International Journal of Innovative Research in Science and Engineering
Volume 9, Issue 06, 2023
www.ijirse.com
ISSN: 2454-9665

AN EXPERIMENTAL INVESTIGATION ON CONCRETE BY PARTIAL REPLACEMENT OF FINE AGGREGATE WITH COPPER SLAG AND COURSE AGGREGATE WITH CERAMIC WASTE

Asst. Prof. Chaitali Himane*[1], Megha Shelke.[2], Suraj shelke [3], Payal Gadekar[4], Tejaswi Kamble[5]

*[1] *Asst. Prof., Civil Department, Parvatibai Genba Moze College of Engineering, Wagholi Pune, India.*

[2,3,4,5] *Students, Civil Department, Parvatibai Genba Moze College of Engineering, Wagholi Pune, India.*

ABSTRACT

In this experimental work the waste materials are used as partial replacements for concreting materials in varying percentages. First of all Normal concrete is designed for M20 grade and their strength were tested, then in the normal mix the copper slag is partially replaced for fine aggregate at different proportions from 10%, 20%, 30%, 40% by weight of sand. The optimum percentage of replacement is found by various testing of concrete. Then ceramic tiles are broken for partial replacement of 20mm aggregates and their strength were tested. The replacement of tiles alone will not promote any increment in concrete strength so the optimum percentage found in slag content is kept as constant percentage replacement for sand and the coarse aggregate is replaced in range of 10%, 20%, and 30%, 40% by weight of coarse aggregate. Finally all the strength factors are tested and compared with conventional concrete strength which should satisfy the increased concrete strength requirements. For testing on concrete totally 63- cubes (150 x150 x 150mm) for compression test, 21 cylinder (150mm x 300mm) for Split tensile test, 1-beams (500 x 100 x 100mm) for flexural test and 14-cylinders of same size for durability test were casted and cured for 7 days, 14 days and 28 days to have increased strength.

KEYWORDS*: Copper Slag, Ceramic waste, water, aggregate, sand, and Concrete.*

INTRODUCTION

Concrete is comprised of cement, fine aggregate, coarse aggregate, water, Pozzolans and air. Cement is made by grinding a calcareous material such as limestone or shell with an argillaceous (clayish) material such as clay, shale. Light weight concrete, high density concrete, Copper Slag reinforced concrete, self-compacting concrete,

ISSN: 2454-9665

high performance concrete, bacterial concrete, geo-polymer concrete, vacuum concrete, aerated concrete are some of the main type of concretes used for construction activities.

Copper slag which is an industrial waste obtained from smelting and refining process of copper. Nearly 4 tons of copper is obtained as waste is disposed to lands cause's environmental impacts. So it can be reused as concreting materials. The slag is a black glassy and granular in nature and has a similar particle size range of sand which indicates that it could be tried as replacement with sand in cementations mixture. Copper slag used in this work was brought from Jayjeet Enterprises, Ranjangaon, Pune.

METHODOLOGY

2.1 General:

The durability of a concrete block will most probably depend on a holistic interplay of many factors. These factors are likely to fall under one or more of the following categories:

1. Materials used
2. Technology and resultant material engineering properties
3. Prevailing environment
4. Appropriateness and care.

This chapter defines in details about all the properties of the material used in Concrete block using Ceramic Waste and coconut fibre.

2.2 MATERIALS USED:

1) Natural Aggregate: Gravels are obtained by crushing natural basalt stone obtain from quarries . They are hard, strong, tough, clear and free from veins, alkali, vegetable matter and other deleterious substances. Aggregates are free from such material, which will reduce strength or durability of concrete. 2) Sand: Natural sand free from silt, veins, alkali, vegetable matter and other deleterious substances, obtained from Bhima, Ghod River. 3) Cement: Ultratech 53 GRADE ordinary Portland cement is used for all mixes. 4) Ceramic Waste : Fine Ceramic Waste obtained from grinding and cutting of glass. 5) Coconut fibre: Obtained from coconut husk.

