International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 10 Issue: 04 | Apr 2023 www.irjet.net p-ISSN: 2395-0072

AN EXPERIMENTAL STUDY ON PARTIAL REPLACEMENT OF CEMENT WITH GGBS AND RICE HUSK ASH

T. SHANTHALA[1], K. BHAVANI[2], D.B. DEENA KUMARI[3], Y. JYOSHNA [4], C. BHANU PRAKASH [5], V. MOHAN KUMAR NAILK[6]

[1]Assistant Professor, Dept. of Civil Engineering, Srinivasa Ramanujan Institute of Technology, Anantapur.
[2]Final Year Student, Dept. of Civil Engineering, Srinivasa Ramanujan Institute of Technology, Ananthapur.
[3]Final Year Student, Dept. of Civil Engineering, Srinivasa Ramanujan Institute of Technology, Ananthapur
[4]Final Year Student, Dept. of Civil Engineering, Srinivasa Ramanujan Institute of Technology, Ananthapur.
[5]Final Year Student, Dept. of Civil Engineering, Srinivasa Ramanujan Institute of Technology, Ananthapur.
[6]Final Year Student, Dept. of Civil Engineering, Srinivasa Ramanujan Institute of Technology, Ananthapur.

Abstract – *Cement is one of the most important material in construction.The production of cement increases and results in reduce of availability of lime. So there are various waste materials which are produced in industries which causes environment pollution. We are using waste materials to reduce pollution in environment. We are using rice husk ash (RHS)which is agricultural waste and ground granulated blast furnance slag (GGBS) which is steel waste. So a considerable amount of rice husk ash and ground granulated blast furnance slag used in concrete improves strength and eco-friendly construction.The cement has been replaced by GGBS in the range of 0%,10%,20%, and 30% by weight of cement and rice husk ash in the constant proportion of 10% by weight of cement for M20 grade mix and compare with plain concrete slump cone test was conducted on the mixture to measure the workability of concrete. The compressive and tensile strength tests are conducted on the cubes and cylinders at 7,14,28 days for determining the strength properties of the hardened concrete. We observe that by replacement of 10% of RHS and 10% GGBS gives more strength as compared with remaining mix.*

Key Words: **GGBS, RHS, Cement, Fine Aggregates, Coarse Aggregates, Water, Compressive strength, split tensile strength.**

1.INTRODUCTION

Concrete is one of the significantly accepted construction materials in the development of infrastructure. Concrete is versatile and durable material that is widely used in construction. It obeys many properties such as strength, durability, impermeability and fire resistant. The current consumption of concrete is approximately 500 million tons per annum and demand is expected to reach one billion tons in next decade. Concrete is a mixture of cement, aggregates and water. Cement is an artificial material manufactured with naturally available limestone, silica and gypsum. Aggregates are considered to be one of main component of concrete since they occupy more than 70% of concrete mix. In the recent years, green the construction eco-friendly. The contribution of ordinary Portland cement production worldwide to greenhouse gas emissions is estimated to be approximately 1.35 billion tons per year.

1.1 OBJECTIVES

The main objective of this study is to determine the strength of concrete by partial replacement of cement with GGBS and rice husk ash.

1.2 SCOPE

- To determine the properties of the materials.
- To examine the mechanical properties of hardened concrete.

2.METHODOLOGY

The project work has been carried out in the following stages

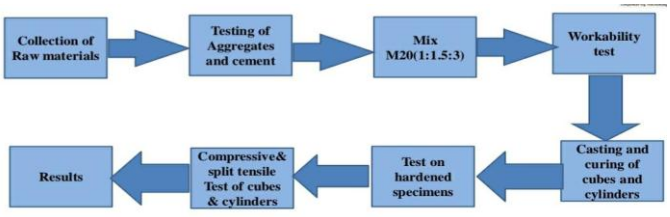

Chart 1: Methodology of the work

3.MATERIALS USED

The materials used in experimental investigation are**:**

1.Cement

Cement is a binder, a chemical substance used for construction that sets, hardens, and adheres to other materials to bind them together. Ordinary Cement OPC 53 Grade was used in the present experimental investigation.

2. Ground granulated blast furnace slag (GGBS):

GGBS is a by product obtained from steel industries. Which is burnt in blast furnace to produce granular material and powder

Fig 1: Ground granulated blast furnace slag

Fig 2: Rice husk ash

3. Rice husk ash (RHS):

Rice husk ash (RHA) is a fine powder left over after burning rice husks, which is high in silica, carbon, and other minerals. RHA is a versatile material that can reduce waste

4. Fine Aggregates

Locally available natural river sand is used. It is naturally available. The Aggregates which are passing from 4.75 mm to 150 microns are termed as fine aggregate.

