An Experimental Investigation on Strength and Durability of Concrete with Coal Cinder as a Replacement of Coarse Aggregate

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Abstract— Concrete is most widely used construction materials due to its strength, performance and durability. To meet the growing infrastructure and industrial needs, huge quantities of concrete is required, which in turn means, the large volumes of natural resources and raw materials are being used for concrete production around the world. Many manufacturing industries use the raw materials for a specific purpose and after utilization, it will become a waste and waste management is a very difficult problem and in the near future an important task will be to increase recycling and economic utilization while lowering storage. Attempt has been made in the present work to ascertain the strength and durability characteristics of concrete with Coal Cinder as a replacement for Conventional Coarse Aggregate.

Keywords: Ordinary Portland Cement, Coal Cinder, Compressive Strength And Durability

I. INTRODUCTION

Many industries such as paper mills use coal as a fuel for firing boilers to generate stem. After the coal is as burnt in the boilers, it leaves a residue known as "coal ash or coal cinder'.it is a basically the power or pieces from burned or unburned coal that is nor reduced to ashes but is incapable of further reduction. Coal cinder is an inorganic waste produced in the combustion of black coal in the boiler house. This by product can be valuable resources, becoming an alternative to natural fines used in bricks and concrete.

Dr. Bashkar Desai et al., describes experimental investigation an attempt is to be made to study the strength properties of light weight cinder aggregate cement concrete in different percentage proportions of 0, 25, 50, 75 and 100 by volume of light weight aggregate concrete can be prepared. By using this

M. A. Calderone and R. G. Burg et al., Structural lightweight concrete is defined as concrete made with low-density aggregate having an air-dry density of not more than (1850 kg/m³) and a 28-day compressive strength of more than (17.2 MPa). This paper presented the test results of very low-density structural lightweight concrete mixtures developed in the laboratory for the purpose of finding a suitable mixture for use on a historic building rehabilitation project. Mixture parameters included a specified compressive strength of 3000 psi at 28 days and an air-dry density approaching 70 lb/ft3. Various constituent materials, mixture proportions and curing methods were examined. The result of this research exemplifies the feasibility of achieving very low densities with structural concretes.

II. MATERIALS

A. Cement

Portland cement is the most common type of cement in general usage. It is a basic ingredient of concrete, mortar and plaster. Of the various ingredients used in concrete, cement is the most energetically and expensive. In the present investigation OPC 43 grade cement is used.

B. Water

Combining water with a cementitious material forms a cement paste by the process of hydration. The cement paste glues the aggregate together, fills voids within it, and makes it flow more freely. Lower water to concrete ratio yields a stronger, more durable concrete, while more water gives a free-flowing concrete with a higher slump. Impure water used to make concrete can cause problems when setting or in causing premature failure of the structure.

C. Manufacture Sand

Sand is used as fine aggregate in mortar and concrete. Natural river sand is the most preferred choice as a fine aggregate material. River sand is a product of natural weathering of rocks over a period of millions of years. It is mined from the river beds and sand mining has disastrous environmental consequences. River sand is becoming a scarce commodity and hence exploring alternatives to it has become imminent. Rock crushed to the required grain size distribution is termed as Manufactured Sand (M Sand). In order to arrive at a required grain size distribution the coarser stone aggregates are crushed in a special rock crusher and some of the crushed material is washed to remove fines. This investigation is an attempt to evaluate the characteristics of mortar and concrete using M Sand as fine aggregate. For the purposes of comparison characteristics of mortar and concrete with river sand has also been explored.

D. Coal Cinder

Lightweight concrete is a very versatile and advantageous material in modern construction industry. It is lighter than normal weight concrete. Because coal cinder is a light weight aggregate with low specific gravity (G-2.05).it is considered as best alternative to conventional coarse aggregate to produce light weight cement concrete. The advantages of light weight concrete (LWC) are its reduced mass of improved thermal and sound insulation properties, while maintaining adequate strength. The use of lightweight concrete has great impact on developing countries as it permits design flexibility and substantial saving in cost of construction.

E. Coarse Aggregates

Crushed stone aggregates of 20mm size obtained from local quarry site were used for the experiment.

