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TO ASSESS THE PERFORMANCE OF CONCRETE BY PARTIAL REPLACEMENT OF CEMENT WITH FLYASH & GGBS

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ABSTRACT : *The purpose of this study is to determine the effect of partial replacement of cementitious materials such as GGBS and fly ash in concrete of grade M-30 when replaced with cement for the fresh and hardened states, i.e. for workability and strength of concrete using OPC (43 grades). As cementitious materials such as GGBS and Fly ash have been added to OPC (43 grade), which ranges from 5% to 30% at intervals of 5% by total weight of OPC, and the same as partial replacement of OPC (43 grade), which varies from 5% to 30% at intervals of 5% by total weight of OPC. GGBS and Fly Ash can be used to substitute cement in concrete in a variety of ways. All concrete mixtures were assessed for workability using slump tests and compaction factor tests on fresh concrete. Compressive strength of hardened concrete was evaluated on the 7th, 14th, and 28th day. Slump was observed to be greater in partial replacement at 25% (GGBS and fly ash) than in addition of GGBS & Fly ash.*

KEYWORDS -*Cementitious substance, Factor of compaction, Compressive power, Concrete that has hardened, Workability*

I. INTRODUCTION

Concrete is a flexible structural material in today's building sector. Concrete is increasingly widely used, just like man is dependent on water for sustenance. Concrete will undoubtedly become the major building material in civilisation as the planet evolves. Future material Concrete built from rubbish must also be avoided in the future as a matter of environmental concern. Carbon Dioxide (CO_2) development is around 1 tonne created during the manufacturing of each tonne of Ordinary Portland cement is a form of cement (OPC). Cement production accounts for 5% of total output. CO_2 emissions on a global scale. As a consequence, by partially replacing OPC, certain waste materials will not only contribute some value, but they will also benefit the environment. This not only adds to the properties of the concrete, but it also regulates the pollutants in the atmosphere.
Only through enhancing workability, flowability, durability, and corrosion resistance can quality concrete perform at its best. In addition to the strength characteristic, there is segregation in the

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w/c ratio, heat of hydration, and a reduction in the w/c ratio. Many researchers have undertaken studies on concrete mix design (normal) for improving performance and high-strength concrete) strength, but little research has been done in this field to evaluate the variation/influence.

To improve the performance of regular concrete, a better industrially recyclable cement composite material should be used with natural fine and coarse particles. GGBS is an abbreviation for GGBS is an abbreviation for GGBS is a well-processed slag with a high glass content and strong reactivity that may be manufactured by a variety of methods. Granulation under control is a slow process. Low-calcium raw materials are mostly composed of calcium silicates. It reduces the amount of water utilised as well as the amount of heat produced during hydration. Its action is to increase compressive strength and Use a workability aid to improve concrete flow. As a result, an endeavour has been made to employ low-cost green building materials. M30 was constructed using GGBS (12000).

Table 1: Constituent of GGBS

Constituent	Percentage, %
Cao	30-50
SiO_2	28-40
Al_2O_3	8-24
MgO	1-18

Table 2: Constituent of fly ash from various sources

Constituent	Bituminous coal, %	Sub - bituminous coal, %	Lignite coal, %
Cao	1-12	5-30	15-40
SiO_2	20-60	40-60	15-45
Al_2O_3	5-35	20-30	20-25
LOI (Loss on ignition)	0-15	0-3	0-5

Table 3: Classification for fly ash as per ASTM C 618

Class	Description	Chemical
F	Fly ash generated by the combustion of anthracite (pure carbon with minimal original plant material) or bituminous coal. It demonstrates pozzolanic characteristics.	$SiO_2+Al_2O_3+FeO_3$>= 70%
C	fly ash formed by the burning of lignite or sub bituminous coal. It demonstrates pozzolanic and cementitious characteristics. It also has more than 10% lime content.	$SiO_2+Al_2O_3+FeO_3$>= 50%

II. LITERATURE REVIEW

- **P. J. Patel and H. S. Patel (2013):** The effects of alccofine and fly ash on the compressive and flexural strength of high-performance concrete were studied. They substituted OPC-53 with Alccofine and fly ash to varying degrees, with Alccofine ranging from 4 to 12 percent at 2% intervals and fly ash ranging from 26 to 18 percent at 2% intervals of the total OPC. It was discovered that compressive strength was at its maximum (even exceeding the planned mean strength) at 90 days, and that strength acquired up to 7 days was very good, strength increase between 7 and 28 days was a little less, but strength growth between 28 and 56 days was quite high due to fly ash. They've also reached an acceptable level of flexural strength.
- **Shaikh Mohd Zubair and S.S. Jamkar:** His investigation was carried out by replacing 10% fly ash with 17% alccofine and 10% fly ash with 17% silica fume by weight of cementitious material for various water binder ratios (W/b) of 0.25, 0.3, and 0.35 in order to investigate the compressive strength of the concrete after 7 days and 28 days. The specimen with three mixes M1, M2, and M3 with W/B ratios of 0.25, 0.30, and 0.35 with replacement cementitious material of 10% fly ash, 17% alccofine, and 10% fly ash, 17% silica fume. Out of three mixes, the greatest compressive strength was 79 N/mm2 with Fly ash (10%) + alccofine (17%) and 76 N/mm2 with Fly ash (10%) + silica fume (17%) after 28 days.

