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STUDY ON STRENGTH OF CONCRETE BY PARTIAL REPLACEMENT OF CEMENT BY GROUND GRANULATED BLAST FURNACE SLAG (GGBS) AND COW DUNG ASH (CDA)

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Abstract*— concrete is the most widely used construction material in civil engineering Industry because of its high structural strength and stability. The concrete industry is constantly looking for supplementary cementations material with the objective of reducing the solid waste disposal problem. Ground granulated blast furnace slag (GGBS) and cow dung ash (CDA) are among the solid wastes. To overcome from this Crisis, partial replacement of cement by GGBS and CDA can be an economic alternative. The experiments were designed to study the effect of adding GGBS and in various percentages by weights 20%,30%&40% of cement and cure for the Periods of 3,7,14&28 days respectively before testing for the compressive strength of concrete. In our project 56 cubes are casted for the compressive strength of the concrete.

***Keywords*— GGBS, Cow dung Ash, Cement, and Coarse Aggregate**

I. INTRODUCTION

The blast furnace slag is a by-product of the iron manufacturing industry. Iron ore, coke, and limestone are fed into the furnace and the resulting molten slag floats above the molten iron at a temperature of about 1500oC to 1600oC. The molten slag has a composition of about 30% to 40% SiO2 and about 40% CaO, which is close to the chemical composition of Portland cement. This brought pressures on researchers for the reduction of cement consumption by partial replacement of cement by supplementary materials. These materials may be naturally occurring, industrial wastes or by-products that are less energy intensive. These materials (called pozzalonas) when combined with calcium hydroxide, exhibits cementetious properties. Most commonly used pozzalona are fly ash, silica fume, meta kaolin, ground granulated blast furnace slag (GGBS). This needs to examine the admixtures performance when blended with concrete so as to ensure a reduced life cycle cost. There are competing reasons, in the long term, to extend the practice of partially replacing cement with waste by products and processed materials possessing pozzolanic properties. Lately some attention has been given to the use of natural pozzolans like GGBS as a possible partial replacement for cement. Amongst the various methods used to improve the durability of concrete, and to achieve high performance concrete, the use of GGBS is a relatively new approach; the chief problem is with its extreme finesse and high water requirement when mixed with Ordinary Portland cement. The present paper focuses on investigating characteristics of concrete with partial replacement of cement with GGBS. The Blast-Furnace slag is a by-product of the iron manufacturing industry. Iron ore, coke and limestone are fed into the furnace and the resulting molten slag floats above the molten iron at a temperature of about 1500 0C to 1600 0C. The molten slag has a composition of about 30% to 40% SiO2 and about 40% CaO, which is nearly similar to the chemical composition of Portland cement.

1. HISTORY OF USING GGBS IN CONCRETE

There are many examples of using the GGBS concrete in the construction; following are some examples where the GGBS concrete were used.
1. World Trade Centre, New York (about 40% replacements).
2. Airfield Pavement of Minneapolis Airport (35 % replacement).
3. Atlanta's Georgia Aquarium (worlds one of the largest aquarium), (20% to 70% replacements).
4. Detroit Metro Terminal Expansion (30% Replacement).
5. The Air Train linking New York's John Kennedy International Airport with Long Island Rail Road Trains (20%-30% replacements). Tsing Ma Bridge, Hong Kong (59%-65% replacement).

From the above examples it is cleared that the world is aware of the advantages of GGBS uses in concrete.
The main aim of the use of GGBS is to improve the durability, reduce the maintenance cost, to increase the service life, increase the economy of the construction with using the cheaper material as a replacement of the cement, and to reduce the cement consumption. Today it is necessary to reduce the carbon footprints as it affects the environment and ultimately affects the life on the planet and around 5% CO2 equivalent is produced from the single industry i.e. from cement industry.

In production of one ton of cement it consumes about 5000MJ of energy, 1.5 tones of mineral extraction, and produces 0.95 tons of CO2 equivalent, this consumption of natural resources and formation of large amount of CO2 equivalent it is necessary to find some alternative material instead of the cement.

2. CHEMICAL COMPOSITION OF GGBS

The chemical composition of a slag varies considerably depending on the composition of the raw materials in the iron production process. Silicate and aluminates impurities from the ore and coke are combined in the blast furnace with a flux which lowers the viscosity of the slag. In the case of pig iron production the flux consists mostly of a mixture of limestone and forsterite or in some cases dolomite. In the blast furnace the slag floats on top of the iron and is decanted for separation.

Typical chemical composition:

Calcium oxide =40%
Silica = 35%
Alumina = 13%
Magnesia = 8%

The glass content of slag's suitable for blending with Portland cement typically varies between 90-100% and depends on the cooling method and the temperature at which cooling is initiated. The glass structure of the quenched glass largely depends on the proportions of network-forming elements such as si and Al over network-modifiers such as Ca, Mg and to a lesser extent Al. Increased amounts of network-modifiers lead to higher degrees of network DE polymerization and reactivity. It is a granular product with very limited crystal formation, is highly cementations in nature and, ground to cement fineness, and hydrates like Portland cement.

