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PARTIAL REPLACEMENT OF CEMENT WITH GGBS AND FINE AGGREGATE WITH FLY ASH IN CONCRETE

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Abstract
Fly ash and granulated blast furnace slag (GGBS) are selected primarily based on cost and durability. In addition, since the emissions of harmful gases such as carbon monoxide and carbon dioxide are very low, environmental pollution can be suppressed to some extent. An examination conducted in a lab on the ideal level of Ground Granulated Blast Furnace Slag (GGBS) to partially replace cement and fly ash to partial replacement of fine aggregate to study the strength characteristics of concrete as compare to conventional concrete (CC) of M20 grade. Significant development in infrastructures leads to production of concrete is more compare to all material. Cement and aggregates both are significant ingredients in concrete. In manufacture of cement, large amount of carbon dioxide is released so it causes global warming [1]. Usage of river sand in great demand causes depletion of natural resources, some industrial waste can be used partially to resolve these problems. The utilization of waste material from the industries has been continuously emphasized in the project work [2]. The present work is to use GGBS (Ground granulated Blast furnace slag) and Fly ash as combined replacement for ordinary Portland cement and river sand respectively. M20 grade of concrete with W/C 0.5 is carried out with percentage of cement replacement by GGBS i.e, 0%, 15%, and 20% along with the Fly ash as 0%, 15% and 20%. For all mixes compressive strength and Spilt tensile Strength are determined at 7, 14 and 28 days of curing. The optimum strength of concrete mix is obtained for the represent of 20% GGBS and 20% fly ash.

Keywords: Fly ash, Ground Granulated Blast Furnace Slag, cement, concrete.

I. Introduction

Cement is an artificial building material which imparts binding property in concrete. Production of cement involves emission of large amount of carbon-dioxide gas into atmosphere which accounts for 6-8 % of CO_2 emitted globally by human activities. CO_2 is a greenhouse gas resulting in global warming. Hence, there is an urgent need for construction industry to look for alternative pozzolanic materials like fly ash, GGBS, silica fumes, red mud etc. for reducing consumption of cement [3-5].
A by-product of blast furnaces used in the production of steel is ground granulated blast furnace slag (GGBS). It is roughly 1500 degrees Celsius outside and operates using a combination of iron ore, coke, GGBS, and charging. Iron is extracted from iron ore, together with a slag by-product that floats on top of the iron. Also, the slag is periodically discharged as a melt and must be quenched with large amounts of water when used to make GGBS. Quenching creates grit-like particles and improves cementation characteristics. The granulated slag was then dried and ground into a fine powder [6].
Fly ash is a heterogeneous by-product produced in the combustion process of coal used in power plants. It is a fine grey powder containing spherical glass particles that rise with the smoke. Fly ash contains

pozzolanic material components that form cementitious materials with lime. For example, fly ash is used in concrete, mines, landfills, and dams.
The compressive strength of the manufactured sand is on par with or more than that of concrete without increasing the mixture's water consumption, lubricating the aggregate system [7,8]. Mortar and concrete both use various forms of slags from the steel and copper industries. Alternative aggregates include recovered aggregates, quarry wastes, and trash from building and demolition [9-12]. Concrete manufacture successfully makes use of these aggregates. We generate 7.8 million tonnes of blast furnace slag in India. By quenching the molten blast furnace slag with a powerful water jet, 100% glassy slag grains are produced [13-15].
The primary goal of this study is to evaluate the strength of M20 Grade concrete by partially replacing cement with GGBS and fine aggregate with fly ash. It was found that replacing cement with fine aggregate enhanced the maximum compressive strength of concrete. Compressive strength was found to be 7 days, 14 days, and 28 days. The results of the compressive test have demonstrated the concrete's strength.

