

# Experimental Investigation on Strength Characteristics of Lead slag in concrete

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**Abstract** — This paper has made an effort to partially replace cement by lead slag for M25 grade concrete. Initially chemical constituents of Lead slag and physical properties of cement, GGBS, River sand, Quarry dust and coarse aggregates were analyzed. Concrete was casted with 0.45 w/c ratio for M25 grade concrete. By varying the percentages of lead slag, cement and GGBS concrete was casted. Compressive Strength characteristics of lead slag in concrete with varying proportions were analysed using graphs. Percentage of cement consumption savings is found out for one cubic meter of concrete without affecting the target compressive strength of concrete.

**Keywords**—Lead Slag, Compressive strength, concrete

## I. INTRODUCTION

Construction industry activities has been rapidly developing day by day throughout the world. Concrete is one such material which has been abundantly used from tiny projects to mega projects. For the production of concrete it mainly requires cement, sand and aggregates with water. It has been found that about 467g of CO<sub>2</sub> is emitted during 1kg production of cement [1]. In order to reduce the usage of cement and reduce the effect towards environmental pollution this paper has made an attempt of partially replacing cement by lead Slag. Lead slag is the waste by-product generated during the recovery of metallic lead by pyro metallurgic process from exhausted batteries.

## II. OBJECTIVES

- 1) To determine the chemical composition of Lead slag and physical properties of Cement, Ground granulated blast furnace slag, River sand, Quarry dust and Coarse aggregates.
- 2) To determine the strength characteristics of Lead slag as a partial replacement for cement and GGBS in concrete.
- 3) To analyse the cost savings in cubic meter

## III. MATERIALS USED

### A. Cement

Ordinary Portland cement of 53 grade confirming to Indian standard IS 269:2013 was used. The various properties of cement are given in the Table I

TABLE I  
PROPERTIES OF CEMENT

Sl.No	Properties	Test results	Requirements as per IS 1S269:2013
1	Specific Gravity	3.19	-
2	Normal Consistency	28.5%	-
3	Initial Setting Time (minutes)	55	>30
4	Final Setting Time (minutes)	230	<600
5	Compressive Strength (N/mm <sup>2</sup> )	3 days	35
		7 days	44.5
			>27
			>37

### B. River Sand

River sand was collected from Trident RMC plant Baikampady Mangaluru. Properties of River sand are given in Table II

TABLE II  
PROPERTIES OF RIVER SAND

Properties	Test Results
Specific gravity	2.55
Water absorption	1.85%
Fineness modulus	3.30

### C. Lead Slag

Lead slag sample was collected from Eshwari Metals Baikampady Mangaluru. Properties of Lead slag are given in Table II

TABLE III  
PROPERTIES OF RIVER SAND

Properties	Test Results
Specific gravity	2.2
Water absorption	11.01%
Fineness modulus	4.14

### D. Quarry dust

Quarry dust was collected from Trident RMC plant Baikampady Mangaluru. Properties of Quarry dust are given in Table IV

TABLE IV  
PROPERTIES OF QUARRY DUST

Properties	Test Results
Specific gravity	2.52
Water absorption	3.80%
Fineness modulus	3.95

Coarse aggregates was collected from Trident RMC plant Baikampady Mangaluru. Properties of Quarry dust are given in Table V

TABLE V  
PROPERTIES OF COARSE AGGREGATES

Properties	Test results of 20mm	Test results of 10mm
Specific gravity	2.69	2.64
Water absorption	0.31%	0.49%
Fineness modulus	2.34	6.26

#### F. Water

Potable water confirming to IS 456-2000 was used.

### IV. METHODOLOGY

#### Step 1:

Procurement of raw material Lead slag from Eshwari Metals Baikampady Mangaluru

#### Step 2:

Identification of similarity in chemical constituents between lead slag and Ordinary Portland Cement 53 grade

#### Step 3:

Casting of concrete in cubical moulds of size 150mm×150mm×150mm for varying water cement ratios in selected proportion of Cement, Lead slag and GGBS, Crushed sand and Natural sand, Coarse aggregates of 20mm and 10mm size with additive admixtures for the preparation of M25 grade of concrete.

#### Step 4:

Determining the slump test, temperature on fresh concrete

#### Step 5:

Compute the compressive strength of concrete for 7 and 28 days of concrete.