GGBS

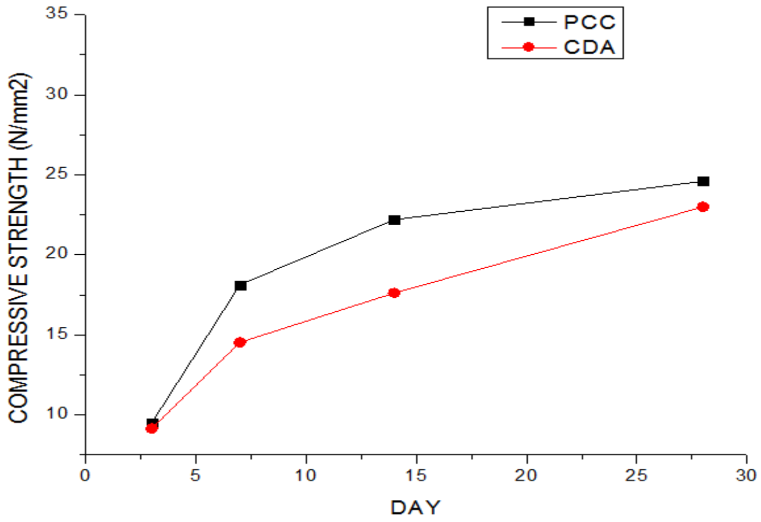
GGBS is obtained by quenching molten iron slag (a by-product of iron and steel making) from a blast furnace in water or stream, to produce a glassy, granular product that is then dried and ground into a fine powder and ground into a fine powder

CONSISTENCY WITH CDA

SL.NO	Percentage of water	Quantity of water added (ml)	Vicats plunger reading
20% Replacement	30	120	16
30% Replacement	31	124	15
40% replacement	33	132	20

RESULTS

The consistency of cement + 20% CDA = 36%
The consistency of cement + 30% CDA = 39%
The consistency of cement + 40% CDA = 42%



GRAPH SHOWING COMPRESSIVE STRENGTH OF PLAIN CONCRETE AND 20% COW DUNG ASH

COW DUNG ASH (CDA)
In this we replaced cement with CDA, it should be highlighted that the initial and final setting time increases as the percentage of CDA, CDA has an advantage that offers lightness of weight and low thermal conductivity, CDA requires more quantity of water as the percentage increases in the concrete therefore it has a serious limitation that must be understood before it is put to use

COW DUNG ASH (CDA)

TEST RESULTS ON CEMENT

SINO	DESCRIPTION	TEST RESULTS
1	Grade of cement	53 grade
2	Type of cement	OPC
3	Normal consistency	28%
4	Initial setting time	33 minutes
5	Specific gravity of cement	3.10
6	Fineness of cement	2%

SLUMP CONE TEST RESULTS FOR CDA

S.NO	Percentage of replacement of CDA	Slump value [mm]
1	20%	75
2	30%	85
3	40%	92

COMPRESSIVE STRENGTH TEST RESULTS FOR CDA

CDA content	After 3 days	After 7 days	After 14 days	After 28 days
20%	9.15	14.53	17.62	23
30%	9.17	12.66	15.81	20.6
40%	7.19	8.79	15.8	17.4

COMPRESSIVE STRENGTH TEST RESULTS FOR GGBS

GGBS content	After 3 days	After 7 days	After 14 days	After 28 days
20%	12.36	16.23	22.8	28.5
30%	18.4	20.5	24.8	29.05
40%	18.8	22.7	28.9	31.2

OBJECTIVE OF THE RESEARCH WORK

The application of supplementary material CDA&GGBS to cement in various percentages is to be done by replacing 20%, 30% and 40% individually for achieving
(i) To produce and evaluate the products for partial replacement of cement using the by products.
(ii) To minimize the overall environmental effects of concrete production using these materials as partial replacement.
(iii) To promote the preservation of the environment and natural resources through a process optimization of waste.
(iv)To develop a cost competitive structural light weight concrete by incorporating supplementary materials.

CONCLUSIONS

The following conclusions can be drawn from the experimental investigations conducted on the behaviour of concretes with GGBS as partial replacements for cement

- By the normal consistency test on CDA and GGBS by replacing 20,30 and 40% respectively by cement quantity, it resulted that, GGBS requires less water for mix, while CDA requires more water than PCC (Plain cement concrete)
- The use of GGBS and CDA increases initial setting time and setting time increases as the replacement percent increases
- The slump test showed increased value in percent of replacement of both GGBS and
- CDA, concluding that both increase the workability
- The Cow Dung Ash requires more quantity of water as the percentage increases in the concrete as its percent increases, giving rise to more water cement ratio, which in turns decreases the strength.
- on study of the graphs of compressive strength values of PCC and CDA, it showed that, strength of plain cement concrete is more than that of CDA, at all days of curing and percent of replacement.
- on study of the graphs of compressive strength values of PCC and GGBS, it showed that, strength of plain cement concrete is more than that of GGBS at the earlier days of curing, while after 14 days of curing GGBS exceeded the compressive strength than that of PCC, at all percent of replacement.
- By comparing the results of strength of GGBS and CDA, GGBS showed far much strength than that of CDA.

By overall study, we can conclude that, usage of GGBS is better option when comparing to CDA, and CDA can be used as replacing material at less percent where the member not carrying much load and CDA available at abundant and at cheaper cost.

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