

# Strength Evaluation of Cement Concrete Mix using Rubber Fibers and Rice Husk Ash

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**ABSTRACT:** This paper investigates the Strength evaluation of cement concrete mix using Rubber fibers and Rice Husk Ash. Rubber fiber is partially replaced with coarse aggregates and rice husk ash is partially replaced with cement. The dimension of the rubber fibers taken as 50-60 mm in length and 1.5 - 2 mm in width .In this investigation M40 grade concrete is to be designed first. The compressive strength test and split tensile strength test were performed on the cubes and cylinders with the partial replacement of coarse aggregates at 0%, 0.5%, 1% and 1.5% with the rubber fibers and 0%, 7%, 11% and 15% rice husk ash with the cement. The results shows that there is increase in compressive strength on the replacement of 11% rice husk ash and 0.5% Rubber fibers and split tensile strength on the replacement of 7%rice husk ash and 1%rubber fibers respectively. These compressive strength and split tensile strength values compared with the controlled concrete strength of 40N/mm<sup>2</sup> at a mix ratio of 1:1.67:2.39.

**KEYWORDS:** Concrete, CS: compressive strength, STS: split tensile strength, RF: Rubber Fibers, RHA: Rice Husk Ash.

## I. INTRODUCTION

Management of waste-tire rubber is very difficult for municipalities to handle because the waste tire rubber is not easily biodegradable even after long-period of landfill treatment. However, recycling of waste tire rubber is an alternative. Recycled waste-tire rubbers have been used in different application. It has been used as a fuel for cement kiln, as feedstock for making carbon black.

Over the past two decades, research had been performed to study the availability of using waste tire rubber in concrete mixes. Recycled waste tire rubber is a promising material in the construction industry due to its light weight, elasticity, energy absorption, sound and heat insulating material in the construction industry due to its lightweight, elasticity, energy absorption, sound and heat insulating properties. In this paper the compressive strength and split tensile strength of concrete utilizing waster tire rubber has been investigated. Recycled waste tire rubber has been used in this study to replace the coarse aggregate by using different percentages.

Rice husk is an agricultural residue which accounts for 20% of the 649.7 million tons of rice produced annually worldwide. The chemical composition of rice husk is found to vary from one sample to another due to the differences in the type of paddy, crop year, climate and geographical conditions.

Burning the husk under controlled temperature below 800 °C can produce ash with silica mainly in amorphous form. Nairetal. reported an investigation on the pozzolonic activity of RHA by using various techniques in order to verify the effect of temperature and burning duration. He stated that the samples burnt at 500 or 700 °C and burned for more than 12 hours produced ashes with high reactivity with no significant amount of crystalline material. The short burning durations (15 – 360 minutes) resulted in high carbon content for the produced RHA even with high incinerating temperatures of 500 to 700 °C. A state-of-the-art report on rice husk ash (RHA) was published by Mehta in 1992, and contains a review of physical and chemical properties of RHA, the effect of incineration conditions on the pozzolonic

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characteristics of the ash, and a summary of the research findings from several countries on the use of RHA as a supplementary cementing pozzolonic material.

## II. LITERATURE REVIEW

The various papers have been studied regarding rice husk ash and rubber fibres. Following are the papers with their author name are as given:

**Ephraim et al. (2012)** investigated Compressive strength of concrete with rice husk ash as partial replacement of ordinary Portland cement. The specific gravity of RHA was found to be 1.55, the density of RHA concrete was found to be 2.043, 1.912 and 1.932kg/m<sup>3</sup> at 10%, 20% and 25% replacement percentages respectively. RHA concrete was found to be very workable with a slump value of over 100mm. The incorporation of RHA in concrete resulted in increase of water demand and enhanced strength. The compressive strength values at 28days were found to be 38.4, 36.5 and 33N/mm<sup>2</sup> at the replacement percentages of 10%, 20% and 30% respectively. These compressive strength values compared favourably with the controlled concrete strength of 37N/mm<sup>2</sup> at a mix ratio of 1:1.5:3.

**Obi lades (2014)** investigate the properties of Rice Husk Ash (RHA) when used as partial replacement for Ordinary Portland Cement (OPC) in concrete. OPC was replaced with RHA by weight at 0%, 5%, 10%, 15%, 20% and 25%. 0% replacement served as the control. Compacting factor test was carried out on fresh concrete while Compressive Strength test was carried out on hardened 150mm concrete cubes after 7, 14 and 28 days curing in water. The results revealed that the Compacting factor decreased as the percentage replacement of OPC with RHA increased. The compressive strength of the hardened concrete also decreased with increasing OPC replacement with RHA. It is recommended that further studies be carried out to gather more facts about the suitability of partial replacement of OPC with RHA in concrete.

