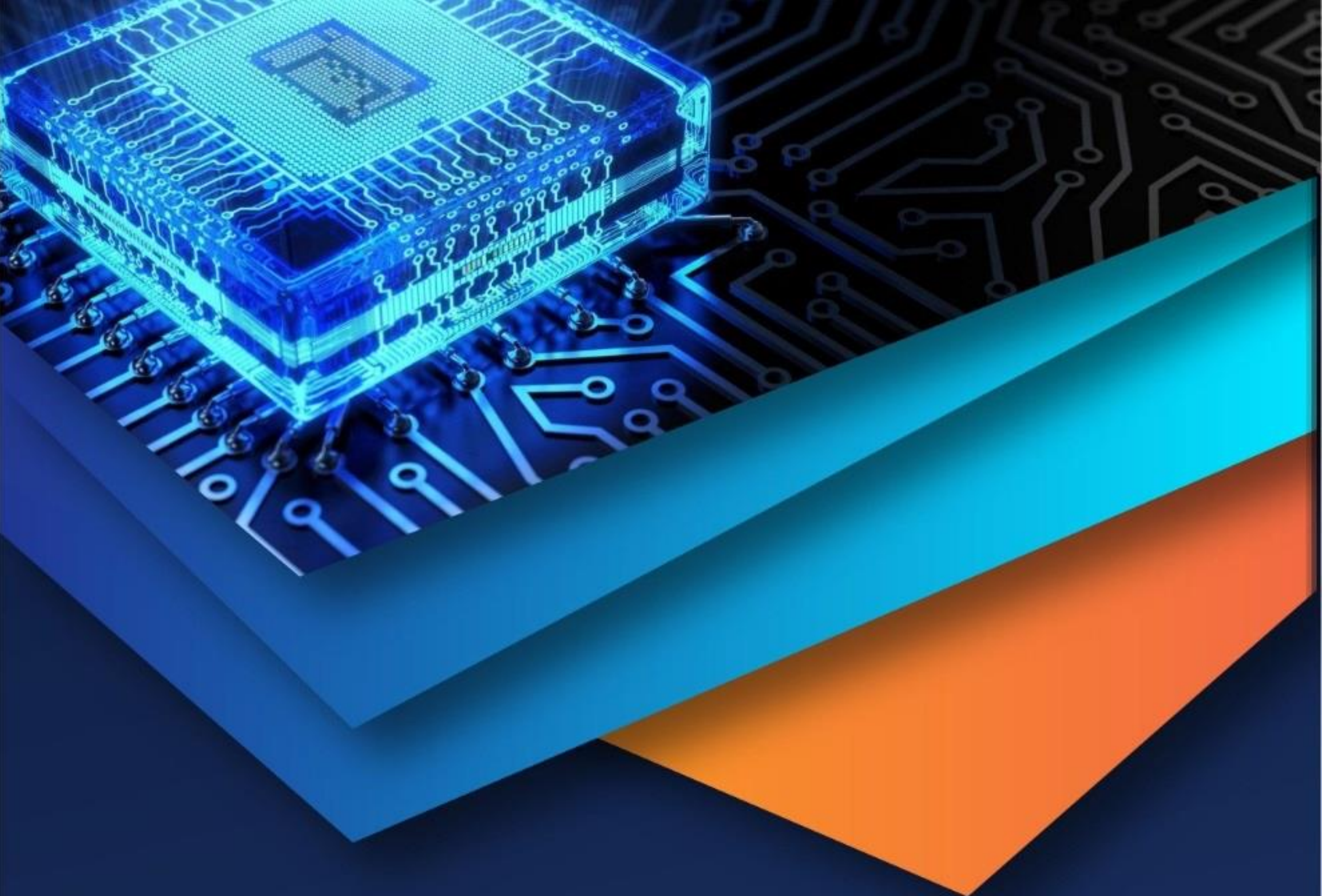
E. The durability properties on acid attack shows the good results compared to conventional concrete strength by normal curing. Variation identified as slightly increase in strength on sulphuric acid and hydrochloric acid curing. Some of the replacement level shows constant value in durability properties.

