iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH
IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 5 Issue: XI Month of publication: November 2017

DOI:

www.ijraset.com

Call: 08813907089 | E-mail ID: ijraset@gmail.com

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor:6.887
Volume 5 Issue X1, November 2017- Available at www.ijraset.com

Effect of Rice Husk Ash on Strength Properties of Crumb Rubber Concrete

Nikhil Brari[1], Dr. Hemant Sood[2]
[1, 2] *M. Tech Student, Professor and Head Department of Civil Engineering, N.I.T.T.T.R, Chandigarh, India*

Abstract: The stockpiling of waste tyres has become an alarming issue for many countries around the world. Due to its adverse environmental impacts, it has become necessary to investigate alternative options for the disposal of this waste. One such alternative is to use recycled tyres in the construction industry. For past few years, scrap rubber tyre aggregates are being used as a replacement of fine as well as coarse aggregates in concrete mixes effectively. However, the content of rubber in concrete mix is restricted to some limits as it is clear from the previous studies that with increase in tyre content there is a significant loss in the strength of rubberized concrete. Hence, to make this practice of using rubber tyre aggregates in concrete a successful attempt, it has become of prime importance to reduce/control this loss of strength in concrete. There are several methods that have been tried to serve the purpose like pre-treatment of crumb rubber, using defoamer in crumb rubber concrete mix etc. Rice Husk Ash is a fine material and also possesses good pozzolanic properties. So in the present research work, Rice Husk Ash has been used to replace cement partially at different replacement levels and its effect on strength properties of rubber modified concrete has been studied. A reference rubber modified concrete mix was prepared by replacing natural fine aggregates in normal concrete of M 30 grade with crumb rubber at a fixed replacement level of 10 % and after that this reference mix was used to prepare another concrete mix in which cement was replaced with Rice Husk Ash at different percentages of 2 %, 4 % and 6 %. The replacement of fine aggregates in both the cases was done at 10 %. The size of crumb rubber varies from 4.75 mm to 0.15 mm. Slump test was conducted on fresh concrete for each mix group of rubber modified concrete to check the workability. Hardened properties like compressive, flexural and split tensile strength were determined for every mix and the results obtained from various laboratory tests were analysed and comparative discussions were done. A slight improvement in the compressive, flexural and split tensile strength properties of rubber modified concrete was seen on the use of rice husk ash in the mix at low replacement level.
Keywords: rubber modified concrete, crumb rubber, Rice Husk Ash, pozzolanic properties

I. INTRODUCTION

Use of tyre waste in construction industry has emerged as an effective idea for the disposal of tyre waste. Many research works have been carried out till now in which researchers have used rubber aggregates in concrete mix as a partial replacement of fine as well as coarse aggregates. This practice has not only solved the issue of the tyre waste disposal but also it serves as an alternative source of aggregate for the construction industry. Somehow, it has helped in improving the flexibility of concrete and making the concrete more resistive to the impact of high amount of energy before the failure [1, 2]. Rubberized concrete can be utilized as a shock absorbing material in highway constructions, also in buildings as an earthquake shock-wave absorber and in sound barriers as sound absorber. Rubberized concrete also has high sound absorption coefficient (a), noise reduction coefficient (NRC) and less thermal conductivity coefficient (k) [3]. Hence, crumb rubber concrete exhibits superior thermal and sound properties than plain concrete. Now a days it is being used in non-load bearing walls in buildings, precast side walk panel and precast roof for green buildings. Since, it has low unit weight and it is not brittle in nature, so it can be used in roadways project, crash barriers, sidewalks, pavement blocks, recreational courts, pathways and skid resistance ramps and mostly where high strength is not required and in low unit weight structures. The main drawback of using rubber aggregates is that it affects the strength properties of concrete. Some studies show that the reduction in the strength is not only due to the air entrapped but also due to poor bond between the cement paste and the rubber particles. Also there is a high difference in specific gravity of waste rubber aggregate and other constituents of concrete because of what the process of crack propagation gets accelerated. These all factors are responsible for the strength reduction in rubber modified concrete. Rice Husk Ash, being a fine and pozzolanic material, can be introduced in concrete mixes partially in place of cement. Since, it is rich in silica, the heat evolution is less, which ultimately results in reduction in thermal cracking and plastic shrinkage to some extent.

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor:6.887
Volume 5 Issue X1, November 2017- Available at www.ijraset.com

Ghassan Abood Habeeb et al, studied the properties of RHA and its effect on the strength properties of concrete. The compressive strength of the blended concrete with 10% RHA has been increased significantly, and for up to 20% replacement could be valuably replaced by cement without adversely affecting the strength. Increasing RHA fineness enhances the strength of blended concrete.

II. EXPERIMENTAL PROGRAMME

A. *Constituent Materials*

Ordinary Portland cement of 43 grade was used matching the requirements as per IS: 8112-1989. Crushed aggregates, angular in shape have been used in the experimental work having a nominal maximum size of 20 mm. natural river sand was used as fine aggregate belonging to Zone III having specific gravity 2.63 and fineness modulus 2.82.

