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Experimental Analysis on Cupola Slag Waste as a Partially Replacement in Coarse Aggregate in Concrete

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Abstract: Cupola Slag Waste As a Partially Replacement Of Coarse Aggregate in Concrete it is expected that in upcoming day, the community of civil engineering have to product structures with the concept of sustainable development by using high performance material and new concept with law environmental impact which per produced at a reasonable cost. Now a days waste materials are utilized in the preparation of conventional concrete. In the present work the waste material considered is cupola slag which is by-product of cast iron manufacturing. The design mix for M20 grade concretes were arrived and the target strength was found to be 23 N/mm^2 (7 Days) and 28 N/mm^2 (28 Days) respectively. Cupola slag was used in concrete as partial replacements for coarse aggregates (10% 20% 30% 45% 60% 80% 100.%) to ascertain applicability in concrete. Since the disposal of cupola slag in open area causes environment pollution, it can be recycled for use in construction industry without producing any harm to human and environment.
Keywords: Cupola Slag , M20 Mix Design , Compressive Strength, Split Tensile Strength.

I. INTRODUCTION

At present, development in India is mainly by implementation of infrastructure projects. Due to that construction projects are executed
at very rapid rate. In the developing country like India, availability of natural resources is also an influencing factor apart from funding
due to this rapid infra- structural growth it requires large amount of construction material like cement, aggregate ,wood etc. R.C.C. structures are preferred over steel structures in India which requires larger quantity of concrete. Since availability of natural resources of
concrete is limited as we get it from natural deposits at present, there is a need to develop a new material that can effectively replace with conventional without compromising with strength and durability properties of concrete.

1) *Concrete Ingredients:* There are many types of concretes available, created by varying the proportions of the main ingredients below:
   a) Cement
   b) Water
   c) Aggregate
      i) Fine aggregate
      ii) Coarse aggregate
   d) Mineral admixtures

The environmental issues associated with the production of OPC are well known. The amount of the carbon dioxide released during the manufacture of OPC due to the calcinations of limestone and combustion of fossil fuel is in the order of one ton for every ton of PPC produced. In addition, the extent of energy required to produce OPC is only next to steel and aluminum.

2) *Cupola Slag:* Cupola slag is by-product material which is gathered forecast iron manufacturing unit. It is produced during melting of cast iron in cupola furnaces. The slag occurs as a molten liquid which solidifies upon cooling. Cupola slag is a complex solution of silicates and oxides. Cupola furnace is cylindrical shaped melting device which is used in steel industries for melting of cast iron ranging from 0.5 to 4 m in diameter.

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II. LITERATURE REVIEW

A. K. Sundara Kumar[1], K.V.Manikanta "performance of concrete by replacing coarse aggregate and fine aggregate with blast furnace slag and crusher dust" International Journal of Science & Engineering Research volume 3, Issue 10,Jun-2016. It stated that by products have been successfully used in concrete. These materials include used crusher dust-cupola slag from metal-casting industries. Cupola slag has also been used as coarse aggregate in concrete. The density (1280 kg/m^3) of cupola slag is between that of normal weight aggregate(1600 kg/m^3) and structural lightweight aggregate (1120 kg/m^3).the absorption for cupola slag was lower than that for the structural lightweight aggregate, Air-cooled cupola slag was used in concretes as a replacement (10%,20%,30%,40%,
50% and 60%) for the coarse aggregate and crusher dust was used as a partial replacement of the fine aggregate for masonry blocks and paving stones.

B. R. Balaraman and S. Anne Ligori "utilization of cupola slag in concrete as fine and coarse aggregate" International Journal of Civil Engineering and Technology Volume 6, Issue 8, Aug 2015, pp. 06-14, Article ID: IJCIET_06_08_002.

III. METHODOLOGY

1) *Cement:* 43 grade ordinary Portland cement was used in the experiment confirming to the IS 8112:1989.

Table 1: Chemical Status of Portland cement

SiO2	Fe2O3	Al2O3	CaO	MgO	Na2O3	K2O
19.96%	3.13%	3.50%	62.65%	3.15%	0.06%	0.7%

Table 2: Chemical Status of Cupola Slag Sample

SiO2	Fe2O3	Al2O3	CaO	MgO	K2O
48.7%	11.1%	11.8%	21.2%	1.3%	1.4%

2) *Fine Aggregate:* The sample of fine aggregate was belonging to zone II to be used in the study.

