Study on Partial Replacement of Conventional Ingredients of Concrete with Rice Husk Ash, Stone Dust and Rubber Aggregate

Bidisha Dutta
dept.of Civil Engineering
Dr.B.C.Roy Polytechnic
Durgapur, India
bidisha.dutta@bcrec.ac.in

Pritam Das
dept.of Civil Engineering
Dr.B.C.roy Polytechnic
Durgapur, India
pritam912das@gmail.com

Abstract: Concrete is the third most used substance in the world next to water and air. Production of cement consumes very large amounts of natural resources and 0.9 tons of Carbon Dioxide is produced per ton of cement production which causes about 8% of world Carbon Dioxide emissions. To cope with that industrial and agricultural waste are used in making concrete which will serve two purposes, disposal of waste and conservation of natural resources. The properties of partially substituted concrete is observed in this paper. The behavior of green concrete with rice husk ash (RHA), stone dust (SD) and scrapped rubber as a partial substitution of cement, fine aggregate and coarse aggregate was experimentally explored. In this paper the combine effect of RHA, stone dust and rubber aggregate in different proportions in concrete will be seen. It has been observed that with increase in rubber aggregate compressive strength of concrete decreases but along with that if rice husk ash and stone dust also increases the compressive strength of concrete increases. The usage of RHA, stone dust lowers the expenses and environmental effects associated with their landfill disposal while using less energy and virgin materials to produce concrete. lowers the expenses and environmental effects associated with their landfill disposal while using less energy and virgin materials to produce concrete. It has been suggested in this study that using leftover tire rubber to make concrete is an environmentally friendly way to dispose of this garbage.

Key words: Rice Husk Ash, Stone Dust, Rubber aggregate, green concrete, environment friendly.

INTRODUCTION

Concrete is the third most used substance in the world next to water and air. It is formed by the composition of fine and coarse aggregate which is bonded by cement. So, recycling of industrial and agricultural waste like stone waste, Rice Husk Ash (RHA), rubber aggregate can be used to make concrete environment friendly which can be called as 'GREEN CONCRETE'. y. So, to limit the use of naturally occurring substances and to cope up with increasing demand of infrastructure, researchers and manufacturers came up with the idea of using industrial and agricultural wastes in making concrete. Industrial and agricultural wastes like rice husk ash, stone waste, fly ash, silica fume, rubber aggregate, glass waste can be used in making concrete. Stone waste or dust is obtained from crusher plant. It is settled by sedimentation and then disposed of which results to dust in air, affects agriculture and health of people and leads to environment pollution. The granite and marble is cut and polished before use. This process generates large amount of cutting waste and causes disposal problem. Meanwhile, over 500 million tons of rice paddy is produced in a year globally. On an average 20% of rice paddy is husk. The husk produced are either burnt or dumped as waste. Approximately 220 kg of rice husk produced per ton of paddy and 55 kg of RHA is produced after burning. RHA contributes to early strength development of concrete because it forms Calcium Silicate Hydrate (C-S-H) gel around particles of cement which gives packed concrete mix. RHA is an active pozzolana which can be used in making cement and concrete without compromising any of its properties. Rubber is not easy to decompose rubber as it takes much time for degradation and causes environmental pollution. Rubber obtained from scrapped tyres can be incorporated as fine/ coarse aggregate in concrete. Replacing natural aggregate with rubber aggregate will make the concrete lightweight which will reduce handling and manufacturing time. The water absorption also depends highly on size of rubber aggregate. Increment in rubber content increases water absorption.

LITERATURE REVIEW

Gemma Rodriguez de Sensale (2005), carried out study by using two types of RHA. One is burnt generally and other is formed from controlled incineration. It was observed that by product produced in former show more strength in early stage, but RHA produced by controlled incineration show significant effect on long term. Controlled incineration of rice husk increases the pozzolanic effect in RHA.

Alireza Naji Givi, Suraya Abdul Rashid, Farah Nora A. Aziz, Mohamad Amran Mohd Salleh (2010): they carried out experiment for two sample series. One containing coarse particle size of RHA (95µm) and other of finer size (5µm). They commented that concrete having finer particle reduces volume of voids leads to dense packing of concrete leading to high compressive strength. Workability means easy flow of concrete while taking care of segregation. Workability is measured with height of slump. So, workability will be higher if height of slump will be higher.

Sarabjeet Singh, Ravindra Nagar, Vinay Agrawal , Anshuman Tiwari ,Salman Siddique (2016), stated that due to its rough, irregular and porous texture, it has good interlocking property and particle size is almost same as sand. So, it can be a good replacement of sand in making concrete

Kunal Bisht, P.V. Ramana (2017), they have replaced fine aggregate with crumb rubber. The decrease in workability

with increase in content of rubber crumb was observed. This is because of high surface are of rubber crumb. They found that workability decreases with increase in rubber content with or without silica fume.