Crumb rubber was added to the concrete mix at a fixed replacement level of 10 % by weight of fine aggregates. Crumb rubber of size varying from 4.75 mm to 0.15 mm was used for the experimental work. Physical properties of fine aggregate and crumb rubber is given below in Table - 1. Particle size distribution curve has been shown for sand and crumb rubber in Fig. 1.

Table – 1: Physical Properties of Natural River Sand and Crumb Rubber

Properties	Natural river sand	Crumb rubber
Specific Gravity	2.63	1.15
Fineness modulus	2.82	3.14
Water Absorption	1.1 %	0.89 %

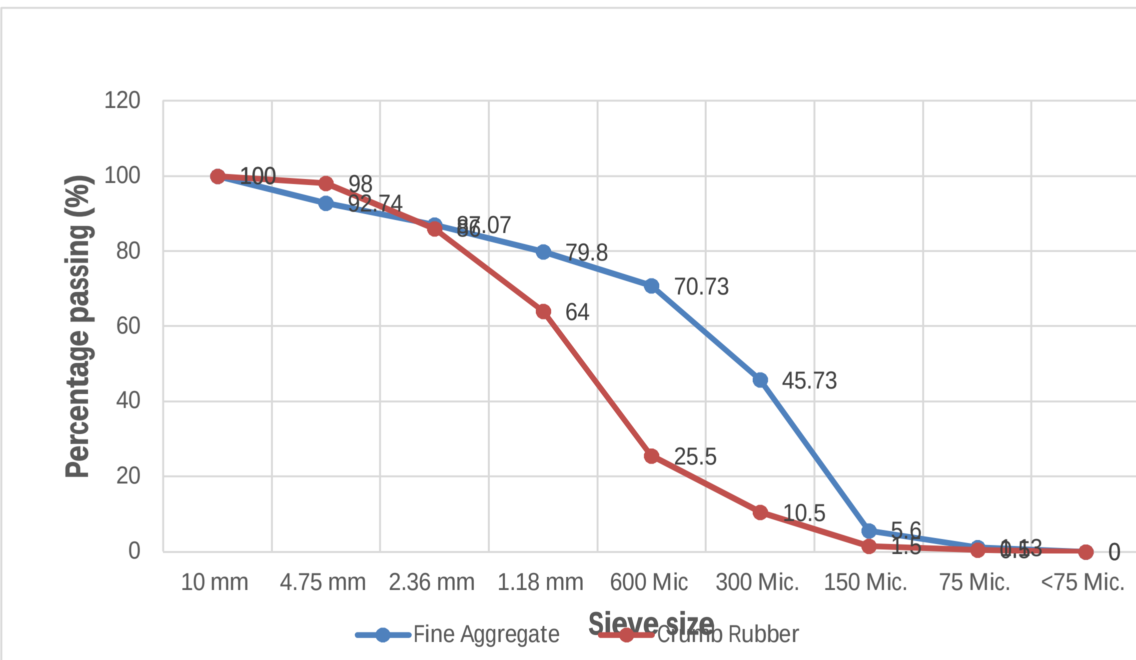

Fig. 1: Particle Size Distribution Curve for Fine Aggregate and Crumb Rubber

Rice husk ash having nominal size 40 µ was used for the partial replacement of cement with varying percentages of 2, 4, and 6 %.

B. *Mixture Proportion*

Firstly, reference concrete mix (C) of M 30 grade was designed as per IS 10262: 2009. After this, proportioning for rubber modified concrete mixes at fixed 10 % replacement of fine aggregate (by weight) with crumb rubber and RHA based rubber modified concrete In which cement was replaced partially with 2 %, 4 % and 6 % replacement levels, was carried out respectively and the proportion obtained are placed in Tables listed below. The cement content and water cement ratio was kept 415 kg/m^3 and 0.42 in all the mixes of rubber modified concrete. The coarse aggregate content was also same (1255.64 Kg/m3) in all the concrete mix groups. The Super plasticizer was added at the rate of 1 % by weight of cement. The control concrete is denoted by "C", rubber modified concrete mix by "CR_{10}" and RHA based rubber modified concrete mixes with different percentages of RHA content by "CRR_x". Where "x" denotes the percentage replacement of cement with RHA.

Table –2: Mix proportioning for rubber modified concrete mix

Mix Group	Cement Content (Kg/m^3)	w/c	Water Content (Kg/m^3)	Crumb Rubber Replacement (%)	Fine Aggregate (Kg/m^3)		Coarse Aggregate (Kg/m^3)		Super Plasticizer @ 1% by weight of cement (Kg/m^3)
					Sand	Crumb Rubber	20 mm	10 mm	
C	415	0.42	174.33	0.0	625.16	0.0	896.87	358.75	4.15
CR_{10}	415	0.42	174.33	10	562.64	62.516	896.87	358.75	4.15