**Dhana Lakshmi et al. (2011)** presents the experimental work was carried out on Rubberized high strength concrete using mineral admixtures and fibers. In order to improve the compressive strength, the mineral admixtures like met kaolin of 12% and copper slag of 40% is used for partially replaced with cement and sand respectively. In addition increases tensile strength of concrete then added 1% to 5% of fibers like waste tire rubber strips (WTRS) were used as a secondary reinforcement. The workability tests are carried out on fresh concrete and compression, split tensile test and flexural test are carried out on hardened concrete. The experimental result shows that, the RFRHSC compressive strength was decreases about 3% to 30% and tensile strength was also increased about 5% to 30%.

**Neela Deshpande et al. (2014)** this investigation is carried out to study the various properties of rubber. An attempt to design concrete of 25Mpa using artificial sand, Shredded rubber and crumb rubber as a source of aggregate is made, using IS 10262:2009. A comparison with control mix mainly their compressive strength, split tensile strength & flexural strength, which uses conventional material will allow assessing the suitability of using shredded aggregate and crumb rubber in concrete as percentage replacement, for structural applications. An attempt is also been made to coat the shredded Rubber particles with NaOH solution and use the same in concrete.

## III. MATERIALS AND METHODOLOGY

The characteristic compressive strength of concrete used for the study was 40MPa. The mix ratio adopted was 1: 1.67: 2.39: 0.40. (Cement: Fine aggregate: coarse aggregate: Water). The materials used in this study were cement, fine aggregate (sand), coarse aggregate (gravel), waste rubber tire strips or rubber fibre, rice husk ash, high performance super plasticizer Top Crete ultra Proof WC and water.

**Cement:** The cement was used as Ordinary Portland Cement and it was satisfying the requirements of IS: 269 -1976.

**Fine Aggregate (sand):** Natural sand having a fineness modulus of 8.78%, specific gravity of 2.61 and water absorption of 0.50%.

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**Coarse Aggregates (gravel):** Natural coarse aggregates having a fineness modulus of 9.5%, specific gravity of 2.75 and water absorption of 0.60%.

**Rubber Fiber (RF):** The Rubber Fibers was used at different percentage of volume of coarse aggregates. The aspect ratio of Rubber Fibers was 50, length of 50 – 60 mm, width of 1 – 2 mm (Fig 1) and the specific gravity of 1.25.

**Rice Husk Ash (RHA):** The Rice husk ash is grey in colour. It is powdered in form and the specific gravity of RHA is 2.29(Fig.2)

**High Performance Super Plasticizer:** The admixture used is Top Crete Ultra Proof WC. The aspect is brown liquid. It must be kept in dry and below 30<sup>0</sup>C (Fig.3)



Rubber fibers

Fig.1

Rice husk ash

Fig.2

Topcrete Ultra Proof WC

Fig.3

## IV. RESULTS AND DISCUSSION

**1. Compressive Strength test:** In compressive strength test, the cubes containing Rubber Fibers and Rice Husk Ash was first increased and then reduced when compare with control specimen. The compressive strength concrete specimens was decreased about 3% to 10%. The reason for reduction in the compressive strength was the waste tire rubber strips were used 0.5% to 1.5%. These factors include:

- As cement paste containing waste tire rubber strips particles surrounding the aggregates is much softer than hardened cement paste without rubber, the cracks would rapidly develop around the rubber particles during loading, and expand quickly throughout the matrix, and eventually causing accelerated rupture in the concrete.
- The compressive strength of concrete depends on physical and mechanical properties of these materials (which have some superiority over rubber). A reduction in compressive strength of concrete can, therefore, be expected.
- The compressive strength first increases due to less percentage of rubber fibers or we can say, it is present in negligible amount and also due to rice husk ash present which is an agro based product and can be used as a substitute of cement without sacrificing the strength and durability. After, when the amount of rubber fibers increases the compressive strength decreases.
- The lower Specific gravity of the rubber fibers and also due to lack of bonding between rubber fibers and the concrete mass. This problem is manifested more clearly. Non-uniform distribution of rubber fibers tends to produce non-homogeneous and leads to a reduction in concrete strength at those parts, resulting to failure at lower stresses.