Kunal Bisht, P.V. Ramana (2017), noticed increase in water permeability with increase in rubber content. Rubber crumb was added in the proportions of 0%, 4%, 4.5%, 5% and 5.5%. With increment in rubber content from 4% to 5.5% water permeability drastically increases from 6.66% to 33.3% respectively. This is due to generation of voids and weak adhesion between rubber and cement which develops micro cracks leading to increase in permeability.

Jaydeo Phadtare et al. (2022) Study of partial replacement of coarse aggregate in concrete by different proportions of Un- Treated waste tyre rubber. Our clear focus is to study the behaviour and properties of concrete in fresh as well in harden condition when its natural coarse aggregates is replaced by 5% & 15% waste tyre rubber with the help of compressive test, spilt tensile test and flexural test for hardened properties of concrete.

Jeevana et al. (2023) Partial replacement of coarse aggregate with crumb rubber chips in the preparation of concrete. This crumb tyre aggregate is added as 5%, 10%, 15% to replace the coarse aggregate. In this study, workability and compressive of rubberized concrete was evaluated to investigate the optimal use of crumb rubber as coarse aggregate in concrete.

From the above research paper. The following understanding can be drawn:

- Workability of concrete made with chipped rubber decrease with increase in rubber content.
- Compressive strength drastically decreases with increase in rubber content at all replacement.
- Strength of rubberized concrete can be improved by using silica fume.
- Water absorption of concrete with inclusion of chipped rubber increases
- Permeability of concrete with addition of chipped rubber increases.
- Rubber crumb used as fine aggregate found to be more useful than chipped rubber.
- With incorporation of chipped rubber. Concrete undergoes large deformation before failure and doesn't show brittle failure as plain concrete.
- The main objective is to find the replacement of cement without compromising its properties.
- The workability of fresh concrete decreases as the amount of RHA content increases in concrete. ϖ There is significant increase in compressive strength at all replacement.
- The reason behind increase in compressive strength was stated as fine particle size of RHA which act as filler and make concrete mix packed.
- Water absorption of RHA concrete is less then controlling concrete. ϖ Increment in RHA content decreases chloride penetration.

OBJECTIVE

This paper intends to find out how waste materials can be used to produce concrete without compromising on its physical and mechanical properties to reduce the use of natural resources & energy and to make its production cost effective. The main objective of this thesis paper is to partially replace conventional ingredient of concrete in different proportions and carry out test to find out if this concrete can be used in place of control concrete without affecting the strength and its properties.

PROCEDURE

To carry out the research work at first the basic constituents of concrete preparation have been collected. RHA and stone dust have collected from local stores and rubber aggregate have been prepared from tyre waste in local factory. Special attention has been given in maintaining the size of rubber aggregate. By following Indian Standard guidelines each ingredient has been tested in the laboratory and then selected for preparation of concrete. The ingredients used for preparation of concrete are listed below. Ingredients to be used are: -

TABLE I. INGREDIENTS TO BE USED IN GREEN CONCRETE

Materials used	Designation	IS Code
Cement	Ordinary Portland Cement of 53 Grade	IS 269:2015
Fine Aggregate	River sand conforming Zone II	IS 383:1970
Coarse Aggregate	Single sized aggregate of nominal size 20 mm	IS 383: 1970
Rice Husk Ash (RHA)	Uniformly burnt Uniform grey colour	Sieved through 2.36 mm sieve
Stone Dust	Sieved through 2.36 mm sieve	
Rubber Aggregate	Rubber tire cut into pieces of 20 mm size	
Water	Running water, free from impurities	
Admixture	CHRYSO Delta G820R	IS 9103: 1999

TABLE II. PHYSICAL PROPERTIES OF RHA

Colour	Black
Appearance	Smooth surface
Particle size	Less than 20 mm

TABLE III. THE EXPERIMENTAL SCHEME FOR THIS RESEARCH WORK

GOVERNING FACTORS	METHODOLOGY			
Total no. of concrete cubes to be investigated	Control concrete= 4 Partially replaced concrete= 30			
	Mix	proportions		
		RHA	Stone dust	Rubber aggregate
	M0%	0%	0%	0%
	M1%	5%	5%	5%
	M2%	5%	10%	10%
	M3%	5%	15%	15%
	M4%	10%	5%	5%
	M5%	10%	10%	10%
	M6%	100%	15%	15%
	M7%	25%	5%	5%
	M8%	25%	15%	15%
	M9%	30%	5%	5%
	M10%	30%	15%	15%
Mechanical properties under investigation	Compressive strength			
Equipment used	150 mm3 concrete cube			
Total number of specimens to be tested for each mix	3 Nos.			
Total number of specimens	34 Nos.			
Age of testing	14 days and 28 days			

EXPERIMENTAL SET UP AND PROCEDURE

In this research work M25 grade concrete of ratio 1:1.9:3.1 is made by replacing cement, fine aggregate, and coarse aggregate respectively. Water- cement ratio of 0.5 is taken.