5. Coarse Aggregates

The crushed stone aggregates were collected from the local quarry. The aggregate which are passing from 80mm sieve to 6.3mm sieve is termed as coarse aggregate.

6. Water

The water which is suitable for drinking can be used for construction.

4.LABORATORY TESTS

1.Tests on cement:

Table - 1: Physical properties of OPC

S.No	Properties	Test Results
1	Specific gravity	3.15
2	Fineness of cement	4%
3	Normal consistency	30%
4	Initial setting time	30 minutes

2.Testsggregates:

Fine aggregates:

a) specific gravity of fine aggregates =2.68
b) Fineness Modulus Of Fine aggregates=3.85

Coarse aggregates:

1.Specific gravity of coarse aggregates

$G = (w_2-w_1)/(w_4-w_1)- (w_3-w_2)$
$G = 2.75$

2.Fineness modulus of coarse aggregates=5.45

3.**Impact test**

The test can be done in toughness test machine to determine the impact strength. The value is 18%.

Fig 3: Aggregates impact machine

4. **Crushing Test**

The aggregate crushing value gives a relative measure of the resistance of an aggregate. The value is 19%.

Fig 4: Aggregate crushing machine

In this project we are partially replaced the Cement with GGBS and Rice Husk Ash. So the different types of test are performed

(I) Fineness test of cement and rice husk ash

The Fineness is done to check particle distribution. Hence we get as 3.87%

(ll) Normal consistency test of cement and rice husk ash

We can take 270gm of cement and 30 grams of rice husk ash and then water is added .Plunger was placed on top of mould and plunger was released into the paste allowing it to sink into it.Water content was increased and the same procedure repeated with in 5mm to 7mm from bottom or 33 to 35 mm from top of Vicat mould.
It is obtained as 38%.

(lll) Initial and final setting time of cement and rice husk ash

For this test Vicat apparatus, Needle and stop watch is used. Take 300 gm of cement and (270gm cement + 30gm RHA) in a pan. For initial setting and final setting time of cement and RHA.

Fig-5: Vicat apparatus

Fig 2: Initial and final setting time of cement &RHS

Setting Time	10% replacement of cement with RHS
Initial setting Time	49 minutes
Final setting time	7 hours

5.MIX DESIGN

Mix design is the process of selecting the suitable ingredients for concrete and determines their relative proportions with the object of certain minimum strength.

Fig-6: Materials

5.1 Mix Design calculation As Per Is: 10262-1982

Grade. = M20
Type = OPC 53 grade
Size of Aggregates = 20mm
Maximum water cement ratio = 0.45(by IS456)
Type of aggregate = crushed angular aggregate
Degree of workability=0.8(100mm)
Specific gravity of cement-3.15
Specific gravity of GGBS = 2.90
Specific gravity of C.A = 2.75
Specific gravity of F.A = 2.68
Specific gravity of Rice Husk Ash= 2.25
Exposure condition = severe
Minimum cement content = 250kg/m^3.

Step1: Target mean strength

F_{ck} = f_{ck}+ (t.s)
S= Standard deviation =4 (as per IS 10262 Table 1)
= 20+ (1.65x4)
= 20+ 6.6
= 27.6 N/mm^2.

Step2: To find w/c ratio

From IS 456

Max w/c ratio = 0.45

Step3: Selection of water content:

From IS 10262
Maximum water content =186 lit (for 25-30mm slump range)
= 186+ ((6/100) x186)
= 197.17 liters

Step4: Calculation of cement content:

Water cement ratio = 0.45
Cement content =197/0.45
=437.78 kg/m^3
From IS456
Minimum cement content = 240kg/m^3
= 437.78kg/m^3. > 240 kg/m^3
Hence ok.