V. CONCLUSION

In this study to be focused on crumb rubber is the product of mechanical grinding (ambient grinding) of tyre showed results were quite satisfactory with no compromise in strength requirements but the concrete is durable. Durability properties on acid attack shows curing on chemicals or crumb rubber treatment with chemicals show good results. Other type of grinding called cryogenic grinding is the process of crumb rubber is made by chemical process which is very rare in India. Further study is required on cryogenic grinding product. Therefore this study has been focused on strength and durability requirement shows the concrete is sustainable and used for non-structural elements where the strength is not required.

REFERENCES

[1] M.M. Al-Tayeb& B.H. Abu Bakar& H.M. Akil& H. “effect of partial replacement of sand by fine crumb rubber on impact load behaviour of concrete beam: experiment and nonlinear dynamic analysis” journal of materials and structures
[2] Ahmed N. Bdour and Yahia A. Al-Khalayleh “Innovative Application of Scrap-tire Steel Cords in Concrete Mixes” Jordan Journal of Civil Engineering, Volume 4, No. 1, 2010
[3] Ashraf Fadiel, Fouad Al Rifaie, Taher Abu-LebdehandEllieFini “use of crumb rubber to improve thermal efficiency of cement-based materials”American Journal of Engineering and Applied Sciences 7 (1): 1-11, 2014
[4] Anu Bala1c, V.K. Sehgal, BabitaSaini “Effect of Fly ash and Waste Rubber on Properties of Concrete composite” concrete research volume 3 sept 2012 p (842-857)
[5] DhirajAgrawal ,Pawan Hinge ,U. P. Waghe ,S.P. Raut “Utilization of industrial waste in construction material – A review” International Journal of Innovative Research in Science, Engineering and Technology Vol. 3, Issue 1, January 2014.
[6] Dina mukeefHamza and RanaHashim “ effect of rubber treatment on compressive strength and thermal conductivity of modified rubberized concrete” Journal of engineering and development, vol 15, 2011
[7] El-Gammal A., Abdel-Gawad A. K., El-Sherbini Y. and Shalaby A. (2010) “Compressive Strength of Concrete Utilizing Waste Tyre Rubber”, Journal of Emerging Trends in Engineering and Applied Sciences (JETEAS) 1 (1): 96-99 © Scholarlink Research Institute Journals, 2010.
[8] Güneyisi E., Gesoğlu M. and Ö zturan T. "Properties of Rubberized Concretes Containing Silica Fume" Cem. Concr. Res. 34 (2004) 2309-2317.
[9] Ganesan N, Bharati raj J and shashikala “strength and durability of self-compacting rubberised concrete” September 2012,The indian concrete journal” p-(15-24)
[10] F. Hernandez-Olivares, G. Barluenga “ fire performance of recycled rubber-filled high strength concrete” cement and concrete research 2004 volume 34 p(109 - 117)
[11] Kotresh K M , Mesfingetahunbelachew “study on waste tyre rubber as concrete aggregates” international journal of scientific engg and technology 2014 vol 3(4) p (433-436)
[12] Krunal N patel and jamnu M A “enhancement of mechanical properties of rubber crumb concrete using pre-treated rubber crumbs and Alccofine” journal of international academeic research 2014 vol 2(2) P (378-385)
[13] Malek K Batayneh, Ibrahim Asi. (2008). “Promoting the use of crumb rubber concrete in developing countries”.)Waste management 28 p(2171-2176
[14] Maroulidou m and Figueiredo “discarded tyre rubber as concrete aggregate a possible outlet for used tyres” 2010 global nest journal vol 12(4) p(359- 367)
[15] Verma Ajay Chandak Rajeev2 and Yadav R.K. “Effect of Micro Silica on The Strength of Concrete with Ordinary Portland Cement” Research journal of engineering science Vol. 1(3), 1-4, Sept. (2012
[16] ASTM International Standards, http: // www.astm.org/standards, 2009.[Viewed 04 August 2009
[17] Silica fume user manual from silica fume association april 2005.



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