II. Methodology

Collection of raw material such as ground granulated blast furnace slag and fly ash for replacement of Cement and Fine aggregate. Initial testing on raw material such as specific gravity, impact test, crushing value and Los Angeles Abrasion test on aggregate. Test on fly ash was done to determine the class of fly ash [16-17]. Concrete mix of M20 grade prepared using Ordinary Portland Cement (OPC), Fine aggregates and Coarse Aggregate.
Concrete mix was prepared with 0%, 15% and 20% replacement of Cement and Fine Aggregate with GGBS and Fly Ash respectively. As per IS: 516 (1959), cubes of 150 mm size were casted and cured for 7, 14 and 28 days. 6 specimens from each mix were tested for compressive strength at 7, 14 and 28 days.

III. Results and Discussions

3.1 Compressive Strength after 7 days

The compressive strength of cube casted by partial replacement of cement and fine aggregates with GGBS and fly ash mix in varying proportions after 7 days of curing are listed below in Table 1.

Table 1: Compressive Strength at 7 days

S. No.	GGBS Mix	Fly Ash Mix	Compressive Strength (N/mm^2)
1	0%	0%	12.64
2	15%	15%	13.78
3	20%	20%	14.44
4	25%	25%	12.234

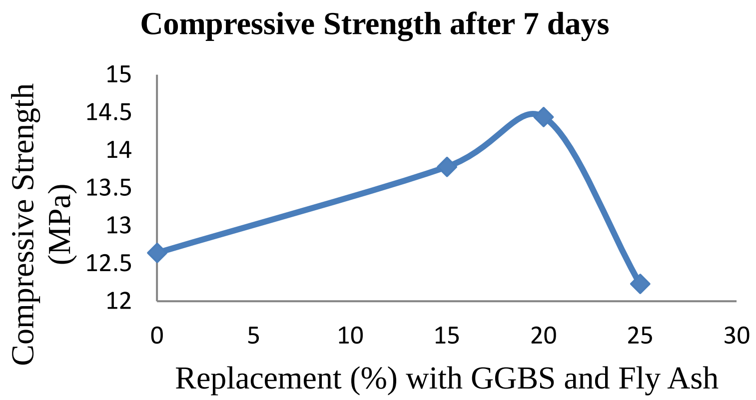

Figure 1: Graph showing Compressive strength at 0%, 15%, 20%, 25% after 7 days

From the results, it can be observed that the optimum compressive strength of cube samples after 7 days is obtained after 20% replacement of cement and fine aggregates with GGBS and fly ash respectively.

3.2 Compressive Strength after 14 days

The compressive strength of cube moulds casted by partial replacement of cement and fine aggregates with GGBS and fly ash mix in different proportions after 14 days of curing are listed below in Table 2.

Table 2: Compressive Strength at 14 days

S. No.	GGBS Mix	Fly Ash Mix	Compressive Strength (N/mm^2)
1	0%	0%	16.88
2	15%	15%	18
3	20%	20%	21.11
4	25%	25%	19

From the results, it can be clearly observed that the maximum compressive strength in cube samples was obtained when 20% of cement and 20% of fine aggregates were replaced with GGBS and fly ash respectively.

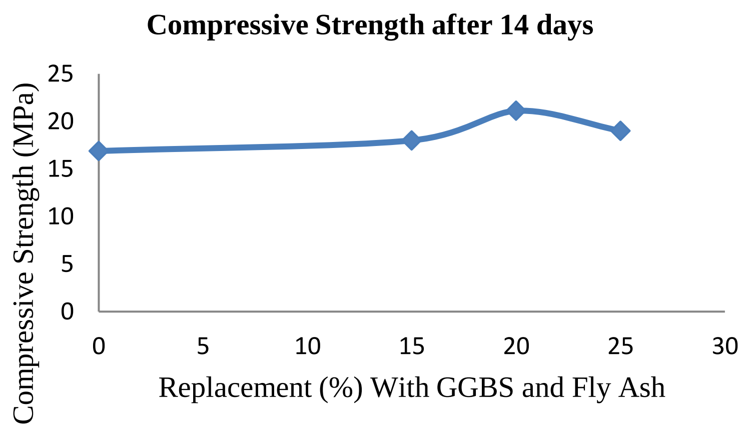

Figure 2: Graph showing Compressive strength at 0%, 15%, 20%, 25% after 14 days

3.3 Compressive Strength after 14 days

The compressive strength of cube casted by partial replacement of cement and fine aggregates with GGBS and fly ash mix in varying proportions after 28 days of curing are tabulated below in Table 3.