Table 2: Test results on Cement

S. No.	Test	Result
1	Specific Gravity	2.98
2	Normal consistency	32%
3	Initial Setting time	67 min
4	Final initial time	268 min

Table 2: Test results on Fine Aggregate

S. No.	Test	Result
1	Specific Gravity	2.45
2	Fineness modulus	3.41
3	Water Absorption	2.02 %
4	Bulk density(kg/m^3)	1831

Table 2: Test results on Coarse Aggregate

S. No.	Test	Result
1	Specific gravity	2.87
2	Fineness modulus	3.07
3	Water Absorption	1.21 %
4	Bulk density(kg/m^3)	1591

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Table 2: Test results on Cupola Slag 10mm And 20mm (60 - 40 Ratio)

S. No.	Test	Result
1	Specific Gravity	2.93
2	Finesse modulus	3.53
3	Bulk density(kg/m^3)	1640
4	Water Absorption	0.4%

Table 3: Numbering of Specimen as per Requirement

S. No.	Test	Cupola Slag								
		10%	20%	30%	45%	60%	80%	100%	N C	Total
1	Compression	12	24	12	12	12	12	12	24	120
2	Split tensile Strength	3	3	3	3	3	3	3	3	24

3) *Water:* Potable water free from salts used for casting and curing of concrete as per IS 456-2000 recommendations however the ph of water was 0.5% Ratio.

Table 4: for 1 m3 volume of concrete, the material were used as following

S. No.	Cement	Fine Aggregate	Water	Coarse Aggregate	W/C ratio	Mix Proportions
1	394kg	416.11kg	197kg	1078 Kg.	0.5	1 : 1.5 : 3

Table 4: for 1 m3 volume of concrete, the material were used as following

S. No.	Cement	Fine Aggregate	Water	Coarse Aggregate	Cupola 20%	W/C ratio	Mix Proportions
1	394kg	416.11kg	197kg	677.13 Kg.	301.87 Kg	0.5	1 : 1.5 : 3

IV. PREPARATIONS AND CASTING OF CONCRETE

All the moulds were kept ready by applying the lubricant on all sides and tighten the bolts of the moulds as it loose state may cause slurry to get out of the moulds during mechanical vibrations. The fully compacted and prepared concrete were filled into the respective moulds of sides 150mm in three different layers by compacting it by tempering rods and then followed by mechanical vibrator for desired compactness.

Over vibration was avoided due to segregation point of view and hence optimum vibration done till no more bubbles appear on the top surface.

The upper top level of concrete was made plane with the help of trowel for uniform level of surface. 150mm*150mm*150mm size of cube and 300mm*150mm were used for estimating compressive strength and split ensile strength of the concrete. Each mould were filled with alternative three layer and was compacted fully using a compacting rod with 25 blows per layer on one time. After compaction of three layers, sides were taped by using hammer to remove tapped air in the concrete and then allowed for mechanical vibrations to ensure fully release of airbubbles.

After compaction, the specimen were kept alone in the environment for 24 hours and then specimen were removed from the mould and then brought for curing .the specimen were cured for 3, 7, 14 And 28 days.

V. MIXING OF STEEL FIBER

To ensure the complete distribution of Cupola Slag, the Cupola slag was spread on the aggregate in drum mixer in a uniform manner. Then the mixer drum was allowed to rotate for five revolutions after each addition for about three minutes. Finally a complete distribution of Cupola throughout the concrete mix was achieved. This mix concrete was filled in the cubes and cylinders.

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VI. RESULT ANALYSIS

. Table 5.1 Compressive Strength of Concrete Mixes with w/c of 0.50

Days	Nominal Concrete	Cupola 20%
3 Days	10.86	12.67
7 Days	19.07	23.41
14 days	25.97	28.59
28 days	28.11	33.87

It can be observed from the above results that the compressive strength of the concrete increases by in corpora ting cupola slag up to 20% And Different % of Add In concrete as partial replacement to coarse aggregate in all the concrete mixes and subsequently decreases on further increase in the cupola slag concentration in the concrete specimen. The results are plotted graphically for curing period of 3, 7, 14 and 28 days.

