Study On Mechanical Properties Of Concrete By Using Industrial Waste

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Abstract: Red mud is a residue of Bayer's process during the production of alumina from the Bauxite ore and it gives significant amounts of fine high percentage of alkalinity residue of bauxite. It produces equal quantity of metallurgical alumina and it is disposed in sealed and unsealed bags which lead to an important environment issue. Foundry sand is a good, evenly sized, smooth, high-quality silica lake sand bonded to form a casting mould for ferrous and nonferrous metal. When these sand has been used for longer time where the sand can no longer be reused in the foundry and it will be treated as waste foundry sand here four test groups were conducted with the replacement percentages of 0%,5%,10% and 15% of cement by red mud and foundry sand of 0%,15%,25%, and 35% by fine aggregates.

Keywords: Compressive strength Red mud, chemical & physical properties, tensile strength, Waste foundry sand

1 INTRODUCTION

India is the 5th largest country in the world has bauxite ore resource and bauxite ore is the one of the main sources for alumina. Red mud is a byproduct obtained by digestion of bauxite ore with caustic soda for the production of Alumina. Which uses bauxite and caustic as a main raw material for the production and it gives a red mud as a waste product that has virtually no broad industrial application and is dumped in the alumina refinery yard called red mud yard. Over the years, the red mud produced has been dumped into the yard without any use and it requires an enormous space of 4.0 acres per year to store the red mud as alternative materials for the low-grade bauxite used by the cement industries for cement production. Ideas stuck that why not try red mud as alternative in cement industries were look out to make up for the deficiency of alumina in their raw materials viz -lime stone for the production of cement. Foundry sand constitutes of high-quality silica of uniformly sized materials used for the moulds of ferrous and Non-ferrous metal casting units. Initially the sand does not contain any impurities or ferrous contents. But, after casting it will be rich in ferrous content of about 90-95% by its volume. Foundry sand is majorly obtained from automobile industries and heavy metal casting units. Sand casting is the most popular and efficient system of casting process in industry. The most common type sand used for preparing the moulds is green sand for ferrous casting.

A. Demand and Materials Used

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Table 1 *World Cement Demand at a glance (million metric tons)*

Cement Demand	*2005*	*2010*	*2015*
North America	*1630.0*	*2250.0*	*2830.0*
Western	*149.6*	*208.0*	*233.0*
Asia/pacific	*954.5*	*1470.0*	*1895.0*
Other regions	*328.2*	*401.5*	*506.0*

B. Objective of study

The key objectives of this research were

- To recognize multiple industrial waste appropriate for use in the production of cement.
- Physio-chemical and mineralogical characterization of industrial wastes.
- To examine the draw backs of industrial waste use.
- Recommendations to encourage the use of industrial waste.

2 MATERIALS

A. Cement

Ordinary Portland Cement (53 Grade) was used throughout the study to confirm IS: 269-1976. Different experiments on the cement were conducted to guarantee that the requirements of the IS specifications were confirmed. The physical characteristics of cement were determined in accordance with IS: 4031-1968 and are presented in table 2 and chemical properties were tabulated in table 3.

Table 2 *Physical properties 53 Grade Cement*

Sl. No	*Characteristics*	*Values*
1	*Standard consistency*	*53*
2	*Fineness of cement as retained on 90-micron sieve*	*3%*
3	*Initial setting time*	*30 minutes*
4	*Specific gravity*	*3.15*
5	*7days compressive strength*	*37 Mpa*

Table 3 *Chemical Properties of Cement*

Sl. No	Components Iron Present	Weight
1	Lime (CaO)	63%
2	Silica (SiO2)	22%
3	Alumina (Al2O3)	6%
4	Iron oxide (Fe2O3)	3%
5	Magnesium oxide (MgO)	2.5%
6	Sulphur trioxide & loss of ignition (SO3)	1.5%
7	Alkalies	0.5%

B. Red Mud

Red mud is acquired from the extraction of bauxite ore, which consists of strong and metallic oxide-bearing impurities, and most frequently encounters disposal problems in the aluminum sector. The red color is due to the oxide resulting in a total red color of 60%. Besides iron, silica, unbleached remaining alumina and titanium oxide are the other dominant particles. Red mud cannot be readily disposed of and environmentally friendly

Fig 1 *Red Mud from Bauxite ore*

Table 4 *Physical properties of Dry red mud*

S. No	Characteristics	Values
1	Standard consistency	45
2	Fineness of cement as retained on 90-micron sieve	5%
3	Initial setting time	45 minutes
4	Specific gravity	2.95
5	7days compressive strength	5Mpa

Table 5 *Chemical properties of the Dry Red Mud*

Compound	Weight [%]
Al2O3	14.14
SiO2	11.53
Fe2O3	48.50
TiO2	5.42
CaO	3.96
MgO	0.049
ZnO	0.027
Na2O	7.50
P2O5	0.297
MnO	1.17
K2O	3.058
L.O. I	7.25

C. Fine Aggregate

The locally available well graded M-sand is used for concrete mix and physical properties of the M-sand is shown below

Table 6 *Physical Properties of River Sand*

Property	River Sand
Specific gravity	2.6
Sieve analysis	Zone-II

D. Foundry sand

Foundry sand of uniformly grade consists of about 85-90% of material ranging under 0.6mm to 0.15mm and remaining foundry sand is finer than 0.075mm. The grains are of rounded and sub angular shaped, but not completely angular.