Table – 3: Mix proportioning for RHA based rubber modified concrete mixes

Mix Group	Cement Content (Kg/m^3)	w/c	Water Content (Kg/m^3)	Crumb Rubber Replace ment (%)	RHA replace ment (%)	RHA kg/m^3	Fine Aggregate (Kg/m^3)		Coarse Aggregate (Kg/m^3)		Super Plasticizer @ 1% by weight of cement (Kg/m^3)
							Sand	Crumb Rubber	20 mm	10 mm	
CRR_2	406.7	0.42	174.33	10	2	8.3	562.64	62.516	896.87	358.75	4.15
CRR_4	398.4	0.42	174.33	10	4	16.6	562.64	62.516	896.87	358.75	4.15
CRR_6	390.1	0.42	174.33	10	6	24.9	562.64	62.516	896.87	358.75	4.15

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor:6.887
Volume 5 Issue X1, November 2017- Available at www.ijraset.com

C. Testing

Workability of all the mixes were determined in accordance with IS: 1199-1959. Testing for compressive, flexural and split tensile strength of control, rubber modified and RHA based rubber modified concrete was carried out as per IS: 516-1959. For each concrete mix group, a set of three cubes of 150×150×150 mm, beams of 400×100×100 mm and cylinders of 200×100 mm were prepared for testing at 7 and 28 days of curing respectively; this way a total of 30 specimens each of cubes, beams and cylinders were cast. The cubes and cylinders were tested in Compression testing machine (CTM) of 3000 KN capacity. The load was applied gradually and increased continuously at a rate of approximately 140 Kg/cm^2/min. beams were tested in automatically operating testing machine.

III. RESULTS AND DISCUSSION

A. Effect on Workability

The consistency of rubber modified and RHA based crumb rubber concrete for each mix group has been determined using the slump test in accordance to IS: 1199-1959. The test results for workability of rubber modified concrete mix at replacement percentage of 10 % and RHA based rubber modified concrete at 2, 4 and 6 % are shown in Table 4.

Table –4: Slump Values for concrete mixes.

Mix Group	Replacement percentage of crumb rubber (%)	Replacement of RHA	Slump (mm)
C	0.0	0.0	75
$CR_{10(fixed)}$	10.0	0.0	50
CRR_2	10.0	2.0	50
CRR4	10.0	4.0	53
CRR_6	10.0	6.0	56

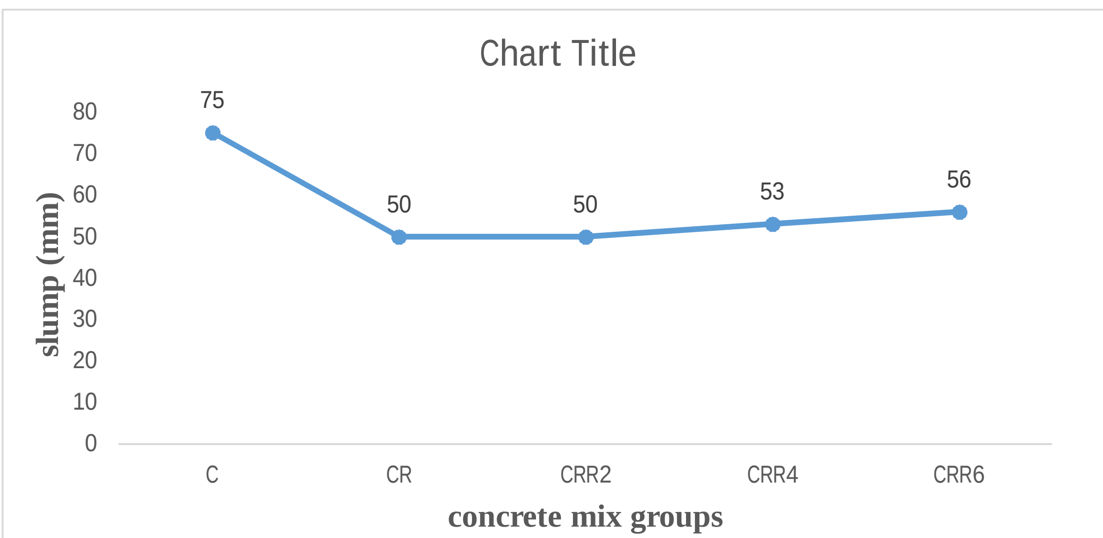

Fig.2: slump variation

Table 4. and the graph (Fig.2) clearly show that addition of crumb rubber in the concrete mix causes decrease in the concrete slump. But even after this reduction in slump, workable mix was produced at all replacement percentage level. Rubber modified concrete mix was harsh and was not easy to compact manually. The slight change in the slump value of mixes having RHA content, can be inferred to the packing ability of RHA particles which reduced the air voids to some extent. Though the mixes which had RHA content did not differentiate from the reference rubber modified concrete much and was poorly workable too. The

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor:6.887
Volume 5 Issue X1, November 2017- Available at www.ijraset.com

poor workability of rubber modified concrete is due to the increased friction between concrete matrix and the rubber aggregates which have rougher texture than the natural aggregates. Also rubber aggregates are hydrophobic in nature, which leads to increase in percentage of air voids. These all factors are responsible for the poor workability of the rubber modified concrete mixes.