Graph 5.1 Compressive Strength Cube

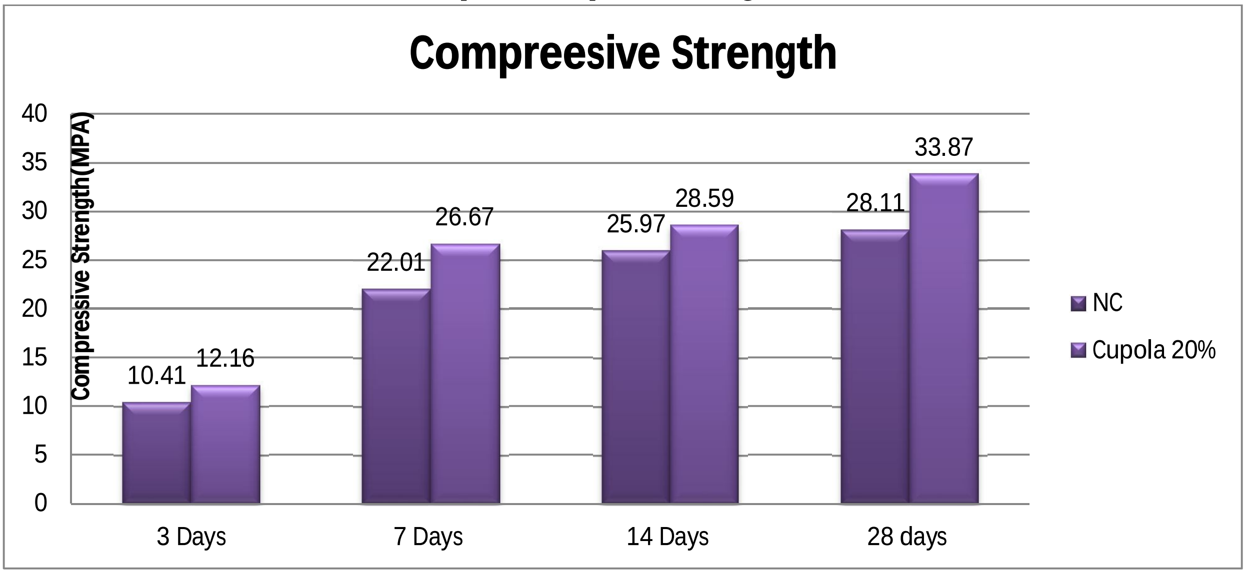

Table 5.2 Compressive Strength of Concrete Mixes with w/c of 0.50

Days	Nominal Concrete	Cupola 10%	Cupola 30%	Cupola 45%
3 Days	6.44	8.93	8.66	9.46
7 Days	11.76	19.68	20.71	17.62
14 days	16.04	22.66	23.43	23.00
28 days	21.66	26.09	26.76	26.43

It can be observed from the above results that the compressive strength of the concrete increases by in corpora ting cupola slag up to 10% 30% and 45% as partial replacement to coarse aggregate in all the concrete mixes and subsequently decreases on further increase in the cupola slag concentration in the concrete specimen. The results are plotted graphically for curing period of 3, 7, 14 and 28 days.

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Graph 5.2 Compressive Strength Cube