III. EXPERIMENTAL INVESTIGATION

1. MATERIAL USED:

1.1. ***Cement*** - For casting the various grades of concrete, ordinary Portland cement, 43 grade defined according to IS 8112-2003, was utilised. Potable water with a pH of 7. According to mix design code IS 10262:2009, the water cement ratio w/c is set at 0.50, and superplasticizer is employed at 1% by weight of cement to maintain the slump. Vicat equipment was used to measure the initial and ultimate setting times, which were 30 and 600 minutes, respectively. The Le-Chetelier equipment measured 8 mm of soundness.

1.2. ***Fine aggregate*** - The size of fine aggregate ranges from 150 to 4.75mm. The fineness modulus was 3.06, and the specific gravity was 2.82.

1.3. ***Coarse aggregate*** - Coarse aggregates are defined as particles larger than 4.75mm in diameter, but often vary from 9.5mm to 37.5mm in diameter. In this situation, the aggregate and particle sizes were 20 mm and 10 mm, respectively, with a specific gravity of 2.65.

Figure 1: Aggregates

1.4. ***Fly ash*** - Fly ash is a powdery, burned derivative of inorganic mineral matter produced during the combustion of pulverised coal in a thermal power plant. Coal ash is mostly composed of silica, alumina, and calcium. Thermal plant fly ash is classified as class-F (less than 10% reactive calcium oxide concentration) or class-C (more than 10% reactive calcium oxide content) (more than 10 percent). The fly ash of type C is employed in this work.

1.5. ***Ggbs*** **-** GGBS is made by quenching molten blast furnace iron slag in water or steam, resulting in a glassy, granular product that is subsequently dried and powdered into a fine powder. GGBS minimises the incidence of thermal cracking in concrete and enhances resistance to alkali-silica reaction, sulphates, and chlorides. Concrete in harsh conditions is substantially more durable when GGBS is used as a partial replacement for cement.

Figure 2: GGBS

Table 4: Physical analysis of material

Physical Analysis	Range
Bulk Density	700-900 kg/m^3
Surface area	12000 cm^2/gm
Specific Gravity	2.86
Particle size	Irregular
Particle shape	N/A

2. MIX DESIGN AND EXPERIMENTAL WORK:

The design mix in this study is M30 (1:1.82:2.79), and the mix design is done utilising the codes IS 10262:2019 & IS 456:2000. As previously stated, the W/C ratio is set at 0.40, and a sufficient 1.25 percent by weight of cement admixture is employed to maintain the slump.

Table 5: Replacement of Fly ash and GGBS into OPC for M30 Grade

Mix designation	Water (liters)	Cement (kg/m^3)	Fly ash (kg/m^3)	GGBS (kg/m^3)	Fine aggregate (kg/m^3)	Coarse aggregate (kg/m^3)

N	161	322	0	0	587.622	900.903
S1	161	298.8	16.1	16.1	587.622	900.903
S2	161	257.6	32.2	32.2	587.622	900.903
S3	161	225.4	48.3	48.3	587.622	900.903
S4	161	193.2	64.4	64.4	587.622	900.903
S5	161	161	80.5	80.5	587.622	900.903
S6	161	128.8	96.6	96.6	587.622	900.903