B. Effect on Compressive Strength

The compressive strength of different mix group of rubber modified and RHA based rubber modified concrete was tested for at 7 and 28 days as per IS: 516-1959. The test results of compressive strength are shown in Table 5. From the test results, it has been found that on replacing natural fine aggregate with the crumb rubber, the strength reduced significantly. However, when cement was replaced with rice husk ash in the crumb rubber concrete mix at 2 % level, the compressive strength of the mix was increased slightly, at 4 % it was approximately the same as before and decreased at 6 %.

Table – 5: Compressive strength of control, crumbrubber concrete and RHA based crumb rubber concrete

Mix Group (M30)	Replacement percentage of crumb rubber (%)	Replacement percentage of Rice Husk Ash (%)	Compressive strength (N/mm^2)	
			7 days	28 days
C	0.0	0.0	24.4	38.37
$CR_{10\ (fixed)}$	10	0	21.77	32.96
CRR_2	10	2	22.6	33.87
CRR_4	10	4	21.87	33.03
CRR_6	10	6	21.2	31.85

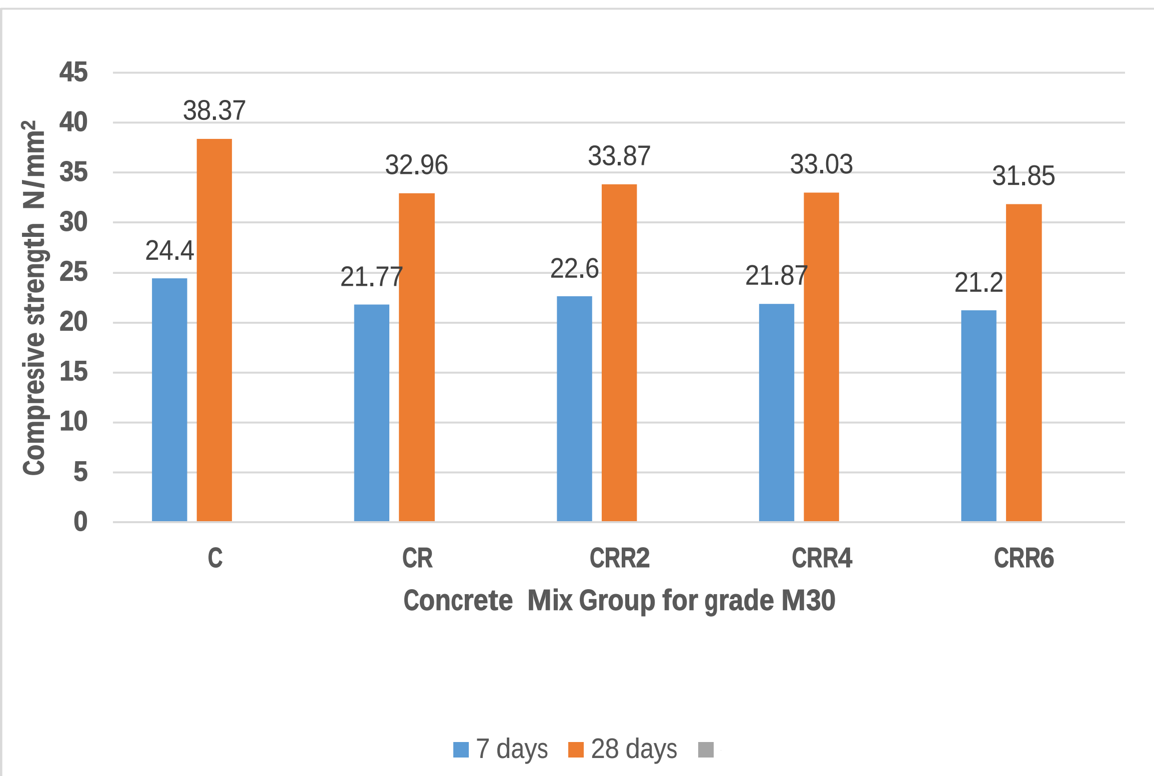

Fig. 3: Comparison of 7th and 28th day compressive strength of concrete mix groups