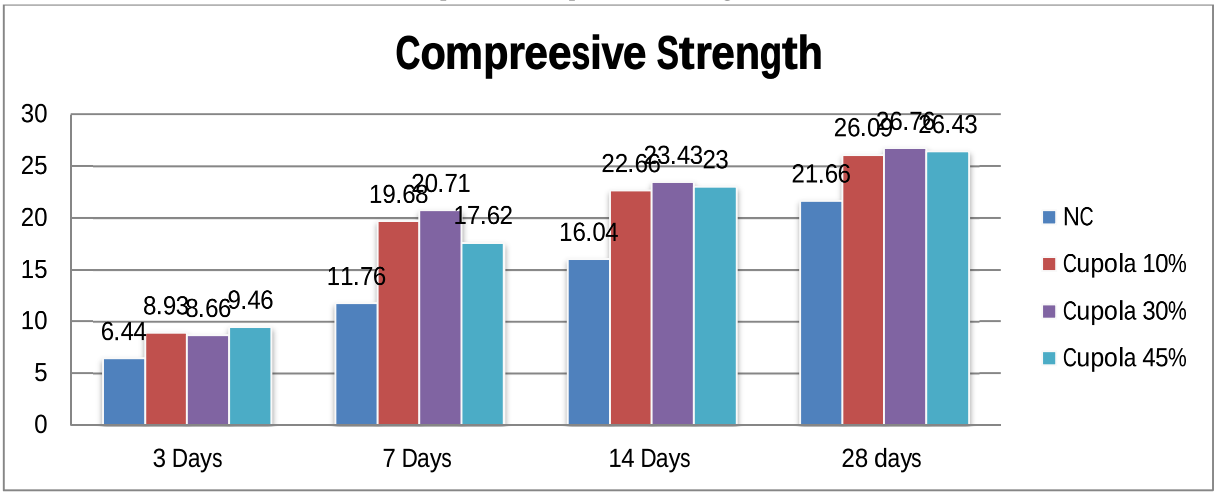
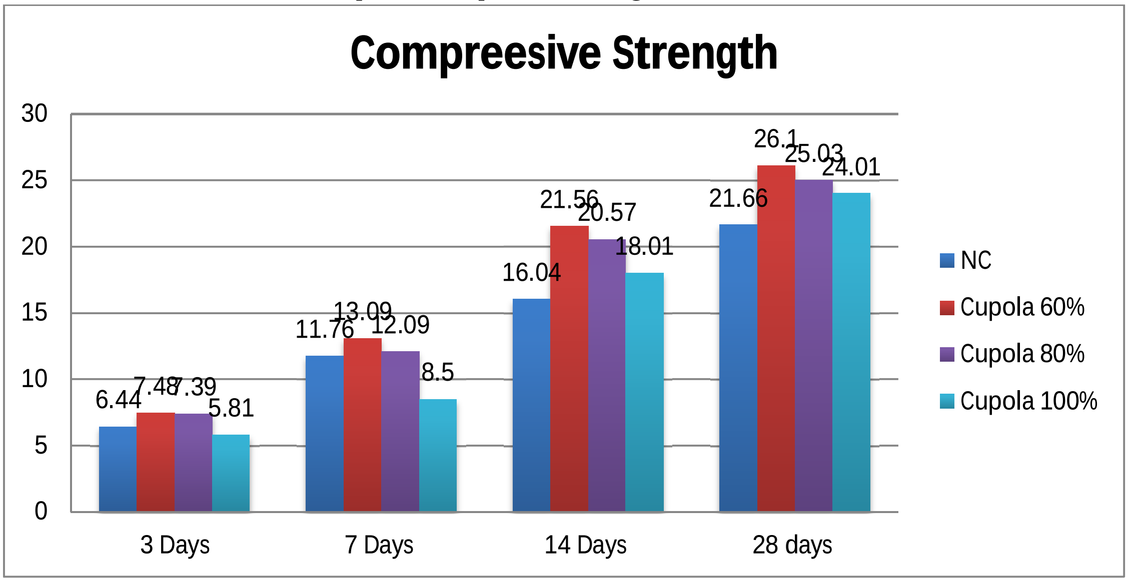


Table 5.3 Compressive Strength of Concrete Mixes with w/c of 0.50

Days	Nominal Concrete	Cupola 60%	Cupola 80%	Cupola 100%
3 Days	6.44	7.48	7.39	5.81
7 Days	11.76	13.09	12.09	8.50
14 days	16.04	21.56	20.57	18.01
28 days	21.66	26.10	25.03	24.01

It can be observed from the above results that the compressive strength of the concrete increases by in corpora ting cupola slag up to 60%, 80% and 100% as partially replacement to coarse aggregate in all the concrete mixes and subsequently decreases on further increase in the cupola slag concentration in the concrete specimen. The results are plotted graphically for curing period of 3, 7, 14 and 28 days.

Graph 5.3 Compressive Strength Cube



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VII. CONCLUSION AND DISCUSSION

A. Concrete casted using tin cans shows poor results giving reduction in the strengths however the split tensile strength of tin cans has better results.

B. Highest increase in compressive strength is achieved for a 20% replacement of coarse aggregates with cupola furnace slag, indicating
that 20% cupola slag is the optimum replacement percentage of coarse aggregates in the concrete mixtures.