2.2.1 Cement: The cement used in the tests was Ordinary Portland Cement (Grade 53) locally available.

Table 2.2.1.1 Properties of Cement

Sr. No.	Characteristic	Result	Requirement
01	Fineness	6.7%	Residue less than 10 %
02	Soundness	8.1 mm	Not be more than 10 mm
03	Setting Time Initial Final	34 Min 493 Min	Should not be less than 30 min. Should not be more than 600min.
04	Compressive Strength	28.2MPa	Not less than 27 MPa

International Journal of Innovative Research in Science and Engineering
Volume 9, Issue 06, 2023
www.ijirse.com
ISSN: 2454-9665

	3 Day 7 Day 28 Day	39.4MPa 54.7MPa	Not less than 37 MPa Not less than 53 MPa

1. **Fine Aggregate (Sand)-** Locally available clean and good graded fine aggregate was used after passing through I.Ssieve2.36 mm.

Table 2.2.2.1 Properties of Fine Aggregate (Sand)

Sr. No.	Characteristics	Result
1	Specific gravity	2.74
2	Water absorption	1.2%
3	Bulk density	1650 kg/m^3
4	Grain size	0-2.36 mm

Table 2.2.2.2Sieve Analysis of Sand

Sr. No.	IS Sieve	% Passing
1	2.36 mm	100
2	1.18mm	72.34
3	600 Microns	32.9
4	300 Microns	7.8
5	150 Microns	1.3

Coarse aggregate

The fractions from 80 mm to 4.75 mm are termed as coarse aggregate. The material which is retained on BIS test sieve no. 480 is termed as a coarse aggregate. The broken stone is generally used as a coarse aggregate. The nature of work decides the maximum size of the coarse aggregate. Locally available coarse aggregate having maximum size of 20 mm was used in the present work.

Material = 20 mm

Weight = 1000 grams

Table No.2.2.3.1- Sieve analysis of coarse aggregate (20mm)

Sieve size	Weight Retained (gm)	Cumulative Weight Retained (gm)	% Cumulative Weight Retained (gm)	% Passing
25 mm	0	0	0.00	100.00
20 mm	140	140	14.00	86.00

ISSN: 2454-9665

10 mm	810	950	95.00	5.00
4.75 mm	50	1000	100.00	0.00
Pan	0	1000	100.00	0.00

.

Properties of Copper Slag:

Copper slag, which is the waste material produced in the extraction process of copper metal in refinery plants, has low cost, and its application as a fine aggregate in concrete production reaps many environmental benefits, such as waste recycling, and solves disposal problems.. Chemical composition of copper slag is given in the table below.

Table 2.2.4.1:-Chemical composition of Ceramic Waste

Appearance	**Black, glassy, more vesicular when granulated**
Bulk density	144–162 lbs per cubic feet
Conductivity	500 ms/cm
Sp. gravity	2.8–3.8
Hardness	6–7 Moh

Photo 2.2.4.2: Raw Copper slag

Properties of Ceramic waste:

Coconut fibres are extracted from the outer shell of a coco-nut. There are two types of coconut fibres, brown fibres ex-tracted from matured coconuts and white fibres extracted ten-der coconuts. Brown fibres are thick,

ISSN: 2454-9665

strong and have high abrasion resistance, which is used commonly. There are many advantages of coconut fibres eg. they are moth-proof, fungi and rot resistant, provide excellent insulation against tempera-ture & sound, not easily combustible, unaffected by moisture and dampness, tough, durable, resilient, springs back to shape even after constant use, totally static free and easy to clean. Coir fibres were added 0.5% by the weight of cement and in 5 cm length.

