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ANALYSIS OF COMPRESSIVE STRENGTH OF CONCRETE PREPARED BY PARTIAL REPLACEMENT OF SAND WITH GBBS AND FLY ASH

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Abstract – *The experiment was performed to conclude the compressive strength properties of the concrete prepared with ground Granulated Blast furnace slag (GGBS) and partial replacement of the fly ash by weight with the cement. As the utilization of the cement is increasing day by day so does its production as its ingredient are dependence on the natural resources. So stress on the natural resources is increasing day by day for the production of the cement. Keep that in notice, alternative or partial replacement of the cement is done with fly ash and replacement of aggregate with GBBS is done with an aim to find the optimum level. After going through the literature review, for this experiment we choose M25 grade of concrete and prepared different sample with different percentage up to 20% of GBBS and up to 10% of fly ash. There is also discussion about the slump representing the effect on the workability of the replacements done as mentioned above. Further the result has been discussed. The outcomes of the research indicate that the addition of GGBS and Fly Ash enhanced the workability and compressive strength of the concrete prepared which eventually improved the mechanical properties of concrete.*

Keywords: *GGBS; Fly Ash; Compressive Strength; Slump; concrete M25 grade.*

1. INTRODUCTION

Natural sand is a admixture of small grains of gemstone and grainy accoutrements which is substantially defined by size, being finer than clay and coarser than ground. And ranging in size from0.06 mm to 2 mm. patches which are larger than0.0078125 mm but lower than0.0625 mm are nominated ground. Beach is made by corrosion or broken pebbles and riding of jewels, which is carried by swell or gutters. And indurating and deliquescing during the downtime break gemstone up the beach will be made. occasionally Beach on strands can also be made by small broken-up pieces of coral, bone, and shell, which are broken up by bloodsuckers and also bombarded by the ocean, and indeed bitsy pieces of glass from bottles discarded in the ocean and other mineral accoutrements or the bones of fishes or other oceanic creatures. Beach can be also considered as a textural class of soil or soil type. A flaxen soil containing further than 85 percent beach-sized patches by mass. Beach is principally made of loose grainy accoutrements conforming of either gemstone fractions or mineral patches or oceanic accoutrements . It's substantially made of silicate minerals and silicate gemstone grainy patches. generally quartz is the most dominant mineral then as it possesses largely resistant parcels to rainfall. Other common gemstone- forming minerals like amphiboles and micas also set up in beach. Heavy minerals similar as tourmaline, baguette, etc can also be present in the beach in lower attention. But from a high position, utmost beach on the sand is made up of argentine or tan quartz and feldspar. still, the most common mineral in the beach is quartz – also known as silicon dioxide. This is formed when silicon and oxygen combine. Feldspar is the most set up group of minerals on the earth's face and forms about 65 of the terrestrial jewels. When the wind and ocean scourge over on the props, they transport these teeny- bitsy grains to the sand and make up the beach with this combination

2. MATERIAL

The materials used in this work can be broadly classified as base material, filler material and binder. The type of material used is having properties of both inert and reactive materials which were used for this study. The various materials used in this work are discussed with their properties and with the test results as follows.

2.1 Cement: Ordinary Portland cement of 53 grades was used in this study which was provided by Ultratech Cements Ltd. The value of specific gravity of the cement Ordinary Portland Cement of 53 grade is 3.15 as per IS: 12269- 1987.

2.2 Aggregates: There are two types of aggregate being used for the experiment: Fine aggregate and course aggregate. The Fine aggregates used in this research are taken from nearby river tributary of Beas having max size of 4.75mm. Coarse aggregates used are of crushed stone from the nearby crusher such that the stone passing through 20mm IS sieve and retained on 4.75mm IS sieve.

2.3 GBBS

GGBS which is termed as Ground Granulated Blast-furnace Slag is actual the byproduct produced from the blast furnace which is used for the manufacturing of the iron having the properties of the cementations material. The operation of the blast furnance is at the temperature of about 1500°C and is fed with proper precaution with a carefully controlled mixture of iron ore, coke and limestone. The ore of the iron is than reduced to iron and waste produced is termed as slag that floats on the top of the iron during the process. This produced slag has to be periodically tapped off as a molten liquid and converted to GBBS by the process of the quenched with the water. The process of quenching help in optimizing the cementitious properties and produced granules which is similar to the coarse sand which can be directly used as replacement fo the coarse sand or further refined to the fine powder after dried properly.