IV. RESULT AND ANALYSIS

A. WORKABILITY TEST:

Table 6: Slump on Replacement of GGBS & Fly ash into OPC For M30 Grade

Mix	Slump (mm)
N	152
S1	156
S2	159
S3	163
S4	167
S5	169
S6	167

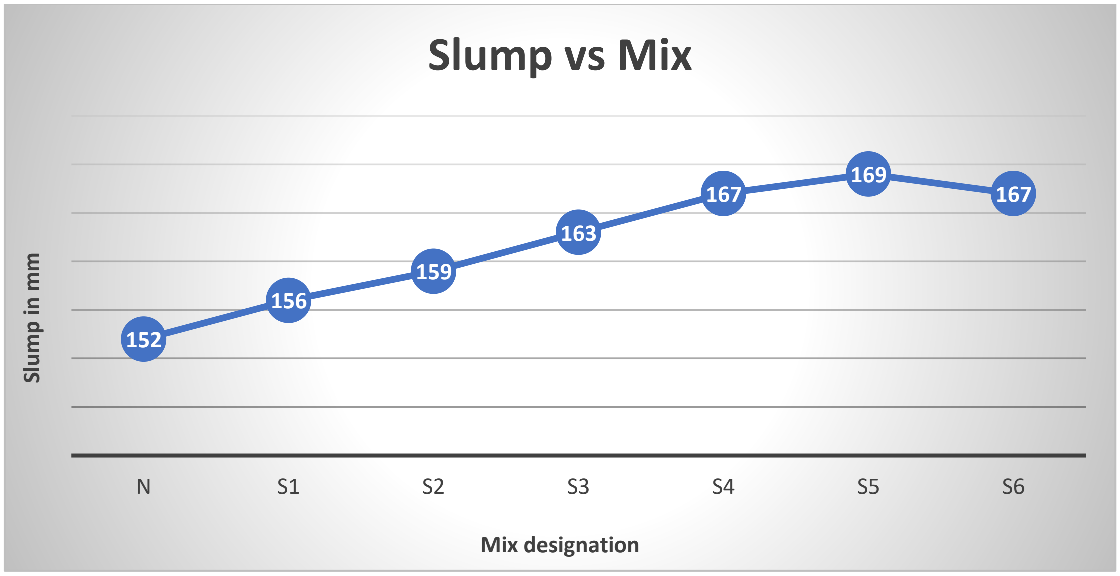

Figure 3: The Effect of GGBS and Fly Ash on Concrete Slump (M-30) Replacement

B. COMPRESSIVE STRENGTH TEST:

The compressive strength of cubical specimens 150mm x 150mm x150mm was calculated. The specimens were evaluated following curing periods of 7th, 14th, and 28th days totally submerged in water according to IS516:1959.

Table 7: Compressive Strength for 7, 14, and 28 days on M30 Grade Replacement

MIX	7th day (N/mm^2)	14th day (N/mm^2)	28th day (N/mm^2)
N	25.245	34.811	41.2
S1	26.345	35.811	42.3
S2	27.545	36.991	43.28
S3	28.445	38.171	44.53
S4	29.345	39.351	45.78
S5	27.463	37.521	43.03
S6	26.841	34.369	40.187

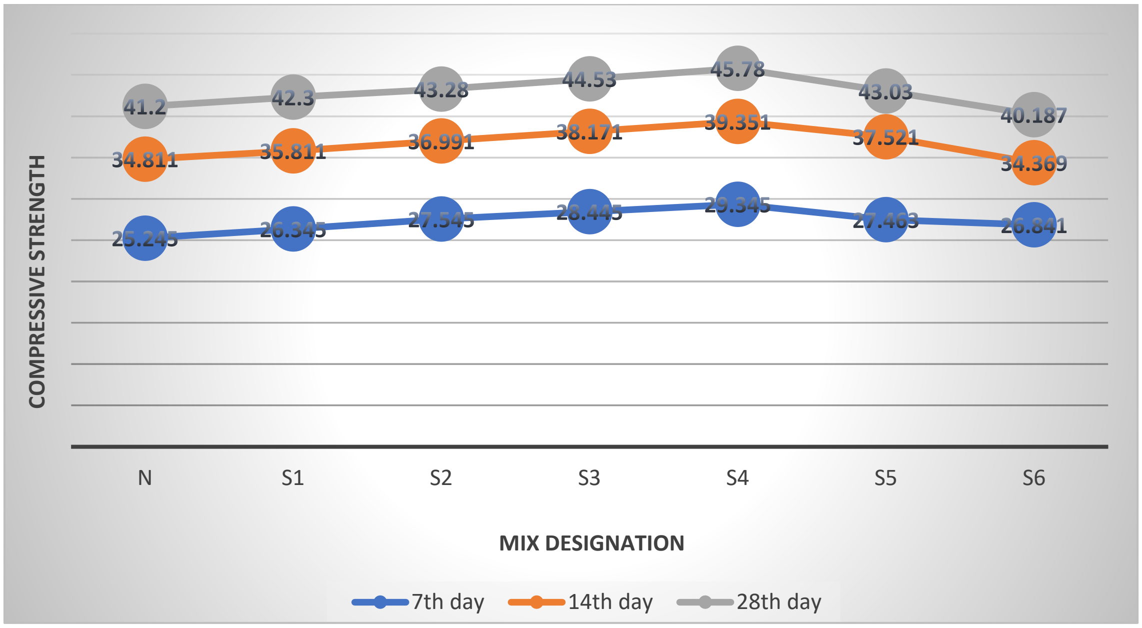

Figure 4 Comparison of Compressive Strength on Replacement for M30 Grade

V. CONCLUSION

1. The slump of concrete GGBS and Fly ash was more than OPC at first, but it gradually decreased and was nearly similar to the slump of the control mix of 10%.

2. When the GGBS mix was boosted (by 5%) compared to the slump of control mix concrete, the slump was raised up to 30% replacement.

3. When GGBS replacement of OPC by GGBS and Fly ash was done, the compressive strength declined.

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