Table 2.2.5.1. Typical Properties of ceramic waste

Properties	**Sand**	**Ceramic waste**
Specific density (kg/m^3)	2650	2440
Water absorption (%)	2.00	4.05
Sand equivalent (%)	62.50	—
Fineness modulus	2.25	2.9

International Journal of Innovative Research in Science and Engineering
Volume 9, Issue 06, 2023
www.ijirse.com
ISSN: 2454-9665

Photo 2.2.5.2: Raw Ceramic waste

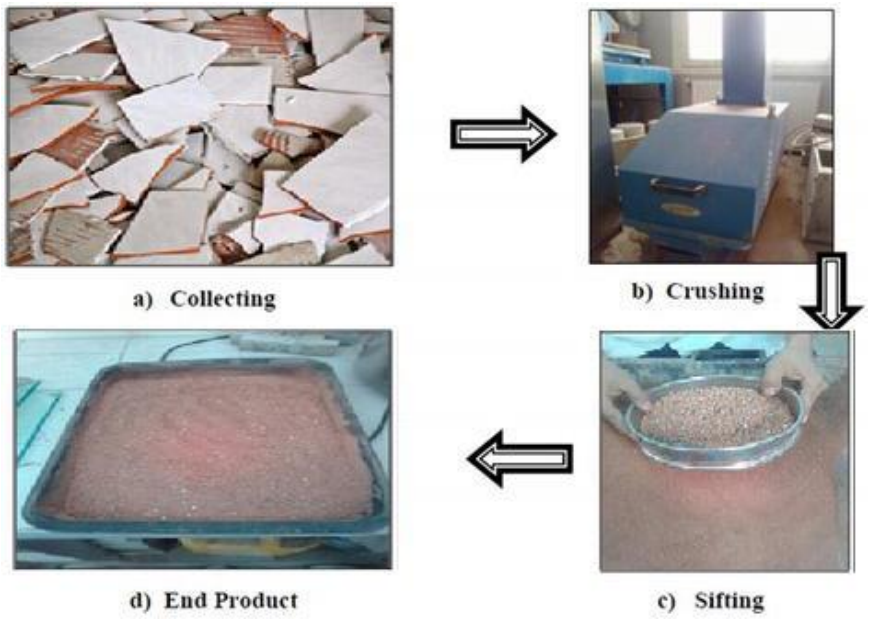


Photo 2.2.5.3 Process of how to crush the Ceramic waste

RESULTS AND DISCUSSION

International Journal of Innovative Research in Science and Engineering
Volume 9, Issue 06, 2023
www.ijirse.com
ISSN: 2454-9665

3.1 Results of Test on Hardened Concrete:

3.1.1 Compressive Strength of Concrete cube:

Table 3.1.1: Compressive strength of concrete cube specimen tested after 14 days of curing.

Ceramic Waste (%)	Copper Slag (%)	Load (KN)	Compressive Strength (N/mm2)	Average Compressive Strength (N/mm2)
0	0	549.9	24.44	24.32
		544.5	24.20	
10	0.25	463.5	20.6	20.95
		479.25	21.3	
20	0.50	594	26.4	26.15
		582.75	25.9	
30	0.75	513	22.8	22.5
		499.5	22.2	
40	1	470.25	20.9	20.25
		441	19.6	

Table 3.1.2: Compressive strength of concrete cube specimen tested after 28 days of curing.

Ceramic Waste (%)	Copper Slag (%)	Load (KN)	Compressive Strength (N/mm2)	Average Compressive Strength (N/mm2)
0	0	643.5	30.6	30.4
		634.5	30.2	
10	0.25	648	28.8	28.6
		639	28.4	
20	0.50	738	32.8	32.75
		735.75	32.7	
30	0.75	662.6	29.45	29.17
		650.25	28.9	
40	1	577.12	25.65	25.37
		564.75	25.10	