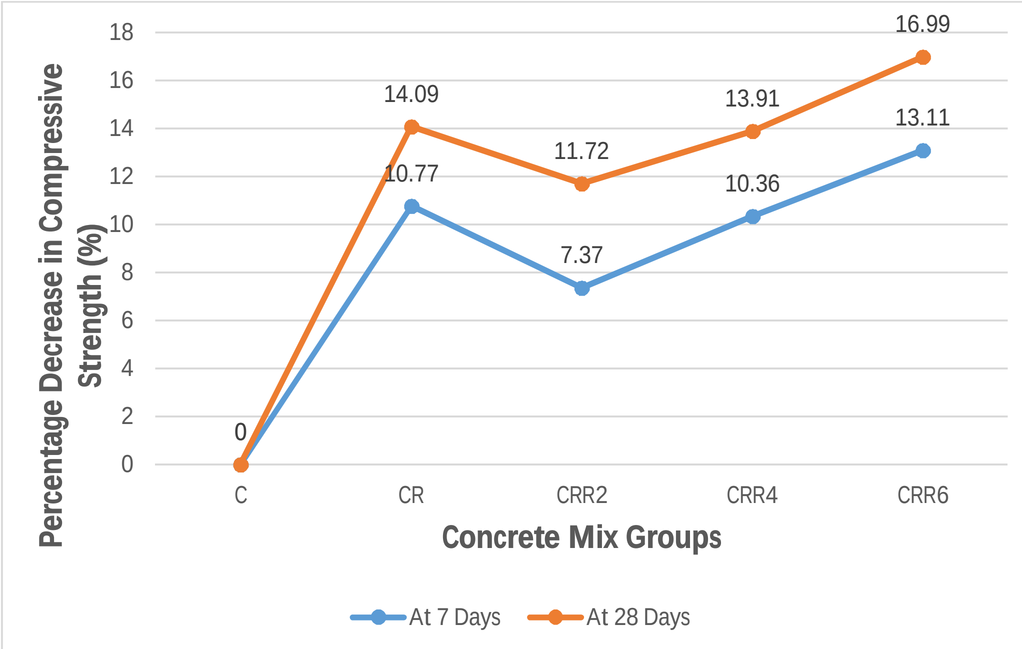

Fig. 4: Percentage Decrease in 7th and 28th day compressive strength of concrete mix groups

This research was mainly concerned with the study of the effect of replacement of cement with RHA on crumb rubber concrete at different replacement level of 2, 4 and 6 %. From the above analysis it can be seen that the percentage decrease in compressive strength of the RHA based crumb rubber concrete is less as compared to crumb rubber concrete at replacement level 2 % and 4%. However it increased as the content of RHA was introduced at 6 % in the mix.

C. *Effect on flexural strength*

Flexural strength also showed decreasing trend in its values as the crumb rubber introduced in the concrete mix. But the variation in the values of flexural strength of crumb rubber concrete mixes in which RHA was used in place of cement at replacement level 2 % was positive and at 4 %, it was almost unchanged as compared to the reference crumb rubber concrete.

Table – 5: Flexural strength of control, crumb rubber concrete and RHA based crumb rubber concrete

Mix Group (M30)	Replacement percentage of crumb rubber (%)	Replacement percentage of Rice Husk Ash (%)	flexural strength (N/mm^2)	
			7 days	28 days
C	0.0	0.0	4.84	7.56
$CR_{10\ (fixed)}$	10	0	4.25	6.42
CRR_2	10	2	4.3	6.5
CRR_4	10	4	4.2	6.3
CRR_6	10	6	3.9	5.9

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor:6.887
Volume 5 Issue X1, November 2017- Available at www.ijraset.com

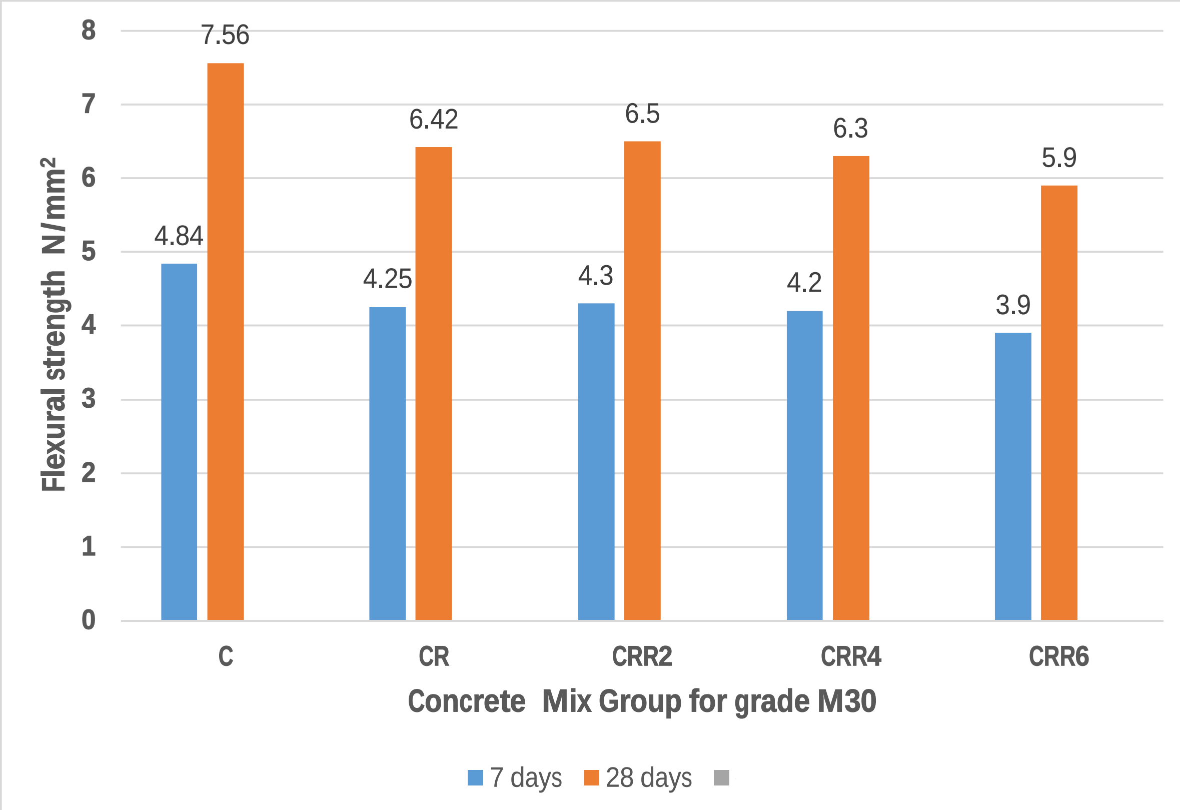

Figure.5: Comparison of 7th and 28th day flexural strength of concrete mix groups