Step5: Volume of aggregate:

We adopt water cement ratio = 0.45

Volume of coarse aggregate corresponding to 20mm size aggregates and fine aggregates zone 4
= 0.66
(at the rate of -1+0.01 for +- 0.05 change in water cement ratio)
=0.66+0.01
=0.67
For pumpable concrete these values should be reduced by 10%
Volume of coarse aggregates = 0.67*0.9 = 0.603
Volume of fine aggregates. = 1-0.603. = 0.397

Step6: Mix calculation:

a) Volume of concrete = $1m^3$
b) Volume of cement = (Mass of cement/ S.G of cement) x (1/1000).
=437.78/3.15x (1/1000)
=0.138 m^3
c) Volume of water = (Mass of water/ S.G of water) x (1/1000)
= 197/1 x (1/1000)
= 0.197 m^3
d) Volume of Aggregates
Volume of all aggregates = 1-(0.138+0.197)
= 0.665 m^3
l) Mass of coarse aggregates = volume of all aggregates*volume of C.A* S.G of C.A *1000
= 0.665*0.603*2.75*1000
= 1102.73 kgs
ll) Mass of fine aggregates = volume of all aggregates*volume of F.A* S.G of F.A*1000
= 0.665*0.397*2.68*1000
= 707.53 kgs

Step7: Mix Proportions

Cement. = 437.78 kg/m^3
Water. = 197 lit
Fine Aggregates. = 707.53 kg/m^3
Coarse Aggregates. = 1102.73 kg/m^3
Water cement ratio. = 0.45

Table-3: Proportion of materials

Cement (kg/m^3)	Fine Aggregates (kg/m^3)	Coarse Aggregates (kg/m^3)	Water Cement ratio
437.78	707.53	1102.73	
1	1.61	2.6	0.45

Procedure to cast concrete cubes and cylinders

1.Batching
2.Mixing
3. Casting
4.Curing

6.TESTS ON CONCRETE

6.1 Workability tests

Slump cone test was done to find the workability performance of the mixes. A slump test is a method used to determine the consistency of concrete.
We obtained a true slump.

6.2 Specimens for Compressive strength test

Compressive strength test is done to measure the maximum amount of compressive load a material can bear before fracturing. The strength of concrete is determined by the crushing strength of 150mm x 150mm x 150mm, at an age of 7 days ,14 days and 28 days.

$$fc = (load(P)/Area(A)) \ N/mm^2$$

where,
P = Load at which the specimen fails in Newton (N)
A = Area over which the load is applied in mm

Fc = Compressive stress in N/mm^2

Fig- 7: Compressive strength of cubes

Table-4: Compressive strength of cubes for 7,14,28 days

S.No	% replacement of RHS	% replacement of GGBS	Compressive strength for 7 days	14 days Mpa	28 days Mpa
1	0%	0%	17.04	20.59	27.66
2	10%	0%	20.66	24.2	29.21
3	10%	10%	31.18	36.25	37.34
4	10%	20%	27.13	34.44	35.88
5	10%	30%	23.5	33.12	34.15

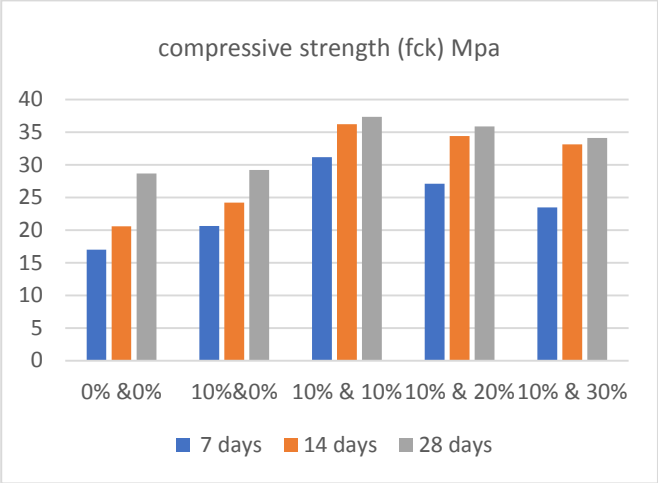

Fig- 8: variation of Compressive strength test of cubes for 7,14,28 days

6.3 Specimens for Split tensile strength test

The strength of concrete is determine the load at which the concrete member cracks. In this test, cylindrical specimens of dimension 150 mm diameter and 300 mm length were cast. The specimens are tested after 7 days,14 days and 28 days. The split tension test was conducted by using digital compression machine having 2000 kN capacity.