Table 3: Compressive Strength at 28 days

S. No.	GGBS Mix	Fly Ash Mix	Compressive Strength (N/mm^2)
1	0%	0%	23.33
2	15%	15%	25.11
3	20%	20%	26.22
4	25%	25%	24.12

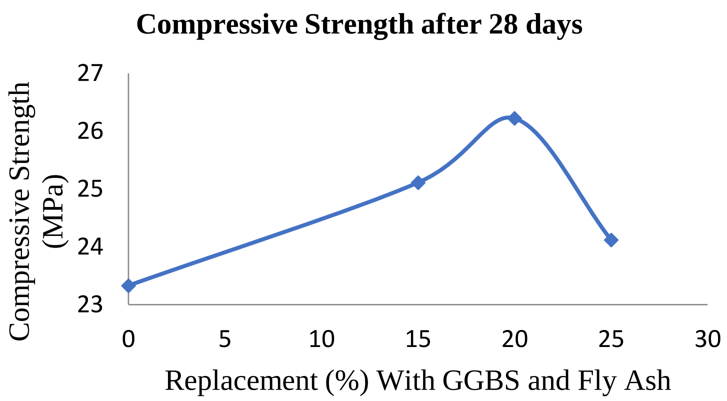

Figure 3: Graph showing Compressive strength at 0%, 15%, 20%, 25% after 28 days

The graph below showing the variation of compressive after 0%, 15%, 20%, 25% replacement of cement with fly ash and fine aggregate with ground granulate blast furnace slag after 7, 14 and 28 days of curing. And it is observed that good results are obtained when 20% of Cement is replaced with fly ash and 20% of fine aggregate is replaced with ground granulated blast furnace slag.

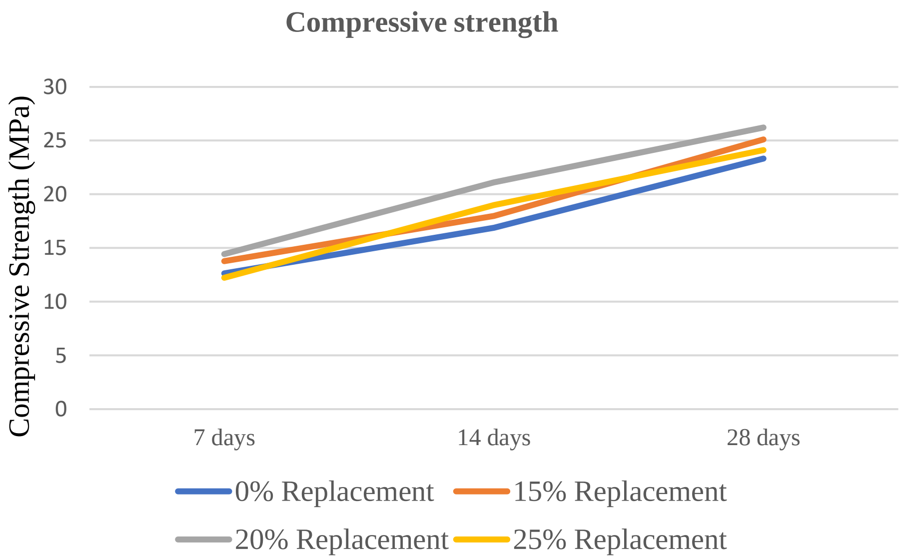

Figure 4: Graph showing Compressive strength at 0%, 15%, 20%, 25% after 7, 14, 28 days

IV. Conclusion

From the results, it is concluded that the GGBS and Fly Ash is a better replacement ofCement and Fine Aggregate. It can be clearly seen from the above graph that best result is obtained when 20% of cement is replaced with ground granulated blast furnace slag and 20% of fine aggregate is replaced with Fly Ash. Preparing concrete with a mixture of fly ash and GGBS in varying proportions gave good results compared to normal concrete. Therefore, it is best to use a combination of these materials.

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