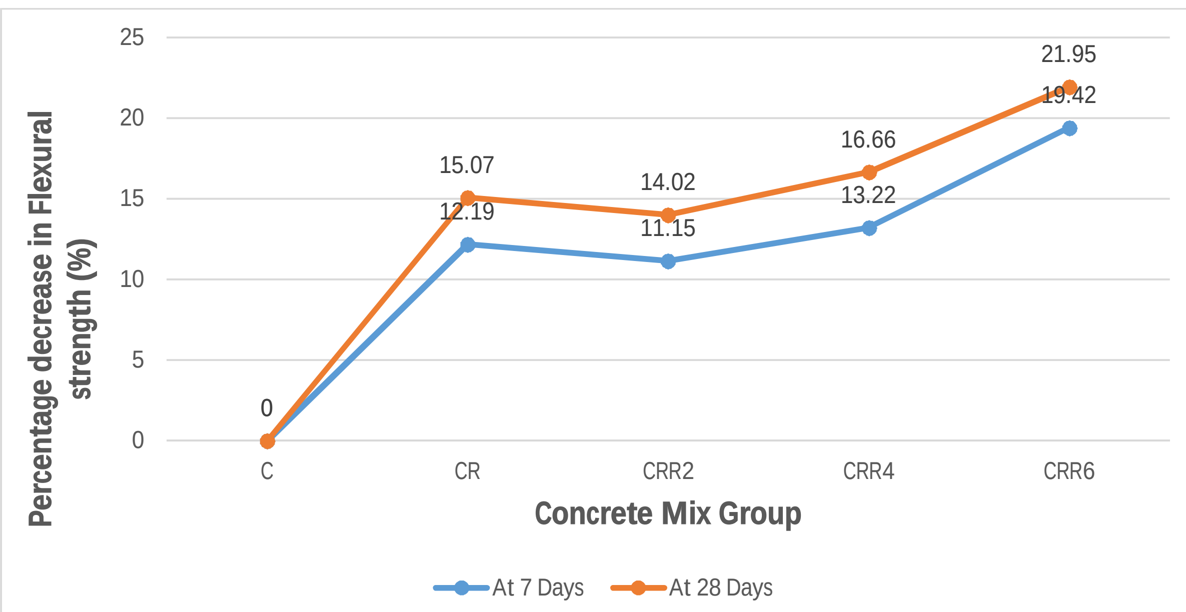

Fig. 6: Percentage Decrease in 7th and 28th day flexural strength of concrete mix groups

From comparison bar chart and the percentage decrease graph, RHA does not seem to be affecting the strength adversely rather than it improved the strength property slightly when it was used at lower percentages like 2 % and 4 %. As from the graph, it can be seen clearly that the percentage decrease in flexural strength for RHA based rubber concrete (at 2 %) was less as compared to reference crumb rubber concrete at 28 days. Though increase in RHA content above these percentages can leads to further reduction.

D. Effect on split tensile strength

Being a weak material in tension, reduction in spilt tensile strength of all the modified mixes was seen as compared to the control mix. From the table 4.4, a huge drop in the strength of the crumb rubber concrete at 28 days as compared to the control mix can be seen. However, RHA based crumb rubber concrete (at 2 % replacement level) showed a slight increase in the strength.

Table -6: Split Tensile strength of control, crumb rubber concrete and RHA based crumb rubber concrete

Mix Group (M30)	Replacement percentage of crumb rubber (%)	Replacement percentage of Rice Husk Ash (%)	Split tensile strength (N/mm^2)	
			7 days	28 days
C	0.0	0.0	2.86	4.29
$CR_{10\ (fixed)}$	10	0	2.01	2.38
CRR_2	10	2	2.04	2.38
CRR_4	10	4	2	2.1
CRR_6	10	6	1.9	2