TABLE IV. PHYSICAL PROPERTIES OF CEMENT TESTED IN LABORATORY

PROPERTIES	TEST RESULTS	IS CODE	Permissible range
Standard consistency	32%	IS 8112-1989	30-35A%
Specific gravity	3.12	IS 4031-1988	3.1-3.15
initial setting time	45 min	IS 8112-1989	Not less than 30 min
Final setting time	580min	IS 8112-1989	Not less than 600 min
Fineness	340 m2 /kg	IS 8112-1989	Not less than 225 m2 /kg

TABLE V. PHYSICAL PROPERTIES OF STONE DUST

Specific gravity	2.3
Appearance	Very fine powder
Particle size	Less than 25µ
Colour	Grey
Odour	0dourless

TABLE VI. PHYSICAL PROPERTIES OF RUBBER AGGREGATE

Specific gravity	2.5
Appearance	Granular particle
Particle size	Less than 2.36 mm
Colour	Dark grey colour

TABLE VII. MIX PROPORTION OF GREEN CONCRETE FOR REPLACEMENT OF RHA, STONE DUST, RUBBER AGGREGATE BY 0%, 0% & 0% RESPECTIVELY

MIX No.	Cement (kg)	RHA (kg)	Fine Aggregate (kg)	Stone Dust (kg)	Coarse Aggregate (kg)	Rubber Aggregate (kg)
M0	100 %	0%	100%	0%	100%	0%
For 1 m3	380	0	717	0	1170	0

MIX No.	Cement (kg)	RHA (kg)	Fine Aggregate (kg)	Stone Dust (kg)	Coarse Aggregate (kg)	Rubber Aggregate (kg)
M1	95%	%5	95%	5%	95%	5%
For 1 m3	361	19	681.15	35.85	1111.5	58.5
M2	95%	%5	90%	10%	90%	10%
For 1 m3	361	19	645.3	71.7	1053	117
M3	90%	10 %	95%	5%	90%	10%
For 1 m3	342	38	681.15	35.85	1053	117
M4	90%	10 %	90%	10%	90%	10%
For 1 m3	342	38	681.15	35.85	1053	117

TABLE VIII. MIX PROPORTION OF GREEN CONCRETE FOR REPLACEMENT OF RHA, STONE DUST, RUBBER AGGREGATE BY 10%, 10% & 10% RESPECTIVELY

MIX No.	Cement (kg)	RHA (kg)	Fine Aggregate (kg)	Stone Dust (kg)	Coarse Aggregate (kg)	Rubber Aggregate (kg)
M5	85%	15%	90%	10%	85%	15%
For 1 m3	323	57	645.3	71.7	994.5	175.5
M6	85%	15%	85%	15%	85%	15%
For 1 m3	323	57	609.45	177.55	994.5	175.5
M7	75%	25%	85%	15%	85%	15%
For 1 m3	285	95	609.45	177.55	994.5	175.5
M8	70%	30%	85%	15%	85%	15%
For 1 m3	266	114	609.45	177.55	994.5	175.5

OBSERVATIONS

In this research paper we have observed the effect of RHA, stone dust and rubber aggregate as cement, fine aggregate and coarse aggregate. We have mixed these materials in different proportion and their effect on compressive strength was noted. Also their effect with age was also observed. The small rigidity of the rubber compared to the high rigidity of the coarse aggregate also contributes to the decrease in strength. High proportion of rubber in concrete will eventually reduces the stiffness of the concrete and also the concrete strength. The gradual decrease in the compressive strength as the percentage of replacement increases at 7 and 28 days & the maximum compressive strength is obtained at 5% replacement of fine aggregate by RH.

