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A Review Paper On Utilization And Effect Of Ground Granulated Blast Furnace Slag In Brick Manufacturing Industry

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Abstract: Due to the limited availability of enviourmental things the manufacturing of cement in manufacturing industry are very difficult and intricate process and this review paper is basically the summary to know how to increase the amount of granulated blast furnace slag as aggregates in the cements. As we know main component of concrete is cement. In the present study, granulated blast furnace slag which is a by-product of steel manufacturing plant is used by replacing partially and completely for different type of fine materials which is either manufactured or naturally obtained (about 0%, 25%, 50%, 75%, and 100% fine material).Characterizations of materials were carried out to know the properties and behaviour of material as block during its fresh and hardened state. Dimensionality, Compressive strength, Water absorption and Block density tests were carried on hardened blocks as per Indian Standards to evaluate the usage of blocks. The main objective is to the intensification of interest towards the utilization of wastes and industrial by-products in block manufacturing unit.

1. INTRODUCTION

Concrete is one of the heavily used construction materials; main ingredient of concrete is cement. The demand for concrete as a building material is on the increase. It is estimated that the production of cement increased from about from 1.5 billion tons in 1995 to 3.2 billion tons in 2016[2].

As we know the utilization of cement causes pollution and reduction of raw material like limestone. The production of Portland cement worldwide is increasing 9% per year. The greenhouse gas emission is about 1.5 billion tons annually or about 7% of the total greenhouse gas emissions to the earth's atmosphere in the manufacturing of Portland cement.

In general Ground slag has been used as a cementitious material in concrete since the beginning of the 1900s. This paper focus on a review of various researched related to alternative partial cement replacement materials, specifically Granulated Blast Slag (GBS).[1]

In recent years, both the growth in the industrial production and the consumption increase in nature have led to a fast decline in available natural resources. A high volume of production has also generated a considerable amount of waste materials which have adverse impact on the environment. [2]

Caron dioxide emission can be controlled up to some extent by the replacement of cement by Ground granulated blast furnace slag. GGBFS not only improve the impermeability of concrete but also improved resistance to corrosion and sulphate attacks. Due to these kind of properties of GGBFS concrete, the service duration of assembly is increased, and maintenance charge is minimized which make the process economical. Substitution of cement by a high percentage of co-environmental GGBFS leads to concrete which not only utilized waste materials but also protects natural resource and energy consumption. [3]

COMPOUND	FORMULA	STANDARD FORM	% BY WEIGHT
Tricalcium aluminate	$Ca_3Al_2O_6$	C_3A	10
Tetracalcium Aluminoferrite	$Ca_4Al_2Fe_6O_{10}$	C_4AF	8
Belite and Dicalciumsilicate	Ca_2SiO_5	C_2S	20
Alite and Tricalciumsilicate	Ca_3SiO_4	C_3S	55
Sodium Oxide	Na_2O	N	Upto 2
Potassium Oxide	K_2O	K	Upto 2
Gypsum	$CaSO_4.2HO$	CSH_2	5

2. Literature Review and Survey

2.1 Properties of cement compound

These compounds like Tricalcium aluminate (C_3A),It has ability to eject lot of heat during starting stage of hydration, but has little strength contribution. Gypsum basically decreases the hydration rate of C_3A.Tricalcium silicate (C_3S), This compound hydrates and hardens at a drastic speed. It is largely responsible for Portland cement's initial gain in strength. Dicalcium silicate (C_2S), C_2S hydrates and hardens slower rate compare to C_3S as well as responsible for gain in strength after one week. Ferrite (C_4AF),

This act as a fluxing agent to decrease the melting temperature of the material in kiln(from 3,000º F to 2,600º F). It hydrates at a larger rate, but does not responsible for increase in strength of the cement.

By mixing these compounds in proper amount manufacturers can produce different types of cement which will suit in several constructions. [4]

2.2 Manufacture of cement

Portland cement is made by crushing, milling and mixed the following materials in exact proper proportion like Lime or calcium oxide (CaO) obtained from limestone, chalk, shells, shale or calcareous rock, Silica(SiO_2) obtained from sand, old bottles, clay or argillaceous rock, Alumina(Al_2O_3) obtained from bauxite, recycled aluminium, clay, Iron(Fe_2O_3) obtained from clay, iron ore, scrap iron and fly ash and Gypsum($CaSO_4.2H_20$) found together with limestone.[5]

The materials with very less amount of gypsum are proportioned to genrate a mixture with the desired chemical composition and then ground and blended by two processes weather by dry process or wet process. The materials are then fed through a kiln at 2,600º F to produce greyish-black pellets known as clinker. The alumina and iron act as fluxing agents which basically lower the melting point of silica from 3,000 to 2600º F. After this stage, the clinker is cooled, pulverized and gypsum added to regulate setting time. It is then ground extremely fine to produce cement. [5]

2.3 Granulated Blast Furnace Slag

Fines of blast furnace slag is a by-product of the iron production process, and consists mostly of calcium silicates and aluminium silicates. The composition of Granulated Blast Furnace Slag (GBS) is procured from JSW Steel Plant at Bellary district, Karnataka to block manufacturing site and material is tested for its following physical properties and chemical composition and results are tabulated.