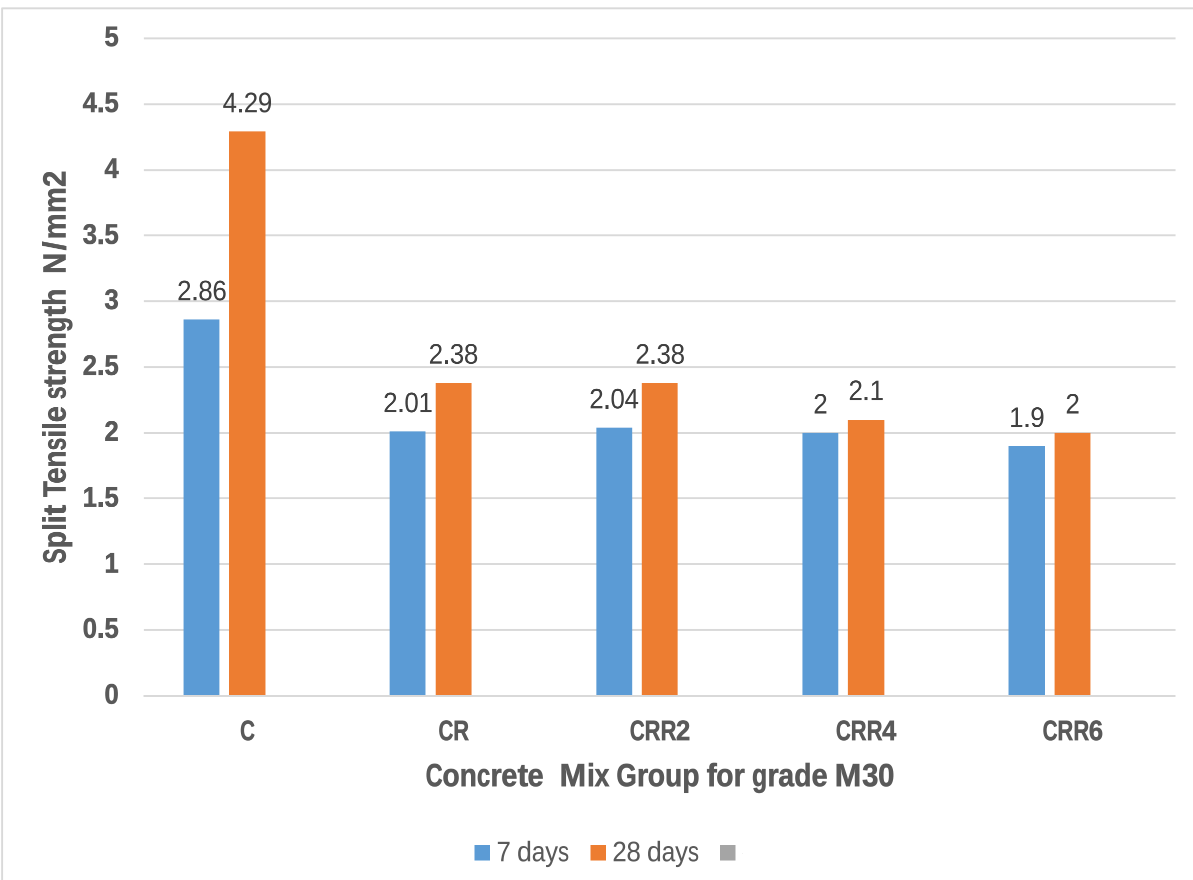

Fig. 7 Comparison of 7th and 28th day split tensile strength of concrete mix groups

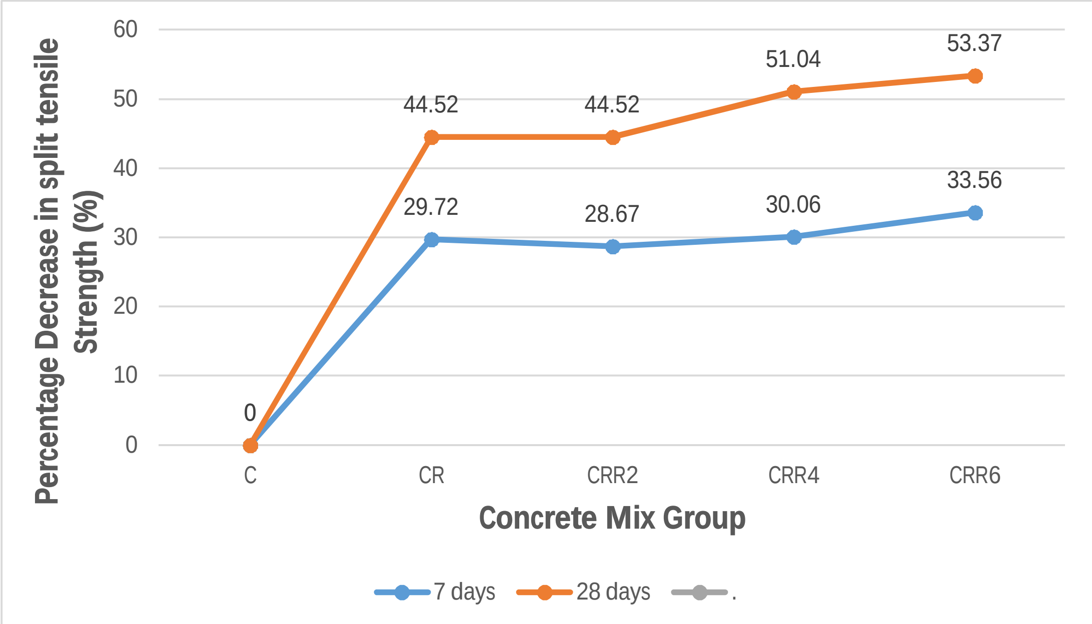

Fig. 8: Percentage decrease in 7th and 28th day split tensile strength of concrete mix groups

From comparison bar chart and the percentage decrease line graph, we can see that variation in strength of control mix and rubber modified mix for 7 days was small. But the drop in 28 days strength for rubber modified concrete was large. Approximately 44 % reduction in split tensile strength of crumb rubber concrete (at replacement level 10%) can be seen. But RHA based crumb rubber concrete (at replacement level of 2 % RHA) showed a slight positive variation in the strength, though it was not enough to match up with the control mix strength value.

