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Strength and Durability of Concrete by using Silica Fume and GGBS

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***Abstract*— The objective of the research is to explore the mechanical and durability properties of concrete. Various concrete mixtures were put to test with cementitious concentration of 0.4% in each mix. The test was reportedly carried out using 53 grade Portland type cement which is a common type. Unlike GGBS that can have up to fifty percent of weight as the highest percentage, silica dust constitutes ten percent of cement. Casting was done in cubes and cylinders in order to test various characteristics. These mechanical properties were tested to obtain the best replacement percentage: compressive and split tensile strengths. The research indicated that silica is most suitable as the material to be used instead of cement. Its strength can be enhanced by adding 10-40 percent of GGBS to normal concrete. The durability of concrete was tested after the concrete was prepared with 5 percent HCl and H2SO4 and dried. Investigators studied the impact of acid on compressive strength, split tensile strength, and durability properties at7,28,60,90 and 180 days.**

***Index Terms*— Collapse, Split Tensile, Flexural and Durability of Ground Granulated Blast Furnace Slag (GGBS) that contains Silica Fume.**

I. INTRODUCTION

The history of concrete as a very durable material is long indeed, and the list of the places where we want to use concrete to erect buildings is long indeed: poisonous subsoil water, extremely polluted urban and industrial regions, the rugged coastline, etc. Very harsh and hostile conditions have much helped to the high rates of structures being at the first steps of collapse because of the utilization of concrete in these environments [1]. This now casts the legendary life span of the content into doubt. The old people did not think of anything when they decided on the concrete mix, but rather the strength of the material. This was because the other properties of concrete that were desirable such as its strength ought to be replicated in its durability. The latest version of the standard, the 2000 edition of the standard, has a section on concrete lifetime. We are also attempting to make sure that it is more aligned with international standards of concrete building life cycle. However, despite the fact that the concrete industry has been reliant on the technological advancement of concrete, the degradation of concrete has been caused by the activities that have enhanced compression strength of concrete over the past. The realisation of the importance of the lifetime exposure of concrete to environmental conditions on its strength is a recent advancement. This is why you need to place a premium on strength and durability in the overall design process [2].

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Another perspective of the correlation between strength and longevity is rather enlightening. Durability is measured by the amount of concrete that resists disintegrants that may be experienced by concrete throughout its lifetime. Research should consider the long-term stability of concrete because the chemical attacks have the ability to initiate the mass loss, cracking and degradation of the concrete with time.
Study objectives.
The current study aimed at achieving the following:

- To explore the effect of silica fume and GGBS on compressive strength of concrete [3].
- To examine the microstructure of the hard cement concrete.
- To show the microstructure to answer any alterations in the concrete properties.

The workability and durability properties of silica-fume-modified cement were studied with the help of OPC mixes of grades M40, M60, and M80 with aggregates up to 20 mm. The findings of the HCL immersion test revealed that the acid effect on the proposed concrete was similar to ordinary Portland cement concrete.
Thus, the study will enhance the performance of concrete composites by studying the impact of OPC on silica fume and encourage more byproducts to be used to improve the environmental condition.

II. Literature Reviews

Ganesha, the Mogaveer. In 2011, Anand V.R.3 and G. Sarangapani They introduced different amounts of quarry dust to the sand under a controlled condition to examine the impacts of this additive on ordinary cement concrete. They show that 25% of the sand can be effectively replaced by quarry dust.
Roz-Ud-Din Nassar4 et al. (2012) carried out a study to determine the strength of recycled aggregate concrete with the use of milled glass rather than cement. When milled glass is used in its place, the structure of hydrated cement paste is changed. We feel that the recycled aggregate issues are going to be reduced by use of this cement alternative which will enhance the connection between the recycled aggregate and the mortar paste. One of the indirect methods to determine the pozzolanic activity of the milled glass debris is to see how much stronger is the debris after 56 days.
Continuing the work of Roz-Ud-Din Nassar5 et al. (2012), the current study is aimed at investigating the stability of recycled-aggregate concrete with milled glass used as a partial cement replacement. Recycled aggregate concrete can potentially be significantly more durable by replacing milled waste glass with some of the cement, the authors argue. Mill ground glass was found to inhibit the alkali-silica reactions [4]. The benefits of milled waste glass in recycled aggregate concrete compared to all cement include improved sorption, chloride permeability and freeze-thaw resistance.
The study was based on ductile self-compacting concrete (DSCC), which employed a number of cement replacement materials as its workability and compressive strength test (Mud Fadhil, 2002). A number of cement substitutes were experimented on the DSCC, as described in the article. The DSCC case revealed a given proportion of MiRHA, SF, and FA can substitute up to 20 percent of cement. It is believed that the compressive strength and self-compacting ability of DSCC with 10% fly ash and 10% MIHRA replaced would be improved.