The results of the compressive strength and split tensile strength for control, rubber fibers and rice husk ash specimens are shown in Table 1, 2.

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**Table No. 1 Percentages of Rubber fibers by replacing coarse aggregates and rice husk ash by replacing cement**

MIX ID	CEMENT	PARTIAL REPLACEMENT OF CEMENT	SAND %	C.A %	REPLACING COARSE AGG. BY RUBBER FIBERS
MIX 1	100	0	100	100	0
MIX 2	100	0	100	99.5	0.5
MIX 3	100	0	100	99	1
MIX 4	100	0	100	98.5	1.5
MIX 5	93	7	100	100	0
MIX 6	93	7	100	99.5	0.5
MIX 7	93	7	100	99	1
MIX 8	93	7	100	98.5	1.5
MIX 9	89	11	100	100	0
MIX 10	89	11	100	99.5	0.5
MIX 11	89	11	100	99	1
MIX 12	89	11	100	98.5	1.5
MIX 13	85	15	100	100	0
MIX 14	85	15	100	99.5	0.5
MIX 15	85	15	100	99	1
MIX 16	85	15	100	98.5	1.5

**Table No 2**

**Compressive strength of concrete cubes at 7 and 28 days at different percentages of Rubber fibers and Rice husk ash**

MIX ID	CURING AT 7 DAYS		CURING AT 28 DAYS	
	LOAD (KN)	Compressive Strength (N/mm <sup>2</sup> )	LOAD (KN)	Compressive Strength (N/mm <sup>2</sup> )
MIX 1	626	27.8	904	40.17
MIX 2	612	27.2	895	39.8
MIX 3	602	26.7	882	39.2
MIX 4	593	26.3	875	38.9
MIX 5	660	29.3	936	41.5
MIX 6	682	30.2	942	41.8
MIX 7	652	28.9	895	39.7
MIX 8	592	26.3	857	38.1
MIX 9	755	33.5	984	43.7

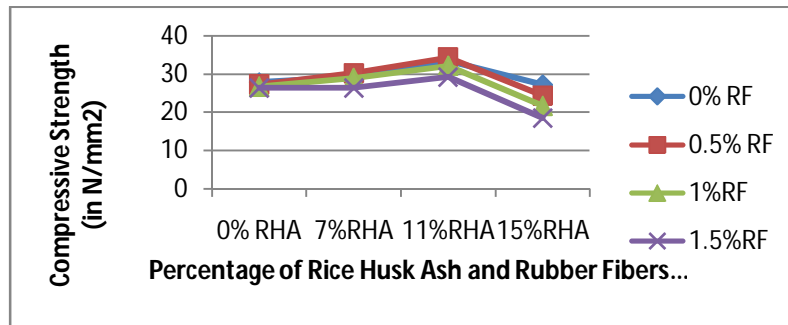
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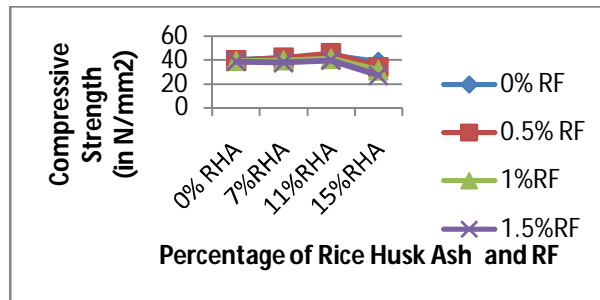
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MIX 10	772	34.3	1026	45.6
MIX 11	725	32.1	928	41.2
MIX 12	655	29.2	896	39.8
MIX 13	612	27.2	845	37.5
MIX 14	548	24.3	770	34.2
MIX 15	488	21.7	710	31.5
MIX 16	415	18.5	612	27.2



**Fig. 4 Compressive Strength of 7 days cured specimens with Rubber fibers and Rice husk ash**



**Fig. 5 Compressive Strength of 28 days cured specimens with Rubber fibers and Rice husk ash**

2. **Split Tensile Strength** As per IS456:2000, the split tensile strength of concrete as 0.70 times of root of characteristic strength of concrete. The split tensile strength of rubber fibers and rice husk ash concrete specimens using 0.5%, 1% and 1.5% of rubber fibers increase the split tensile strength as 2%, 5% and 7%, respectively when compared with the split tensile strength of control specimens. The reasons for increase in split tensile strength of rubber fibers and rice husk ash are:

- When the waste tire rubber strips was as a ductile material and also the rubber fibres and topcrete ultra proof also indirectly increased the strength.
- The rice husk ash is a pozzolan material. So the strength of concrete was increased.
- The rice husk ash is a filler material, which is the bond between the aggregates and rubber fibers surrounding cement paste.