Serial number	Characteristics	Requirement as per IS: 12089
1.	SiO2	-
2.	Al2O3	-
3.	Fe2O3	-
4.	CaO	-
5.	MgO	17.0 MAX
6.	Loss of ignition	-
7.	IR	5.0
8.	Manganese content	5.5
9.	Sulphide sulphur	2.0
10.	Glass content	85 MIN
11.	Moisture content	-
12	Particle size passing 50.0mm	95%
13.	Chemical moduli (CaO+MgO+Al2O3) /SiO2	Greater than or equal to 1.0

Fig: chemical composition GBS as follows [6]

2.4 Application of ground granulated blast furnace slag (GGBS)

Ground granulated blast furnace slag(GGBS) genrally used in the manufacturing of quality-improved slag cement, namely Portland BF cement and high slag BF cement with GGBS content ranging typically from 30 to 70% and in the production of ready-mixed and site-batched durable concrete. GGBS eliminates the risk of damages caused by alkali-silica reaction.

Advantages:

- Durability
- Appearance
- Strength
- Sustainability
- Better workability [7]

3. Methodology:

In this work, fine blast furnace slag is utilized as a partial or complete replaced by manufactured sand in the manufacturing of blocks(e.g. for mix proportion 1:4:5 i.e., 1 part of cement, 4 part of Fine aggregate, 5 part of coarse aggregates of slag.)[6]The main thing of work is to utilize the industrial waste as an alternative material, so that the scarcity of natural raw materials can be reduced to some extent. Through this we are able to evaluate the properties of slag in mix (like compressive strength, density test, water absorption test) and to calculate the optimum amount of granulated blast furnace slag which can be added in the mix to improve its mechanical strength during the manufacturing of the block with the help of that mix.

3.1 Determination of compressive strength of the blocks

The concrete cubes (after being cured through air for 7, 14, 21 and 28 days) were placed in the compressive machine and load was then applied gradually without shock till the concrete cubes failed, the maximum load was recorded and any unusual features in the type of failure was noted.

$$\text{Compressive strength} = \frac{\text{Loads in KN}}{\text{Gross area of unit perpendicular to direction of that load}} \quad (N/mm^2)$$

3.2 Water Absorption ability of the block

Three blocks are selected from each source and it is completely immersed in water for a period of 24 hours. Further, blocks are removed from water and allowed it to drain for a minute. Visible surface water is cleaned from damp cloth and immediately weighed(M2) and then the blocks are kept to oven dry for 24 hours at temperature 100℃. Samples taken from oven were cooled to room temperature and dry weight and measurements are taken(M1). The water absorption is calculated from below formula:

$$\text{Water absorption, percent} = \frac{(M2-M1)}{M1} * 100$$

3.3 Block Density of the block

Three blocks are taken from each source of twenty blocks and it is kept for oven drying at temperature 100℃ for 24 hours. After 24 hours the blocks is cooled to room temperature and overall dimensions of blocks are measured and weight of the block is taken. The block density is calculated by the formula given below:

$$\text{Density} = \frac{\text{Mass of Block, in Kg} \; * 100}{\text{Volume of specimen,(in cm sq.)}}$$ [8].

4. Conclusion

(1) During the study, I found that 20% of addition of slag in concrete block formation have the maximum strength of 20N/mm2. So From this we can easily conclude that with the increase in granulated blast furnace slag in concrete block formation, the compressive strength gradually decreases. That is why compaction factor (i.e. the weight of partially compacted mix to the weight of the mix when fully compacted in the same mould) decreases with increasing the amount of granulated blast furnace slag in the mix.[8]

(2) Water absorption capacity also increases when the amount of granulated blast furnace slag increases from 0% to 100%. [6]

(3) For 25% replacement of GBS, the block density will be similar to that of conventional mix blocks . But after 25% replacement, the block density of blocks decreases gradually.[6]

(4) Up to 75% of replacement the block density will be more than the required block density of 1800 kg/m3 and for 100% replacement there will be decrease of block density than the required limit.[6]

(5) The drying shrinkage of concrete with slag is higher than concretes without slag about 2.9%.There is not any kind of changing in drying shrinkage is seen upon the slag content in the range between 20% and 80%. This is different from the result reported by Fulton et al. [9], where the increment in shrinkage was found to be related with the slag content, changing between 15% increase at 30% slag content to approximately a 50% increase at 70% slag content. [10]

(6) As we all know construction waste and Granulated blast furnace slag wastes are available in huge amounts in India, it is economically and environmentally suitable to use these materials as aggregates in the production of more durable concrete block mixtures. [2]

Through this, the test results show us the industrial waste material GBS can be used efficiently in the manufacturing of blocks.

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