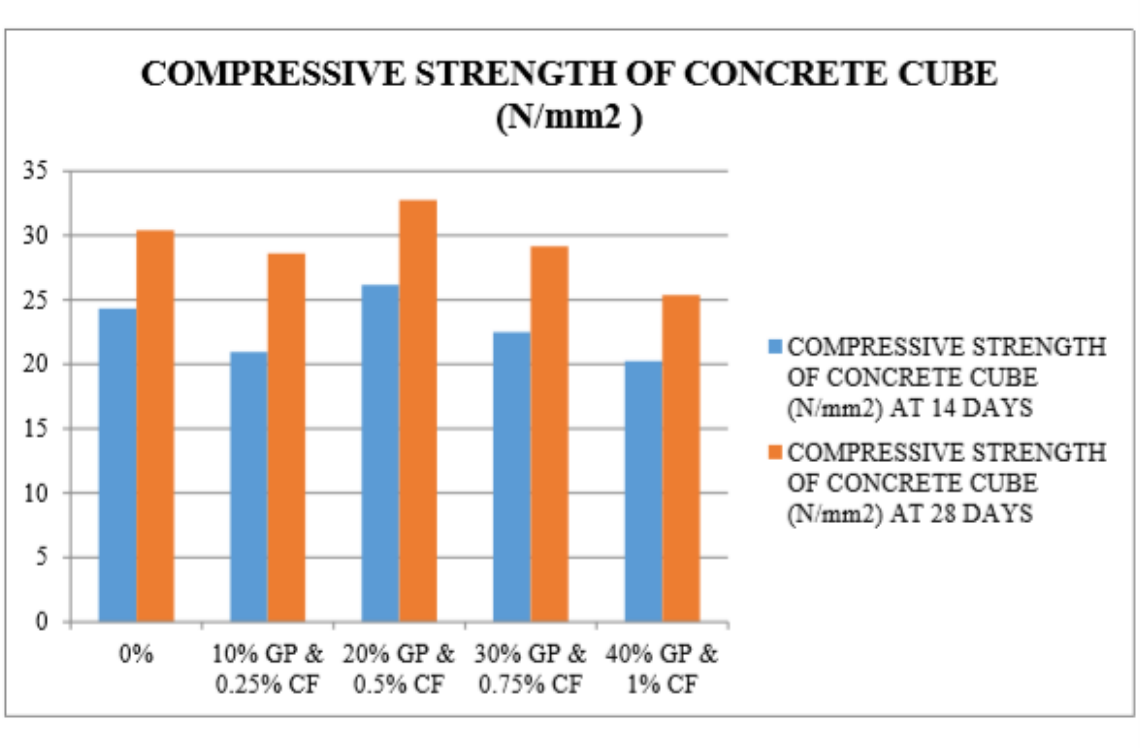
International Journal of Innovative Research in Science and Engineering
Volume 9, Issue 06, 2023
www.ijirse.com
ISSN: 2454-9665

3.2 Discussion:

• The maximum compressive strength is 32.75 N/mm2 at 20% replacement of ceramic waste and 0.50% replacement of copper slag.

• The maximum compressive strength at 20% replacement of ceramic waste and 0.50% replacement of copper slag is 7.73% greater than the compressive strength of traditional concrete.

• Compressive strength from 20% replacement of ceramic waste and 0.50% replacement of copper slag is reduced as we increase percentage of ceramic waste and copper slag.



Graph 3.2.1: Compressive strength of Concrete Cube after 14 & 28 Days of Curing.

CONCLUSION

The test conducted on materials like Aggregate, Sand, Cement, Ceramic Waste , Copper Slag having all test result within permissible limit as per IS codes.

1. The modified concrete mix using Ceramic Waste and Copper slag performs satisfactorily on various tests, with acknowledgement to the proportional relationship between its rates of strength-loss and contain in the mix. Mixing, casting and compacting of concrete mix using Ceramic Waste, Copper Slag and coarse aggregates with local materials can be carried out in a similar fashion to that of traditional concrete mix.

2. The maximum compressive strength obtained is 32.75 N/mm2 at 20% replacement of Ceramic waste and 0.50% replacement of copper slag.

3. By reinforcing the concrete with copper slag which are easily available, we can reduce the environmental waste.

4. Modified concrete casted using Ceramic Waste and Copper Slag helps in resisting cracks under the action of compressive forces.