The split tensile strength specimens are tested at 28 days as shown in the table

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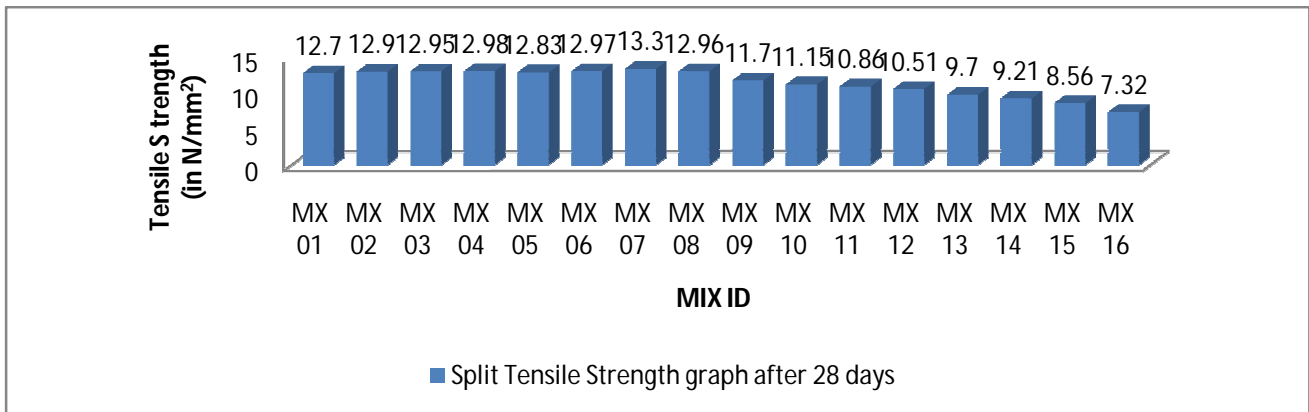
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**Table No 3 – Split tensile strength of concrete at different percentage of Rubber fibers and Rice Husk Ash  
(D = 150mm, L = 300mm)**

MIX	RHA%	RF%	LOAD (IN KN)	Split Tensile strength (ft = 2P/IDL) in N/mm <sup>2</sup>
MX 01	0	0	904	12.7
MX 02	0	0.5	913	12.9
MX 03	0	1	915	12.95
MX 04	0	1.5	916	12.98
MX 05	7	0	907	12.83
MX 06	7	0.5	917	12.97
MX 07	7	1	943	13.3
MX 08	7	1.5	917	12.96
MX 09	11	0	825	11.7
MX 10	11	0.5	790	11.15
MX 11	11	1	768	10.86
MX 12	11	1.5	742	10.51
MX 13	15	0	685	9.7
MX 14	15	0.5	655	9.21
MX 15	15	1	602	8.56
MX 16	15	1.5	521	7.32



**Fig 6 Graph representation of Split tensile strength after 28 days**

## V. CONCLUSIONS

This paper presents the results of rice husk ash as a partially replacement to cement and the various percentage of rubber fibers as partial replacement of coarse aggregates used in concrete. From the results of this study, the following conclusions and recommendation are taken out:

1. The investigation revealed that, as the partial replacement of cement by rice husk ash and coarse aggregates by rubber fibers in concrete mix increases, the workability of concrete mix decreases.

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2. The partial replacement of cement is 0% rice husk ash and coarse aggregate is replaced by 1.5% rubber fibers, compressive strength decreased by 1.6% when compared with control concrete.
3. The partial replacement of cement by 7% rice husk ash and coarse aggregates by 0.5% rubber fibres in concrete mix results in increase of compressive strength by 0.27% as compared to controlled mix.
4. The maximum increase in compressive strength was found when partial replacement of cement with rice husk ash at 11% and partial replacement of natural coarse aggregates with rubber fibers at 0.5% was 34.3 N/mm<sup>2</sup> for 7 days and 45.6 N/mm<sup>2</sup> for 28days.
5. The partial replacement of cement with rice husk ash at 7% and coarse aggregates with rubber fibers at 1% in concrete mix results in increased tensile strength as compared to control mix.

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