C. Highest increase in split tensile strength is achieved for a 20% replacement of coarse aggregates with cupola furnace slag, indicating that 20% cupola slag is the optimum replacement percentage of coarse aggregates in the concrete mixtures

D. Save Environment

E. Economical Construction

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[4] IS: 2386- Methods of tests for aggregate for concrete

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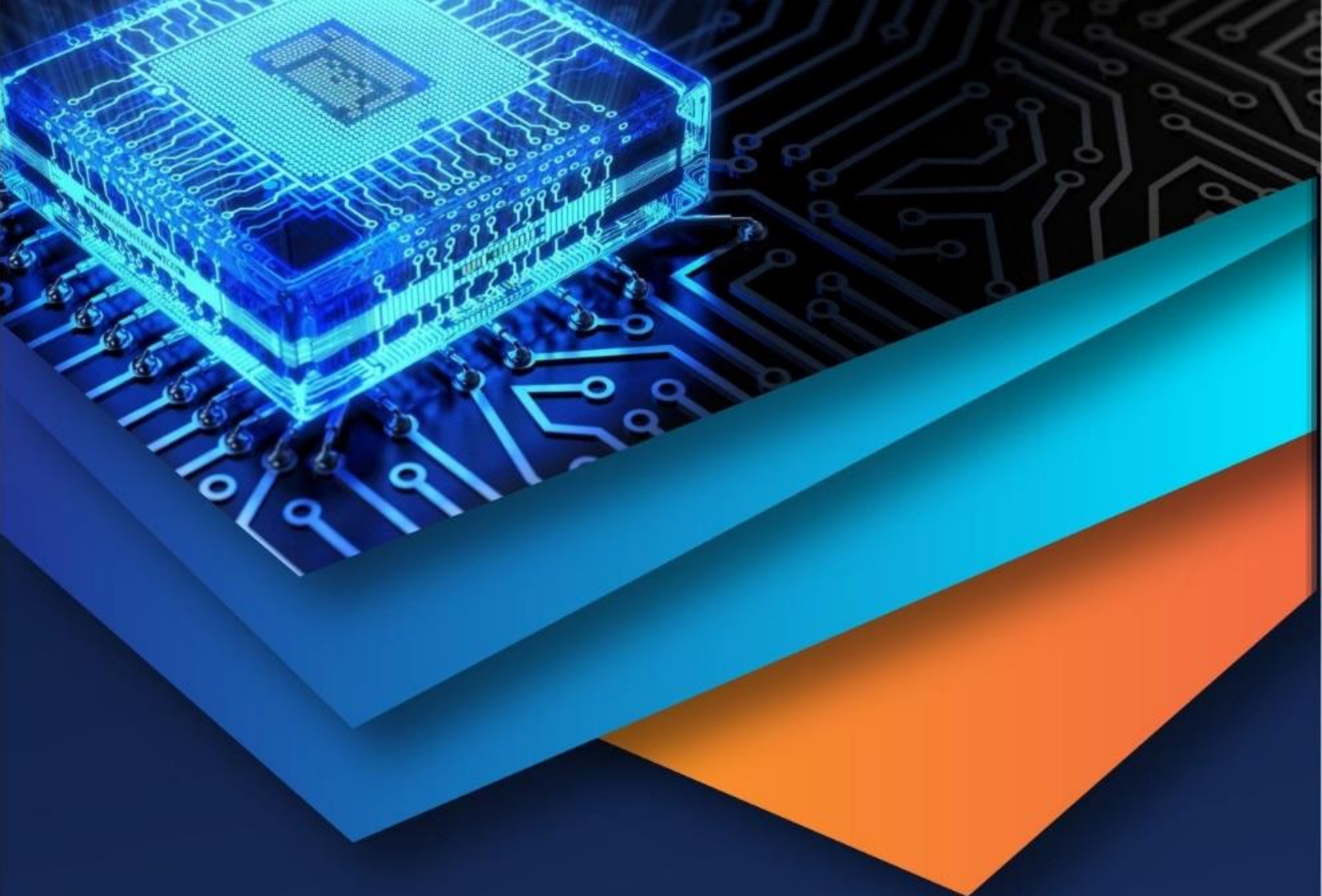

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