III. METHODOLOGY

A. Tests on materials

1) Cement

Elements	Content
Specific Gravity	3.16
Standard Consistency	31%
Initial Setting time	43min
Final Setting time	600min

Table 3.1: Physical properties of Cement

Oxides	Percentages
Cao	62.85
SiO_2	20.98
Al_2O_3	5.42
Fe_2O_3	3.92
MgO	1.76
SO_3	2.36
Na_2O	0.28
K_2O	0.53
Loss of Ignition	1.90

Table 3.2: Chemical properties of Cement

Sl No	Particulars	Obtained values
1	Specific gravity	2.65
2	Sieve analysis	Well graded sample
3	Bulk Density	1750 kg/m^3
4	Water absorption	2.0%

Table 3.3: Physical properties of Manufactured Sand

Sl No	Particulars	Obtained values
1	Specific gravity	1.78
2	Water absorption	6.4%

Table 3.4: Physical properties of Coal Cinder

Sl No	Particulars	Obtained values
1	Specific gravity	2.70
2	Sieve analysis	3.82%
3	Water absorption	1.63%

Table 3.5: Physical properties of coarse aggregate

Fig 1. Coal Cinder

IV. RESULTS AND DISCUSSIONS

Test at Day	M20 with 0% Replacement of CA	M20 with 25% replacement of CA	M20 with 50% replacement of CA	M20 with 75% replacement of CA	M20 with 100% replacement of CA
3 days	2.50	5.82	4.95	3.81	2.95
7 days	8.50	15.87	13.94	11.88	7.84
28 days	21.12	28.06	25.13	23.30	22.15

Table 4.1: 28 days Compressive Strength in N/mm2 with different percentage of Coal cinder replacing Coarse aggregate for M20 grade concrete

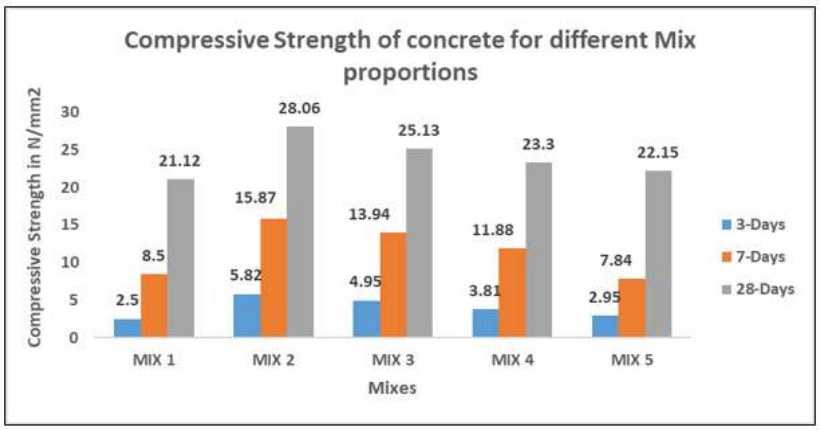

Fig 2. Average Compressive Strength values for different mix proportions after 3, 7 & 28days of curing

Graph shows the variation of compressive strength values for 3, 7 and 28days of curing for Normal concrete and concrete mix with different percentages of replacement of CA by coal cinder varying from 0, 25, 50, 75 & 100%. Test results for the above said concrete mixes shows that compressive strength values vary about 32.85, 18.98, 10.32 & 4.87% higher than that of conventional concrete.

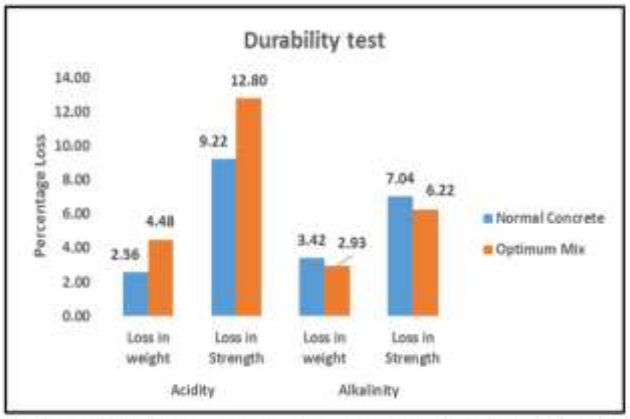

Fig 3: Percentage loss in weight & compressive strength values treated with acid & based for 28days

Graph shows that percentage loss of weight and loss of compressive strength values for optimum mix (concrete with 25% replacement of CA with Coal Cinder) is more in case of acidity test than compared to that of alkalinity test because when mineral composition of cinder reacts with acids it gets diluted and increases the porosity which in turn permeability increases.

V. CONCLUSION

Results were analyzed to derive useful conclusions regarding the strength characteristics of concrete with different percentages replacement of Coal cinder with the Coarse aggregate for M20 grade. The following conclusions may be drawn from the study are,

1) Coal cinder has higher absorptivity (Piotr Smarzewski Et. al) which keep the concrete moist for longer period of time in turn facilitates the hydration of cement and may improve the strength of the concrete.
2) The specific gravity of Cinder is less than compared to conventional aggregate (Anil Sinha Et. al) which reduces the density of concrete.
3) Coal cinder contains higher amount of silica and can be effectively utilized as a replacement for aggregate is preparing concrete mix which reduces the cost of construction.
4) Average Compressive strength values for concrete made with 25% replacement of CA by Coal Cinder shows a promising result of 32.85% higher compared to that of conventional concrete.
5) Coal cinder as a replacement of CA in concrete paved the way for preserving the natural resources for future.

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