Step 6: Comparing the normal concrete and lead slag additive concrete to analyze cost savings for cubic meter of concrete

### V. RESULTS AND DISCUSSIONS

#### A. Comparison between Chemical Composition of cement versus Lead Slag

The following Table VI shows the chemical composition of ingredients existing in Ordinary Portland cement and Lead slag. It has been found that lead Slag contains similarity in chemical compounds which includes Silica Iron and

Parameters	Lead Slag	Oxide composition in OPC
Specific Gravity	3.11	3.19
Silica SiO <sub>2</sub> %	42.86	17-25
Iron Fe <sub>2</sub> O <sub>3</sub> %	1.91	0.5-6
Aluminium Al %	40.28	-
Manganese Mn %	1.62	-
Magnesium Mg %	2.19	0.5-4
Calcium Cao %	7.24	-
Sulphur %	7.22	-

Magnesium with cement

#### B. Concrete mix proportions for M25 grade concrete

Table VII shows the various proportions of Cement replaced by Lead slag in 55Kg, 100Kg, 80 Kg and 60 Kg on Trial and error basis.

TABLE VII  
MIX PROPORTIONS M25 GRADE CONCRETE

Grade of concrete	M25	M25	M25	M25	M25
W/c ratio	0.45	0.45	0.45	0.45	0.45
Corrected w/c ratio	0.65	0.52	0.52	0.52	0.52
Cement	170	140	140	160	230
GGBS	170	145	120	80	0
Lead Slag	0	55	60	80	100
C.A 20 mm	540	560	590	560	560
C.A 10 mm	480	460	440	460	460
C.Sand	430	425	425	425	430
Q.Sand	430	425	425	425	430
Water	158	178	174	167	174
Slump	180mm	160mm	170mm	170mm	170mm
Slump at 60Min	150mm	130mm	120mm	140mm	130mm
Slump at 120Min	100mm	100mm	100mm	90mm	80mm

Notations: w/c-Water to cement ratio, GGBS-Ground Granulated blast furnace slag, C.A-Coarse aggregate, Q-Quarry sand, R-River sand.

#### C. Compressive strength of concrete

The compressive strength of concrete was found out by casting moulds of size 150mm×150mm×150mm and was tested using compressive testing machine. From the Fig.1 shown below it was found that 18.75% of cement can be replaced by Lead slag in concrete.

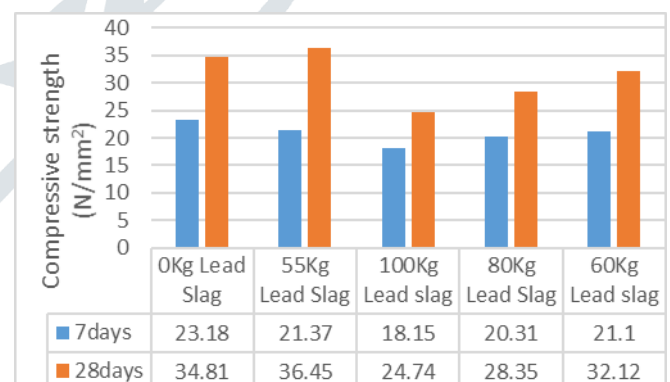


Fig. 1 Compressive Strength of Concrete moulds

### VI. CONCLUSIONS

- It was found that Cement and GGBS can be replaced by lead slag up to 18.75% in concrete.
- Lead slag can be added up to 60Kg by replacing cement and GGBS in concrete.
- It was also found that for 1 cubic meter of concrete 6.4 bags of cement and GGBS was consumed. Hence by replacing lead slag material 1.2 bags of cement and GGBS can be saved.

- Target Compressive strength of concrete was  $25\text{N/mm}^2$  and strength gained after 28 days was found to be  $32.12\text{N/mm}^2$  with replacing cement with lead slag up to 18.75% in concrete.

## VII. REFERENCES

1. Gartner, E. Industrially interesting approaches to “low- CO<sub>2</sub>” cements. Cem. Concr. Res. (2004), Volume 34, pp. 1489–1498.
2. Alessandra Smaniotto, Angela Antunes, Irajá do Nascimento Filho, Luciana Dornelles Venquiaruto, Débora de Oliveira, Altemir Mossi, Marco Di Luccio, Helen Treichel, Rogerio Dallago “Qualitative lead extraction from recycled lead–acid batteries slag” Journal of Hazardous Materials 172 (2009) pp. 1677–1680.
3. Tarek U. Mohammed, Md N. Rahman, Aziz H. Mahmood, Tanveer Hasan, and Shibly M. Apurbo “Utilization of Steel Slag in Concrete as Coarse Aggregate” Sustainable material and construction Technologies Las Vegas, USA, August 7-11, 2016
4. Indian standard concrete Mix Proportioning – Guidelines IS 10262:2009 Bureau of Indian Standards.
5. Indian standard concrete Mix Proportioning – Guidelines IS 456:2000 Bureau of Indian Standards.