2.4 FLY ASH

The other used in the experiment is the Fly ash which is locally available. For the experiment class F fly ash was used and was collected from the cement supplier. It is actually the waste produced from the coal power plant. Since its a waste and cannot be deposed of easily creating health issue. As having cementations properties as well as the grain shape are spherical can be used in combination with ordinary cement to enhance the mechanical properties of the concrete. It also proven to be increase in the durability and strength of the hardened concrete.

Properties	GGFBS	Fly Ash
Specific gravity	2.79	2.43

Table 1: Physical properties of GGBS and Fly Ash

Properties	Cement	GGFBS	Fly Ash
SO_2	20.6	34.4	63.5
Al_2O_3	4.0	9.0	11.1
Fe_2O_3	3.1	2.58	5.2
caO	62.8	44.8	14.7
MgO	2.6	4.43	1.98
SO_3	3.1	2.26	0.35
Na_2O	_	0.62	0.48
K_2O	_	0.5	0.4
LOI	1.8	1.32	2.1

Table 2 Chemical properties of GGBS and Fly Ash

2. Methodology

Initially, M25 grade concrete is prepared as per the mix proportion. The casting of the specimens for the experiment was done using standard equipment in the laboratory. Each batch consisted of standard cubes and Beams. For Standard cubes for determination of 7-days and 28-days compressive strength of each batch. Every batch of the concrete prepared , the quantity of the various ingredients i.e. cement content, fine aggregate, coarse aggregate, water were kept ready in required proportions. We started mixing the sand nad cement thoroughly to get a uniform mix such that concentration of other material is not visible. Clear water free from impurities and admixture was added slowly to get a uniform mix.

The moulds for casting the specimens were cleaned, brushed and oiled and placed on vibrating table are shown below with a speed range of 12000± 400 r.p.m. and an amplitude range of 0.055 mm. The homogenous concrete mix, already prepared was placed in the specimen moulds 150x150x150mm^3 for compressive strength and 300 x 150 mm for flexure strength in three layers, each layer vibrated properly. The excess concrete at top of the mould was struck off with a wooden Straight edge and top finished by a trowel as shown in below. The specimens were marked with their respective

designations after 3 hours of setting and were allowed to set in the moulds for 24 hours. Subsequently the specimens were remolded and immersed in fresh water for curing.

3. TESTING AND RESULTS

Test specimens of size 150 × 150 × 150 mm were prepared for testing the compressive strength concrete.

In this experiment, for the preparation of the concrete, cement and fine aggregate were first mixed dry to uniform colour and then coarse aggregate was added and mixed thoroughly with the pre mix of the cement and fine aggregate. Water along with admixture as added in the mix to make it workable. The interior surface of the moulds and the base plate were highly oiled before concrete was placed. After this the specimens were removed from the moulds and placed in clean fresh water at a temperature of $27^0 \pm 2^0$C for 28 days curing. For testing in compression, no cushioning material was placed between the specimen and the plates of the machine. The load was applied axially without shock till the specimen was crushed. Test results of compressive strength test at the age of 3, 7, 14 and 28 are given in the Table 4.1. The cube strength results of concrete mix are also shown graphically

3.1 COMPRESSIVE STRENGTH

The cube of specimens of size 150 *150* 150 mm was prepared in the laboratory for testing of compressive strength concrete. The specimens casted were tested after 7 and 28 days of curing after the water is dried under room temperature. All the precaution was taken before and after testing. The results obtained are:

Mix proportion	Compressive strength (MPA)			
	3 days	7 days	14 days	28 days
S0	14.12	16.87	21.45	24.65
S1	15.07	17.23	22.11	25.93
S2	16.23	18.14	23.46	27.05
S3	16.98	19.32	24.33	28.12
S4	16.21	20.22	25.37	28.96
S5	17.02	20.93	26.14	29.14
S6	18.17	21.56	27.46	30.56
S7	20.31	22.65	25.44	31.07
S8	21.45	22.17	26.13	32.22
S9	21.97	23.43	26.78	33.45