III. Materials and Mix Design

A. Portland Cement

All the tests were based on one batch of UltraTech cement, 53 grade Ordinary Portland Cement (OPC). It was new, good and free of lumps. The outcomes of the tests performed based on the Indian Standard of cement, IS: 8112: 1989 are presented in the table below and indicate that the high-quality cement must be kept at the proper level in order to retain its properties since its properties deteriorate over time as a result of water absorption.

Figure 1. OPC 53 grade UltraTech Cement

B. Aggregates

The aggregates are the predominant constituent of concrete and depending on their size determine the stability of a material. In order to achieve a more compact mix, it is standard to incorporate aggregates of different sizes. To make the mix viable and possessing the appropriate consistency, the fine aggregate is essential.

C. Coarse Aggregates

The aggregates are the primary component of concrete and, based on their size, the material stability is determined by them. It is a normal practice to add aggregates of different sizes to make the final mix denser. The fine aggregate is essential to make the combination workable and with the right consistency.

Figure 2. 20mm Size Coarse Aggregates

D. Fine Aggreagtes

The particles that constitute fine aggregate are initially sieved using three sieves, i.e., 4.75 mm (No. 4), 9.5 mm (3/8 in.) and a 75 0m (No. 200) sieve to be recirculated. The smaller amount of cement is because the fine aggregate is rounded and increases the workability of the mixture, and minimizes the amount of money spent. The fine aggregate has a twofold role as a filler to the coarse aggregate and to make the mixture more workable.

Figure 3 Fine aggregates

E. Silica Fume

Microsilica is an amorphous silicon dioxide polymorph also referred to as silica fume, and with the chemical formula CAS 69012-64-2, and EINCS 273-276-1. Due to the processing of ferrosilicon alloy and silicon, it is converted into a fine powder, made up of spherical particles with an average diameter of 150 nm. The powder is applied as a constituent of UHP concrete which is primarily used as a pozzolanic constituent [8].

Figure 4 Silica Fume

F. GGBS

To prepare Granuated Blast Furnace Slag, the blast furnace slag is cooled quickly by using water. This process is done to refine the slag to be used in Portland Slag Cement by cutting it down to size and converting it into glassy amorphous grains as per the specifications in the IS 12089: 1987. To prepare GGBS, the granulated slag is milled to the required fineness.

IV. RESULTS AND ANALYSIS

Concrete Tests Fresh Concrete Tests

A. Slump Cone Test

Figure 5. M40 Grade concrete Slump cone test values

Figure 5 indicates that the M40 grade concrete slump cone values were also affected when GGBS and silica fume were substituted with cement. Figure 5 illustrates that slump value is lower when the silica fume and GGBS levels in M40 grade concrete are high [9].

B. Compaction Factor Test

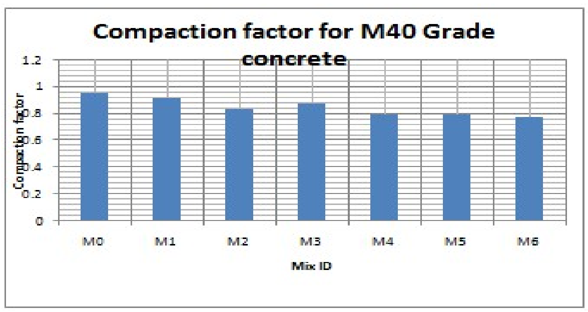

Figure 6. Compaction factor test values for M40 grade concrete

The compaction factor value of M40 grade concrete was found to change with the quantity of silica fume and GGBS as illustrated in Figure 6. The higher the content of silica fume and GGBS in M40 grade concrete, the lesser their compression value is [10].