Table 7 *physical properties of spent green foundry sand*

Property	Results	Test Method
Specific Gravity.	2.50	ASTM D854
Bulk Relative Density, kg/m3	2590 (160)	ASTM C48/AASHTO T84
Absorption, %	0.40	ASTM C128
Moisture Content, %	6.4	ASTM D2216
Clay Lumps and Friable Particles.	10	ASTM C142/AASHTO T112
Coefficient of Permeability (cm/sec).	10-4	AASHTO T215/ASTM D2434
Plastic limit/plastic index.	Non plastic	AASHTO T90/ASTM D4318

Table No 8 *Chemical oxide composition in Foundry sand*

Constituent	Value (%)
SiO_2	87.93
Al_2O_3	4.70
Fe_2O_3	0.94
CaO	0.12
MgO	0.30
SO_3	0.09
Na_2O	0.19
K_2O	0.21
TiO_2	0.15
P_2O_5	0.00
Mn_2O_3	0.06
SrO	0.03
LOI	5.15 (0.45 to 9.47) 2.1 - 12.1
TOTAL	99.87

E. Coarse Aggregate

Crushed stone aggregate is used to produce concrete as a coarse aggregate. The maximum aggregate size used for this study is 20 mm, with a specific gravity of 2.78.

F. Water

Fresh and clean potable water for casting and curing of concrete specimens. The water should be relatively free from organic matters like silt, oil, chloride and acidic contents as per the requirements of Indian Standards.

3 MIX PROPORTIONS

The properties of concrete are determined by replacing Portland cement by red mud about 0%, 5%, 10%, 15% and fine aggregate of about 0%, 15%, 25% & 30% by foundry sand. With constant water/cement ratio four concrete design mix of grade M30 was prepared and each concrete design mix was studied for Compressive.

Table 9 *Concrete Design Mix Proportions*

Cement	*Sand*	*Aggregate*	*w/c ratio*	*Admixture*	*Slump value*
1	*1.25*	*2.72*	*0.45*	*0.4%*	*75-100mm*
1	*1.25*	*2.72*	*0.45*	*0.5%*	
1	*1.25*	*2.72*	*0.45*	*0.6%*	
1	*1.25*	*2.72*	*0.45*	*0.7%*	

4 RESULTS

Table 10 *Replacement of red mud & Foundry sand*

Replacement of red mud in %	*0*	*5*	*10*	*15*
Replacement of foundry sand in %	*0*	*15*	*25*	*35*

Table No *11 Compressive Strength*

Grade of concrete	*Mix*	*% of red mud used*	*% of Foundry sand used*	*28 days compressive strength (N/mm2)*
M30	*Mix-1* *Mix-2* *Mix-3* *Mix-4*	*0* *5* *10* *15*	*0* *15* *25* *35*	*33.30* *37.42* *38.50* *36.21*

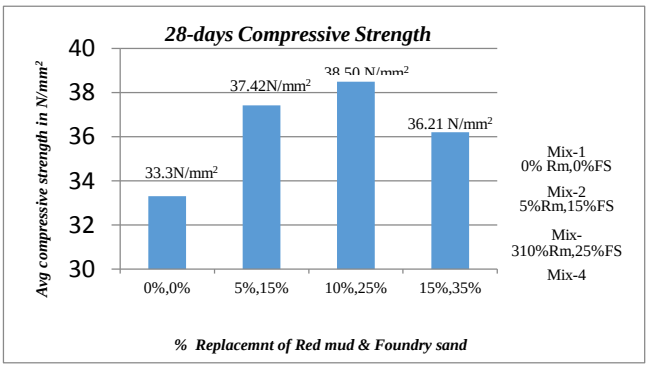

Figure.2 *28-days cube Compressive strength*

Table 12 *Split Tensile Strength*

Grade of concrete	*Mix*	*% of red mud used*	*% of Foundry sand used*	*28 days Split Tensile strength (N/mm2)*
M30	*Mix-1* *Mix-2* *Mix-3* *Mix-4*	*0* *5* *10* *15*	*0* *15* *25* *35*	*2.84* *3.20* *3.96* *3.54*

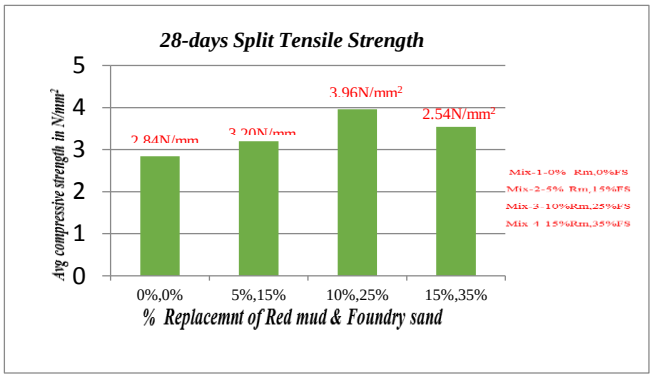

Figure 3 *28-days Cylinder Split Tensile Strength*

5 CONCLUSIONS

It has been noticed that using waste materials from the industries we can develop the economical concrete at the optimum replacement level from the proper tests for mass concrete works. With the use of super plasticizer proper workability and W/C ratio is maintained. From the fresh properties test it was noticed that percentage of super plasticizer is increasing with the increase of replacement levels due to increase of fines in the mix. Mix-1 is conventional i.e. 0% of replacement from the 28-days curing period the value obtained is about 33.30 N/mm2 with that all the values obtained from the different replacement levels of red mud and foundry sand are compared. The values obtained from the compressive strength and split tensile strength it is observed that replacement level of red mud and foundry sand is optimized at Mix-3 with compressive strength of 38.50N/mm2 (maximum) and again in the Mix-4 it got decreases in this experimental work.

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