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An Experimental Study on High Performance Concrete Using Mineral Fly Ash and GGBS with M-60 grade Concrete

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***Abstract:** This work presents the determination of the mechanical properties (compression, split tensile and flexural) of the specimens (cubes, cylinders and beams). The test specimens are M60 high strength concrete which includes ground granulated blast furnace slag (0%,10%, 20%, 30% and 40%) and fly ash (0% 10%, 20%, 30% and 40%) to obtain the desired resistances and properties. Finally, we used granulated blast furnace in different percentages as cement and concrete were replaced. We prepared concrete cubes, beams and cylinders and stored them for a 28-day cure. The tests are performed after 7, 21 and 28 days. To achieve the desired strength that cannot be achieved with conventional concrete and the current method, a large number of test mixtures with different percentages of fly ash and different percentages of ground granulated blast furnace slag are needed to select the combination of materials.*

***Keywords:** Fly Ash (FA), Ground Granulated Blast Furnace Slag (GGBS), Compressive strength, Tensile strength, Flexural strength, Ordinary Portland Cement (OPC)*

I. INTRODUCTION FLY ASH AND GGBS

A. Fly ash

FA is an Industrial waste which is accepted as an environmental pollutant, generated during the combustion of coal for energy production. When the coal is fired inside the grate of a boiler, Carbon and volatiles materials completely burnt off. But still, some inorganic impurities of earth elements (sand, Feldspars etc.) are bonded together and are discharged out through flue gases. When these fused materials are allowed to solidify, it results in the formation of fine and spherical particles called Fly ash.

B. Ground Granulated Blast Furnace Slag

Ground granulated blast furnace slag (GGBS) is a byproduct of iron industry. Iron ore, coke and limestone are fed into the furnace to produce iron, and the resulting flowing slag floats above the molten iron at a temperature of about 1500ºC to 1600ºC. The melted slag has content 30-40% silicon dioxide (SiO2) and approximately 40% calcium oxide (CaO), which is close to the chemical configuration of OPC.

II. LITERATURE REVIEW

Anjali Prajapati et. al. (2017) studied the effect of performance of HPC using mineral admixture i.e. fly ash and GGBS with M-60 grade of IS cube specimen .We partially replaced Portland cement by weight of binder. Fly ash and GGBS replacement varies from 10% to 30%.

Praveen Kumar S R et. al. (2016) prepared a high strength SCC of quality M60 by partly replacing the cement content with the untreated industrial by-products such as fly ash & ground granulated blast furnace slag (GGBS) and also by replacing 100% natural sand with manufactured sand (M. Sand

Vinayak Awasare and Prof. M. V. Nagendra(2014), considering those works, this work is carried out to study the durability and strength characteristics of high strength concrete with partial replacement of GGBS and fly ash under acidic environment.

III. OBJECTIVE

The following are the main objectives of the study

1) To find out the mechanical properties of control concrete of M-60 grade at various percentage of fly ash and ground granulated blast furnace slag as a partial replacement of cement at 7 day, 21 day and 28 days tests are conducted.
2) To find the optimum % of replacement of cement by GGBS and Fly ash by imparting better strength and durability properties.
3) To find the optimum percentage of GGBS and Fly ash to give the maximum value of compressive, flexural and split tensile strength

IV. MATERIALS AND METHODOLOGY

A. Material

1) Cement
2) Fine aggregate
3) Coarse aggregate
4) Water
5) Admixtures
6) Fly ash
7) GGBS

FLOW CHART OF PROPOSED METHODOLOGY

Collection of required materials such as Steel Fly ash ,GGBS Cement Fine aggregate, Coarse aggregate and Water