IV. CONCLUSIONS

From the results and analysis of this experimental work, carried out, the following conclusions were arrived:

A. The harshness of the crumb rubber concrete is slightly decreased due to the addition of RHA as checked through slump test, the value of true slump was increased a bit.
B. The strength parameters such as compressive, flexural and split tensile strength showed slight increase in their value when RHA was added to the crumb rubber concrete at lower percentages like 2 and 4 %.
C. During compression test, it was observed that the failure pattern in control concrete was brittle, macro cracks appeared and concrete portion separated out from the main specimen. Where as in RHA based crumb rubber concrete the failure behaviour pattern was gradual and not brittle, smaller size cracks appeared and no concrete portion was separated out; whole specimen remained intact. Thus, indicating that RHA based rubber modified concrete might be capable of bearing load and undergoing deformation even after the cracks has appeared and failure may not be brittle.
D. At 4 % level, cement replacement with RHA did not affect the strength properties of crumb rubber concrete much and the previous strength values were still achieved. However, at replacement level of 2 %, enhancement in compressive, flexural and split tensile strength was observed.
E. From the above discussion it is concluded that RHA can be used as a replacement for cement in crumb rubber concrete under certain limits as it is showing positive results. Also it can lower down the content of cement ultimately making the concrete cheaper and eco-friendly.

V. LIMITATIONS OF THE STUDY

From the research it has been found that RHA wasn't able to enhance the strength properties to greater extent but with restricted use of it the strength properties can be enhanced or the same strength as crumb rubber concrete was having before are achievable. However, there are some limitations related to present study which are highlighted as follows:

A. Pre-treatment of rubber aggregates was not done.

B. The type and quality of tyres which are used to manufacture the crumb rubber used in present study were not taken into account.

C. Quality of FA and RHA can also change the properties of RHA based crumb rubber concrete.

D. From the previous studies, it has been found that concrete mixes having RHA show better results when tested for days more than 28. In the present work, testing was carried out for maximum 28 days.

REFERENCES

[1] Nadim A. Emira and Nasser S. Bajaba, "Utilization of Waste Crumbed Rubber Tyre As Fine Concrete Aggregate", Yanbu Journal Of Engineering and Science, Vol 4,april 2012 (1433H), 2012.

[2] Dimitrios, G. G., and Al-Hosain, "Non Destructive Evaluation of Rubber Modified Concrete, Infrastructure Condition Assessment", Rubber Modified Concrete Evaluation, Polytechnic University, Six Metro-tech, Brooklyn, NY,11201, 111-120, 1995.

[3] piti Sukontasukkul, "Use of crumb rubber to improve thermal and sound properties of pre-cast concrete panel", Construction and Building Materials 23 (2009) 1084–1092.

[4] S.Selvakumar, R.Venkatakrishnaiah, "Strength Properties of Concrete Using Crumb Rubber with Partial Replacement of Fine Aggregate", International Journal of Innovative Research in Science, Engineering and Technology Vol. 4, Issue 3, March 2015 ISSN(Online): 2319 – 8753 ISSN (Print): 2347 – 6710.

[5] S.Talukdar, S. T. Islam, and N.Banthia," Development of a Lightweight Low-Carbon Footprint Concrete Containing Recycled Waste Materials", Advances in Civil Engineering Volume 2011, Article ID 594270.

[6] N Kaarthik Krishna, S Sandeep, K M Mini, Study on concrete with partial replacement of cement by rice husk ash, IOP Conf. Series: Materials Science and Engineering 149 (2016) 012109 doi:10.1088/1757-899X/149/1/012109.

[7] A. E. Abalaka, "Strength and Some Durability Properties of Concrete Containing Rice Husk Ash Produced in a Charcoal Incinerator at Low Specific Surface", International Journal of Concrete Structures and Materials, International Journal of Concrete Structures and Materials Vol.7, No.4, pp.287–293, December 2013 DOI 10.1007/s40069-013-0058-8 ISSN 1976-0485 / ISSN 2234-1315

[8] Ghassan Abood Habeeb, "Rice Husk Ash Concrete: the Effect of RHA Average Particle Size on Mechanical Properties and Drying Shrinkage", Australian Journal of Basic and Applied Sciences, 3(3): 1616-1622, 2009 ISSN 1991-8178 © 2009, INSInet Publication.

[9] Ghassan Abood Habeeb and Hilmi Bin Mahmud, Study on Properties of Rice "Husk Ash and Its Use as Cement Replacement Material" Materials Research. 2010; 13(2): 185-190.