5. Considering the strength criteria, the replacement of cement by Ceramic Waste and Copper Slag is feasible. Therefore we can conclude that the utilization of waste Ceramic Waste and Copper Slag in concrete as cement replacement is possible.

ACKNOWLEDGEMENTS

I would like to express my gratitude, sincere thanks and a deep sense of appreciation to our principal Dr. N. S.NARWADE, Head of department Prof. Arshi Khan and Asst. Prof. Chaitali Himane for accepting my studentship and continuously assessing my work. Also providing great and valuable guidance throughout the academic year by timely suggestions and discussions at every stage of this work making my project work in reality.

REFERENCES

[1] Majid Ali , Xiaoyang Li, Nawawi Chouw, “Experimental investigations on bond strength between Copper Slagand concrete” Department of Civil and Environmental Engineering, The University of Auckland, New Zealand 14 August 2012.

[2] Majid Ali , Nawawi Chouw “Experimental investigations on coconut-fibre rope tensile strength and pullout from Copper Slagreinforced concrete” Department of Civil and Environmental Engineering, The University of Auckland, New Zealand 20 December 2012.

[3] Dr.G.Vijayakumar1, Ms H. Vishaliny2, Dr. D. Govindarajulu3 “Studies on Ceramic Waste as Partial Replacement of Cement in Concrete Production” International Journal of Emerging Technology and Advanced Engineering Website: www.ijetae.com (ISSN 2250-2459, ISO 9001:2008 Certified Journal, Volume 3, Issue 2, February 2013).

[4] R.Vandhiyan, K. Ramkumar And R. Ramya, “Experimental Study On Replacement Of Cement By Ceramic Waste ” International Journal of Engineering Research & Technology (IJERT) Vol. 2 Issue 5, May – 2013 ISSN: 2278-0181.

[5] Olonade, Kolawole Adisa, Alake, Adewale Doyinsola And Morakinyo, Abiola Gabriel “Strength Development And Crack Pattern Of Copper SlagReinforced Concrete (CFRC)” Civil and Environmental Research, Vol.4 2013 Special Issue for International Congress on Materials & Structural Stability, Rabat, Morocco, 27-30 November 2013

[6] Gunalaan Vasudevan, Seri Ganis Kanapathy Pillay “Performance Of Using Waste Ceramic Waste In Concrete As Replacement Of Cement” American Journal of Engineering Research (AJER) e-ISSN : 2320-0847 p-ISSN : 23200936 Volume-02, Issue-12, pp-175-181 (2013).

[7] Dhanaraj Mohan Patil1, Dr. Keshav K. Sangle2 “Experimental Investigation Of Waste Ceramic Waste As Partial Replacement Of Cement In Concrete” International Journal of Advanced Technology in Civil Engineering, ISSN: 2231 –5721, Volume-2, Issue-1, 2013.

ISSN: 2454-9665

[8] J.Sahaya Ruben,Dr.G.Baskar "Experimental Study of Coir Fiber as Concrete Reinforcement Material in cement Based Composites" J. Sahaya Ruben et al Int. Journal of Engineering Research and Applications, ISSN : 2248-9622, Vol. 4, Issue 1(Version 3), January 2014, pp.128-131.

[9] K.Madhangopal, B.Nagakiran, S.R.Sraddha, G.Vinodkumar, P.Thajun, S.A. Kishore Sankeerth, T.Varalakshmi "Study The Influence Of Waste Ceramic Waste On The Properties Of Concrete" IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE) e-ISSN: 2278-1684,p-ISSN: 2320-334X, Volume 11, Issue 2 Ver. VI (Mar- Apr. 2014), PP 34-38.

[10] Shilpa Raju, Dr. P. R. Kumar "Effect Of Using Ceramic Waste In Concrete" International Journal of Innovative Research in Science, Engineering and Technology, An ISO 3297: 2007 Certified Organization, Volume 3, Special Issue 5, July 2014 ISSN (Online) : 2319 – 8753 ISSN (Print) : 2347 – 6710.