Concrete Mix Proportions

Preparation of Concrete Mix

Casting of Samples for Testing

Curing of Concrete Samples

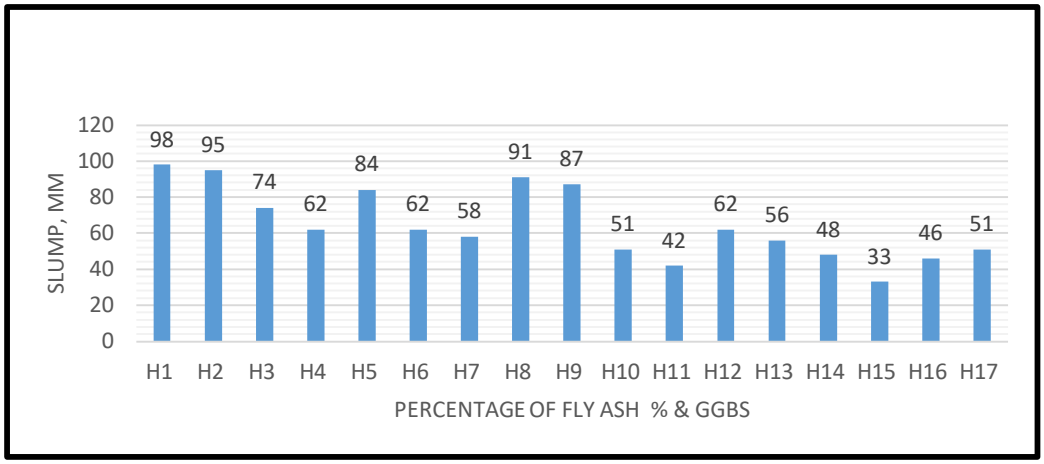
Testing of Specimens

Analysis of Results

V. EXPERIMENTAL RESULT.

A. Workability test results

The fresh property test that is considered is the slump cone test. Slump values of various mix proportions of GGBS with fly ash replacing cement in M60 grade concrete

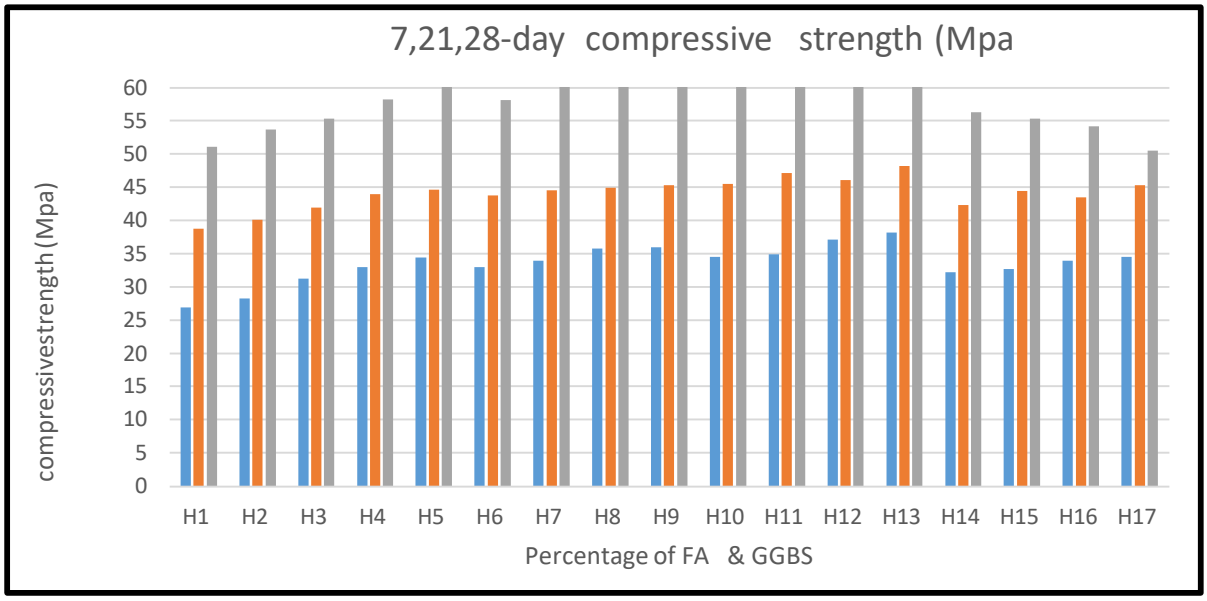


Variation of slump of concrete with cement replacement by GGBS and fly ash for M60 Grade of concrete

The increase in slump value is due to the higher smoothness and fineness of slag increases the entrainment of air in the matrix, subsequently increasing the volume of paste. It is clear from the figure below, constant 20% GGBS has shown more cohesiveness. But the stickiness in concrete was observed with increase percentage of GGBS and fly ash i.e. 30% to 40% and increase percentage of GGBS and fly ash i.e. 0% to 10%, the stickiness in concrete was observed.

B. Compressive Strength Test Results

For each concrete mix, the compressive strength is determined on three 150x150x150 mm cubes at 7, 21 and 28 days of curing. Following table gives the compressive strength test results of control concrete and concrete made with fly ash and GGBS as partial replacement of cement.



Compressive Strength of M60 grade concrete at 7 ,21,28 days curing

The compressive strength of concrete with GGBS has been increased to 30% and after 30% of the replacement the strengths are gradually reduced. The maximum values of compressive strength at 30% GGBS and 40% fly ash are 38.2 MPa for 7day . The maximum percentage of the GGBS and fly ash on the cement replacement must therefore be 30% and 40% when OPC is used.The compressive strength of concrete with GGBS has been increased to 30% and after 30% of the replacement the strengths are gradually reduced. The maximum values of compressive strength at 30% GGBS and 40% fly ash are 48.21 MPa after 21 day curing, The maximum values of compressive strength at 30% GGBS and 40% fly ash are 68.81 MPa after 28 day curing . From the Experiment, it was found that Mix H13 is having higher compressive strength than all other mixes.

