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To Determine the Strength Development of Concrete Made from Ground Granulated Blast-Furnace Slag as a Partial Replacement for OPC in Cement Concrete

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Abstract: Concrete is the most widely used construction material on the planet, with around six billion tonnes manufactured each year. In terms of per-capita usage, it is only second to water. However, both the damage caused by raw material exploitation and CO2 emissions during cement manufacturing harm the environment's long-term viability. This put pressure on researchers to find ways to reduce cement use by partially substituting additional materials for cement. These materials could be naturally occurring, industrial leftovers, or less energy-intensive byproducts. When these components (known as pozzalonas) are mixed with calcium hydroxide, they produce cement. Fly ash, silica fume, metakaolin, and crushed granulated blast furnace slag are the most regularly utilised pozzalonas (GGBS). It is necessary to investigate the performance of admixtures when mixed with concrete in order to provide a lower life cycle cost. The purpose of this work is to investigate the characteristics of M20 grade concrete with partial substitution of cement with ground granulated blast furnace slag (GGBS) at percentages of 10%, 20%, 30%, 40%, and 50%.
Keyword: Pozzolans, hardened mortars, thermal shrinkage, Increase the water tightness, Improve workability and Lower costs.

I. GENERAL

Concrete is the most widely used construction material on the planet, with around six billion tonnes manufactured each year. In terms of per capita usage, it is only second to water. However, both the damage caused by raw material exploitation and CO2 emissions during cement manufacturing loss the environment's long-term viability. This put pressure on researchers to find ways to reduce cement use by partially substituting additional materials for cement. These materials could be naturally occurring, industrial wastes, or less energy-intensive by-products. These materials have cementitious characteristics when mixed with calcium hydroxide. In the long run, there are conflicting motives to continue partially replacing cement with waste by products and processed materials having pozzolanic qualities.

Natural pozzolans, such as GGBS, have recently received some interest as a possible partial replacement for cement. The usage of GGBS is a relatively new strategy among the different methods used to improve the durability of concrete and to achieve high performance concrete. The main concern is its extreme fineness and high water demand when mixed with Ordinary Portland cement.

II. REVIEW OF LITERATURE

Venu Malagavelli et al. The percentage improvement in compressive strength of concrete when 50 percent of cement is replaced with GGBS and 25% of sand is 11.06 and 17.6 percent at the age of 7 and 28 days, respectively, according to a study on high performance concrete with GGBS and robo sand.

Tamilarasan et al. investigated chloride diffusion in concrete when GGBS was used as a partial replacement for cement, both with and without Superplasticiser. The study found that when the amount of GGBS increases, the Chloride diffusion of concrete reduces. Chloride diffusion is also observed to be lower in M25 concrete than in M20 concrete.

Soutsos et al. investigated the use of high-strength concrete mixtures including Ground Granulated Blast Furnace Slag in fast track construction. They demonstrated that conventional maturity functions, such as the Nurse-Saul and Arrhenius equations, may not be appropriate for GGBS concretes.

III. EXPERIMENTAL PROGRAM

A. *Experimentation Plan*

The following is a schedule for the experimental investigation.

1) Determine the characteristics of several materials, including cement, sand, coarse aggregate, water, and GGBS.
2) Using the IS technique, determine the OPC concrete mix proportions for M20 (10262-2009).
3) To compute the mix proportion with partial replacement of GGBS by OPC, such as 0%, 30%, 40%, and 50% of GGBS.
4) To construct concrete specimens in the laboratory, such as cubes for compressive strength, cylinders for split tensile tests, prisms for flexural strength, and cubes for durability studies, with 0%, 10%, 20%, 30%,40% and 50% replacement of GGBS with OPC for M20 grade concrete.
5) To cure the specimens for 28 and 90 days, respectively.
6) To evaluate the characteristics of concrete such as compressive strength.

IV. RESULTS AND DISCUSSION

A. *Compressive Strength of Concrete.*

Sl. No.	% of GGBS	Compressive Strength (N/mm2) 28 days
1	0	32.9
2	10	33.7
3	20	34.6
4	30	35.1
5	40	36.3
6	50	33.6

V. DISCUSSION ON RESULTS

A. *Effect of variation of GGBS on Compressive Strength*

The compressive strength of concrete for 28 days for 0%, 10%, 20%, 30%, 40% and 50% replacement of GGBS and the values are presented in Figure 1.

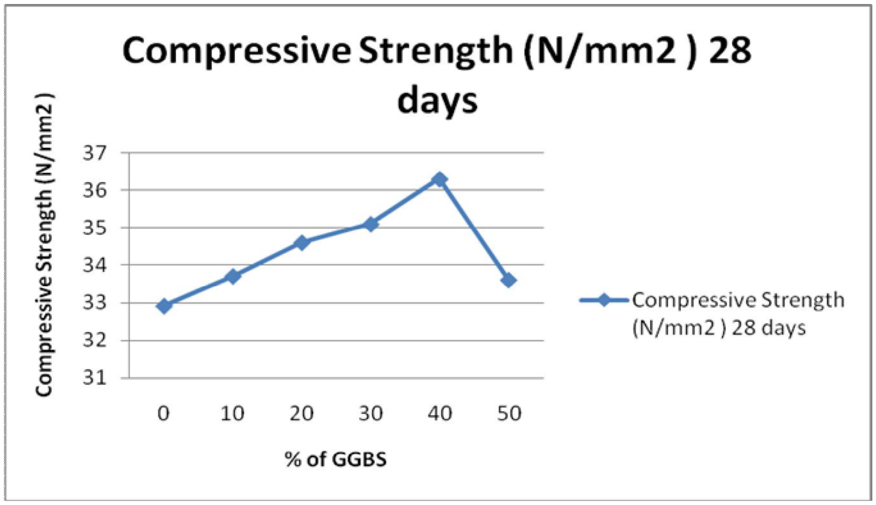

Figure 1: Compressive Strength of concrete for M20 vs % of GGBS

Figure 1 shows that when around 40% of cement is replaced with GGBS, concrete achieves its maximum compressive strength for both M20 grade concretes; however, when the replacement reaches 40%, the compressive strength begins to decline significantly. And a 40 percent GGBS replacement is better than a 50 percent GGBS replacement.

VI. CONCLUSIONS

The following conclusions can be drawn based on the examination and discussion of experimental results.

1) The workability of concrete improves as the GGBS replacement level increased.
2) When cement was replaced with GGBS, the compressive strength of both M20 grades of concrete increased. For both M20 grades of concrete, the highest compressive strength was achieved when 50% of the cement was replaced by GGBS.

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