Table 1. Average Compressive Strength

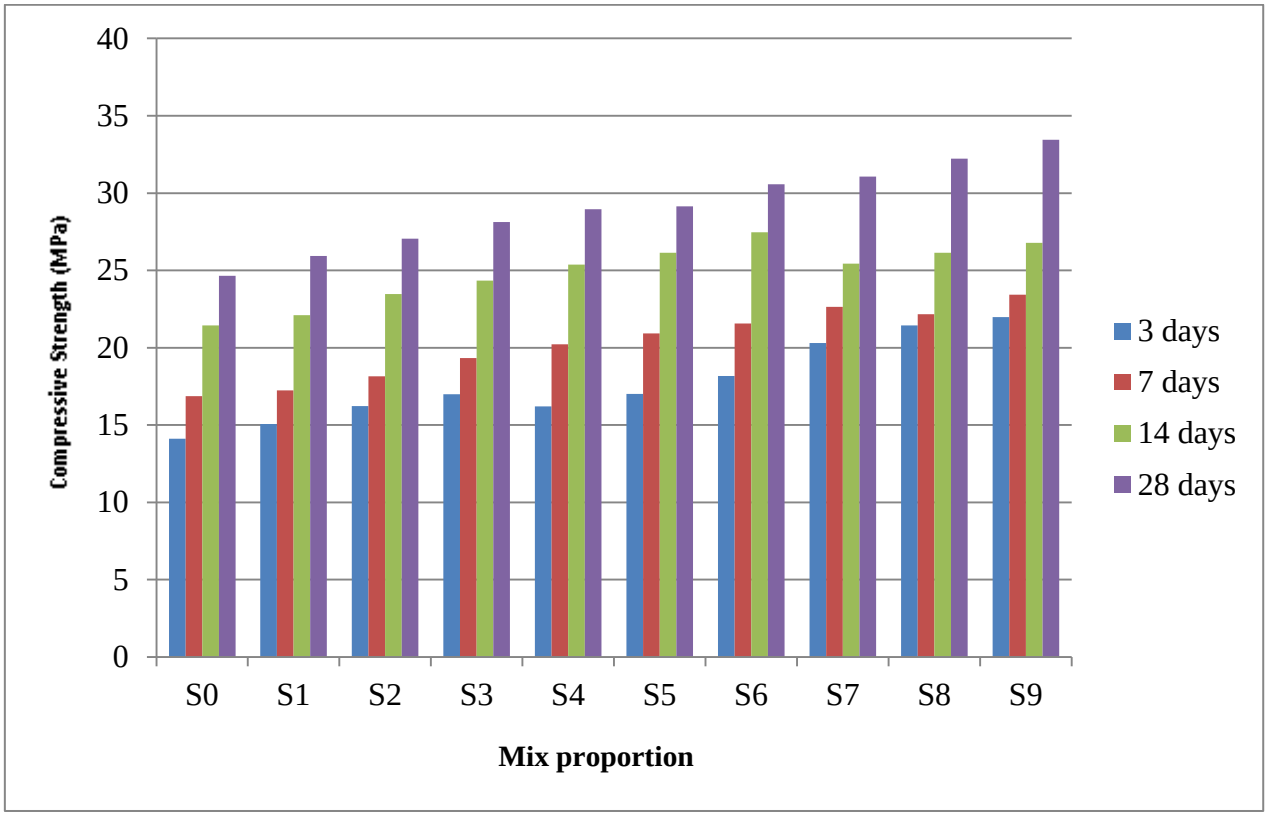

Figure 1. Compressive Strength on Different Ages with Mix Proportion

3. CONCLUSIONS

The following observation and conclusion were based on the experimental results obtained from the investigation of GGBS and Fly ash as a partial replacement of cement in concrete after the ages of 3,7,14 and 28 days. They are:

- As we increase the content of GGBS and fly ash the workability reduces at the same water containing and w/c.
- The pattern show initially there is increase in the workability with increase in percentage up to an optimum limit, but soon starts to decrease.
- Optimum workability was observed at replacement percentage of 15% as compared normal or control mix which achieved with 30%.
- The cube of concrete with 30% partial replacement of cement with GGBS and Fly ash obtained under Sample(9) achieved highest compressive strength 33.45 MPA as compared to the normal or control mix sample (0).

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