VI. CONCLUSION

A. It is observed that the slump value of concrete increases when the percentage of GGBS increases up to 20% of substitution and therefore decreases. The increase in the slump value is due to the greater smoothness and the fineness of the slag increases the entrainment of the air in the matrix, subsequently increasing the volume of paste.

B. Cement replacement by in combination of fly ash and adding Ground granulated blast furnace slag leads to increase in compressive strength upto 30 % GGBS and 40 % Fly Ash for M60 grade of concrete. Beyond 40% replacement of fly ash and 30 % of ground granulated blast furnace slag compressive strength decreased.From the experiment it was fund that low volume replacement mix H13 (40% Flyash+30% GGBS+30% OPC) is giving good result ,The maximum percentage of the GGBS and fly ash on the replacement of cement should be 30 % and 40 % when OPC used.From the above observations we have concluded that the compressive strength is increasing normally for 28 days when compared with controlled concrete.

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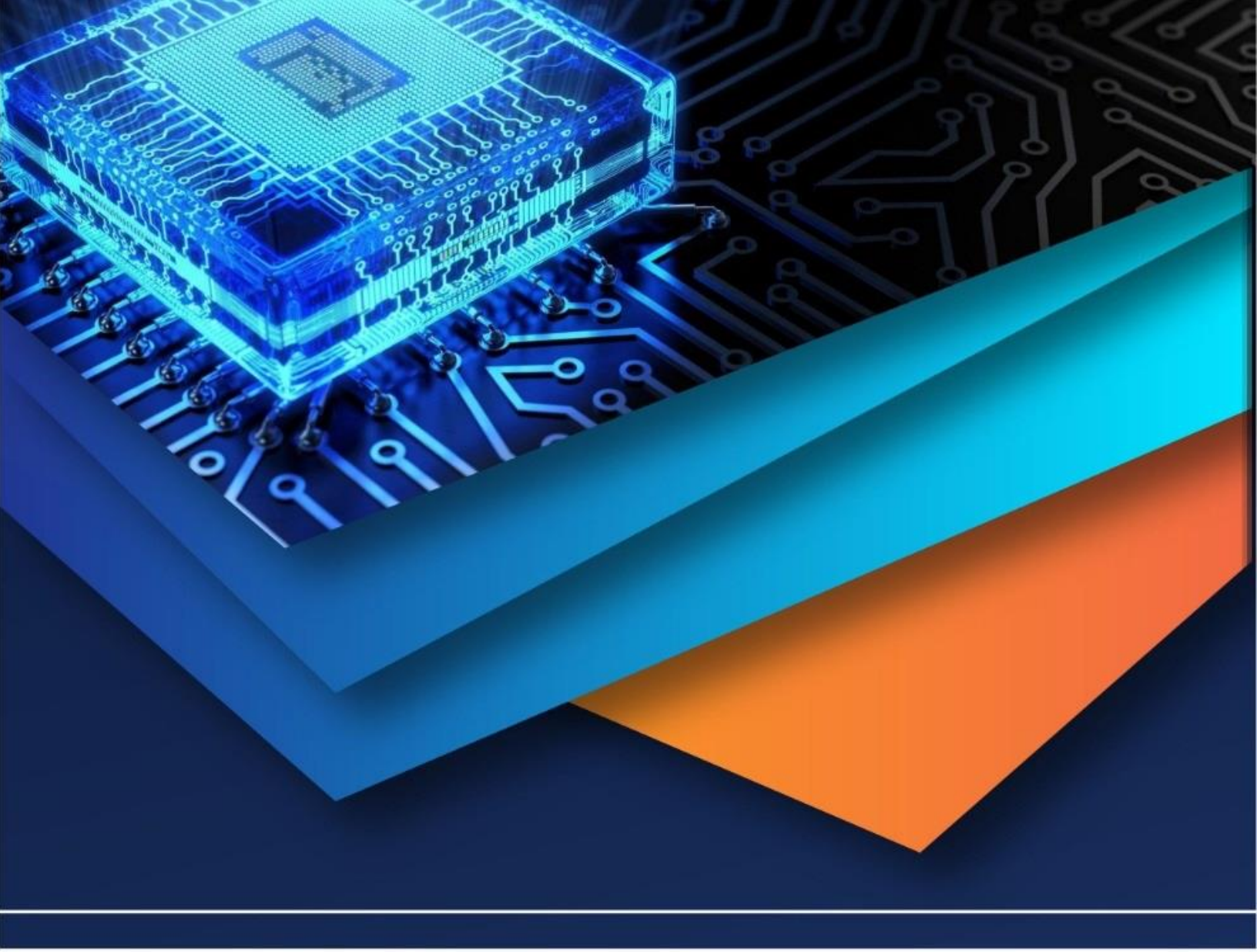

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