$f_t = 2P / \pi DL$ (N/mm^2)
where, P = Maximum Load (kN)
D = Diameter of Specimen (150 mm)
L = Length of Specimen (300 mm)
f_t = Tensile strength N/mm^2

Fig -9: split tensile strength of cylinders

Table -5: Split tensile strength of cylinders for 7, 14, 28 days

S.No	% replacement of RHS	% replacement of GGBS	Split tensile strength for 7 days	Split tensile strength for 14 days Mpa	Split tensile strength for28 days Mpa
1	0%	0%	1.68	1.84	2.6
2	10%	0%	1.72	1.91	2.71
3	10%	10%	3.33	3.54	3.65
4	10%	20%	3.29	3.48	3.52
5	10%	30%	3.13	3.27	3.31

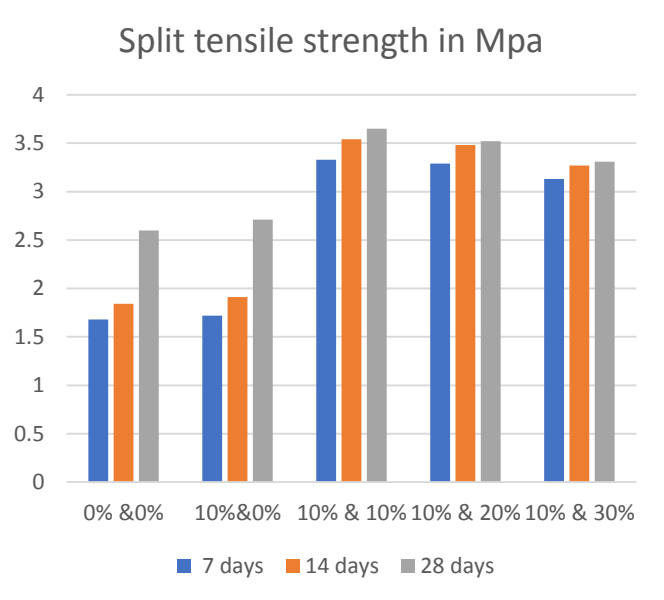

Fig-10: Variation of split tensile strength test results of cylinders for 7, 14, 28 days

7.CONCLUSION

- We can observed that 10%&10% replacement of cement with GGBS and RHS in mild condition are showing an increase in compressive strength for 28 days.
- By increasing more %of GGBS the strength of concrete decreases.
- By addition of 10% of RHS and 20% of ggbs the strength of concrete decreases.
- By this we observe that 10% of rice husk ash and 10% of ground granulated blast furnance slag gives more strength when compared with plain concrete mix .
- By using this materials we can increase strength and reduce pollution in the environment

REFERENCES

1. Rughooputh, Reshma, and Jaylina Rana. "Partial replacement of cement by ground granulated blast furnace slag in concrete." *Journal of Emerging Trends in Engineering and Applied Sciences* 5.5 (2014): 340-343.

2. Prasanna, P. K., K. Srinivasu, and A. Ramachandra Murthy. "Strength and durability of fiber reinforced concrete with partial replacement of cement by Ground Granulated Blast Furnace Slag." *Materials Today: Proceedings* 47 (2021): 5416-5425.

3. Ahmad, Jawad, et al. "A comprehensive review on the ground granulated blast furnace slag (GGBS) in concrete production." *Sustainability* 14.14 (2022): 8783.

4. Suresh, Dr, and K. Nagaraju. "Ground granulated blast slag (GGBS) in concrete–a review." *IOSR journal of mechanical and civil engineering* 12.4 (2015): 76-82.

5. Samad, Shahab, Attaullah Shah, and Mukesh C. Limbachiya. "Strength development characteristics of concrete produced with blended cement using ground granulated blast furnace slag (GGBS) under various curing conditions." *Sādhanā* 42 (2017): 1203-1213.

6. Mosaberpanah, MOHAMMAD A., and SADIQ A. Umar. "Utilizing rice husk ash as supplement to cementitious materials on performance of ultra high performance concrete:–a review." *Materials Today Sustainability* 7 (2020): 100030.

7. Hawileh, Rami A., et al. "Performance of reinforced concrete beams cast with different percentages of GGBS replacement to cement." *Archives of Civil and Mechanical Engineering* 17 (2017): 511-519.

8. Sun, Bo Cheng, and Shao Qing Wang. "Rice Hull Ash Concrete Mechanical Properties." *Applied Mechanics and Materials*. Vol. 193. Trans Tech Publications Ltd, 2012.

9. Arivalagan, S. "Sustainable studies on concrete with GGBS as a replacement material in cement." *Jordan journal of civil Engineering* 8.3 (2014): 263-270.

10. Paul, Abhinaba, and Monowar Hussain. "Sustainable Use of GGBS and RHA as a Partial Replacement of Cement in the Stabilization of Indian Peat." *International Journal of Geosynthetics and Ground Engineering* 6 (2020): 1-15.