C. Compressive strength of concrete

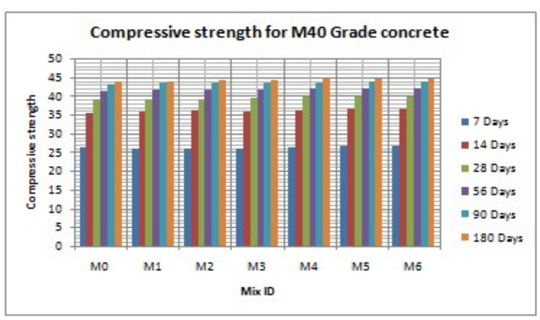

Figure 7. Comparison of compressive strength for M40 grade concrete

The compressive strength of M40 grade concrete using silica fume and GGBS as partial cement replacement are indicated in figure 7. Figure 7 indicates that at the days at7,14,28,56,90, and 180, the optimum compressive strength of a mix in M40 grade concrete was realized with an M5 mix in M5 grade concrete [11].

D. Split tensile strength of concrete

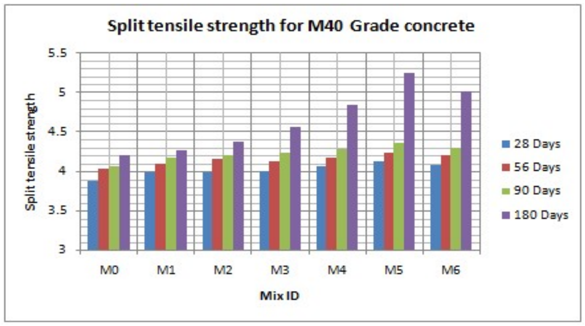

Figure 8. Comparison of split tensile strength for M40 grade concrete

There is also a possibility that the split tensile strength varies when the cement partially substituted silica fume and GGBS in M40 grade concrete as observed in Figure 8. An M5 mix of M40 grade concrete was utilized to obtain the right value of the split tensile strength at7,14,28,56,90 and 180 days as illustrated in figure 7 above [12].

E. Flexural strength of concrete

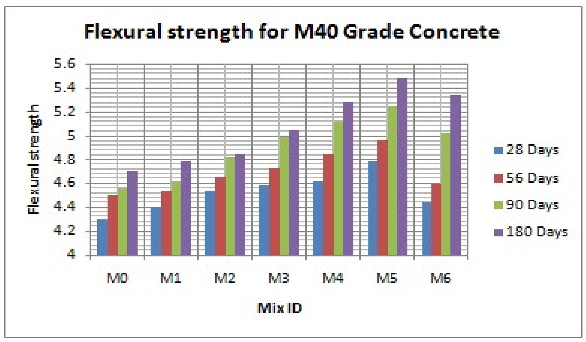

Figure 9 Comparison of split tensile strength for M40 grade concrete

Figure 9 illustrates how flexural strength of M40 grade concrete changes with cement partially substituted with silica fume and GGBS. Figure 7 indicates that, an M5 mix was used in M40 grade concrete and the optimum flexural strength value was obtained at 7, 14, 28, 56, 90 and 180 days.

V. CONCLUSIONS

According to the above-mentioned tests, the following preliminary results were achieved:
The cement, fine and coarse aggregates have been tested and found to fit within the acceptable ranges as outlined in the IS code. We will be able to use those resources in our job.
A smaller slump cone value means that the GGBS concrete is more workable, which is directly proportional to the silica fume it has.
The higher the level of silica fume and GGBS in the concrete, the higher the compaction factor value.
The concrete obtains its maximum compressive strength 90%SF and 40%GGBS after 7285690 and 180 days of curing.
With the combination of 10% Sf and 40% GGBS, cylindrical samples with the best tensile strength will be obtained. The treatment periods are between 28 days and 180 days.
The outcomes indicate that the concrete containing copper slag, 10 percent Ssf, and 40 percent GGBS has flexural strength after 28,56, 90 and 180 days of curing.
A combination of 10% SF and 40% GGBS in the durability test always increased four times the weight loss and compressive strength fall. Concrete is thus able to sustain loads up to 10%SF + 40%GGBS.
Because concrete grades M40, M60 and M80 have higher strength values, it is customarily recommended to use 40%GGBS, rather than 10%SF.

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