TABLE IX. COMPARISONOFCOMPRESSIVESTRENGTHOFPARTIALLYREPLACEDCONCRETEOF14 AND28 DAYS

MIX	REPLACEMENT			COMPRESSIVE STRENGTH	
	RHA	STONE DUST	RUBBER AGGREGATE	14 Days	28 Days
M0	0%	0%	0%	31.15	31.70
M1	5%	5%	5%	18.31	30.10
M2	5%	10%	10%	10.35	11.70
M3	5%	15%	15%	9.62	11.03
M4	10%	5%	5%	16.00	22.43
M5	10%	10%	10%	12.40	23.99
M6	10%	15%	15%	18.00	20.30
M7	25%	5%	5%	20.58	30.79
M8	25%	15%	15%	20.02	28.90
M9	30%	5%	5%	22.34	31.06
M10	30%	15%	15%	20.78	29.89

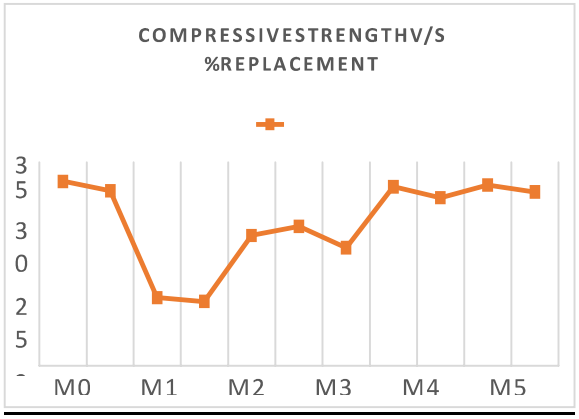

Fig. 1. GRAPHOFCOMPRESSIVESTRENGTHV/S%REPLACEMENTFOR28DAYS

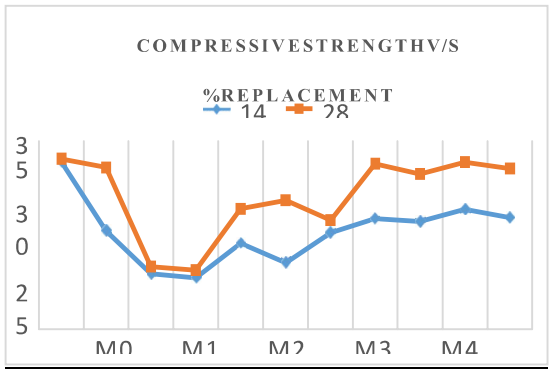

Fig. 2. COMPARISONOFCOMPRESSIVESTRENGTHOFPARTIALLY REPLACEDCONCRETEOF14 AND28 DAYS

RESULT & DISCUSSION

In this research I have found fluctuation in compressive strength of concrete with increase or decrease in rubber aggregate keeping rice husk ash same. It was observed that in Mix M9 having 30% RHA,5% stone dust and 5% rubber aggregate, the compressive strength was 31.06N/mm2.The purpose of study was to partially replace cement, fine aggregate and coarse aggregate with RHA, stone dust, and rubber aggregate respectively by create a concrete is made up of waste materials. It will be Environment friendly as well as cost friendly. Compressive strength test: Compression Testing Machine of 2000kN is used for Compressive strength test. Cube size of 150 x150x 150 mm was used. Two cubes of each batch were casted and tested for 7 and 14 days. Compressive strength tests were conducted at the ages of 7, 14 days. A comparative study was made on control concrete with replacement of cement by RHA and coarse aggregate by tyre rubber in 0%, 5%, 10% and 15%.

CONCLUSION

From previous studies it was observed that with increase in rubber aggregate compressive strength of concrete decreases and with increase in rice husk ash and stone dust compressive strength increases. Through this study it was observed that compressive strength of concrete can be increased with inculcation of rubber aggregate if along with this percent of Rice huskash and stone dust also increases. Fluctuations in compressive strength of concrete withincreaseordecreaseinrubberaggregatekeepingricehuskashsamewasobserved.Thehighestcompressivestrengthof31.06 N/mm2wasformixM9(30%RHA,5%stonedust&5%rubberaggregate)which is 97.9%of strengthofcontrol concrete.By using this Rice husk ash in concrete as replacement the emission of greenhouse gases can be decreased to a greater extent. As a result there is greater possibility to gain more number of carbon credits.

LIMITATION

The following are some research constraints with the partial substitution of stone dust, rice husk ash (RHA), and rubber aggregate:

a. Concrete strength: The characteristics of the RHA utilized can affect how strong the concrete is. One study, for instance, discovered that adding more rubber aggregate to concrete reduced its compressive strength.

b. Water demand: Adding RHA to concrete may result in a higher water consumption.

c. Environmental stress: Concrete disposal may result in environmental stress.

d. Effect of water-to-cement (w/c) ratio: More research is advised to determine how altering the w/c ratio will affect the concrete mix that uses RHA.

e. Particular gravity: The parent rocks and the gradation can affect the specific gravity (SG) of stone dust.

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