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Replacement of Fine Aggregate by Foundry Sand and Optimization of Cement with Fly Ash and GGBS

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ABSTRACT: Use of concrete around the world is second only to water. Ordinary Portland Cement is conventionally used as the primary binder to produce cement concrete. Here in this project cement is optimized by Fly ash and Ground Granulated Blast Furnace Slag in order to increase the strength and decrease overall damages to the environment. Since Normal Concrete when subjected to environment it emits carbon dioxide which results in causing Green House Effect. For this we bring an alternative solution that is Partial Replacement of Cement Using Fly ash and GGBS also Fine Aggregate is replaced by Foundry Sand. Fly ash and GGBS have similar properties, so define the optimizing point of fly ash and the equal rate fly ash and GGBS also added to the cement. The optimum value of fly ash is 20% and 10% fly ash and 10% GGBS combination is fixed as control mix. Foundry sand is replaced in 0% 10% 20% , 30% and 40% for M30 mix. Concrete mixtures produced, tested and compared in terms of Compressive strength, split tensile strength and Flexural strength with the conventional concrete for 7,14,28 days. It is found that 30% foundry sand can be effectively replaced when using this combination i.e., Fly ash and GGBS.

KEYWORDS: Alkali activated fly ash slag, Alkali activated concrete, Natural course aggregate.

I. INTRODUCTION

Concrete is a well-known composite construction material composed primarily of aggregates, cement and water. There are many formulations which provide varied properties. The aggregate is generally coarse, gravel or crushed rocks such as limestone or granite, along with a fine aggregate such as sand. The cement, commonly Portland cement and other cementitious materials fly ash and slag cement serve as a binder for the aggregate. Various chemical admixtures are also added to achieve varied properties. Water is then mixed with this dry composite which enables it to be shaped and then solidified and hardened into rock-hard strength through a chemical process called hydration. The water reacts with the cement which bonds the components together eventually creating a robust stone-like material. Concrete has relatively high compressive strength, but much lower tensile strength. For this reason, it is actually reinforced with materials that are strong in tension. Now-days, all over the world, construction activities are taking place on huge scale. Natural river sand is one of the key ingredients of concrete, is becoming expensive due to excessive cost of transportation from sources. Also large scale depletion of sources creates environmental problems. Unfortunately, production of cement involves large amount of carbon dioxide gas into the atmosphere, a major contributor for greenhouse effect and global warming.

The reduction in the sources of natural sand and the requirement for reduction in the cost of concrete production has resulted in the increased need to identify substitute material to constituent materials as aggregates in the production of concretes. Several types of materials have been investigated for this purpose both in developing and developed countries and the outcome of success has been varying. The materials usually researched for this purpose are either by-product materials or even sometimes manufactured aggregates. Manufactured aggregates are mostly used to produce concretes to meet specific purposes such concrete with superior properties or structural lightweight concrete. On the

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other hand, the advantages of utilization of byproducts or aggregates obtained as waste materials are pronounced in the aspects of reduction in environmental load and waste management cost, reduction concrete production cost and enhancement in some properties of concrete.

II. LITERATURE SURVEY

Study on workability and mechanical properties of alkali-activated fly ash-slag concrete cured at ambient temperature, Guohao Fang et al. [1]. conducted a study on workability and mechanical properties of alkali-activated fly ash-slag concrete cured at ambient temperature. A series of experiments were carried out to measure workability, setting time, compressive strength, splitting tensile strength, flexural strength and dynamic elastic modulus of AAFS concrete. The results showed that workability and setting time decreased with the increase of slag content and molarity of sodium hydroxide solution (SH). Compressive strength increased with the increase of slag content and molarity of SH as well as the decrease of alkaline activator to binder (AL/B) ratio, but it did not have significant relationship with sodium silicate to sodium hydroxide (SS/SH) ratio.

Waste foundry sand in concrete, Bavita Bhardwaj and Pardeep Kumar [2] prepared a review on waste foundry sand in concrete. This paper contains review of various publications on use of WFS as substitute to natural sand in concrete. The conclusions made are as: Presence of impurities such as clay, saw dust etc. particles reduces the specific density of the material, and also decreases the density of the concrete by creating air voids in the concrete. Increase in substitution of WFS leads to decrease in unit weight of concrete. Majority of waste foundry sands are categorized as nonhazardous waste (that is non-corrosive, ignitable, reactive or toxic) and have shown good durability. In general, increase in substitution leads to decrease in workability of concrete attributed to presence of finer particles of sand and additives. The trend was same in case of special concretes like SCC and GPC. Waste foundry sand addition had positive influence on sulphate resistance of concrete at up to 30% replacement ratio. At higher substitution the resistance degraded which is attributed to traces of SO₃ present in WFS. Similarly beyond 30% substitution led to increase in carbonation depth in concrete with WFS which is attributed to poor workability which led to poor compaction. Concretes with WFS as partial to full replacement by WFS produced concrete with good quality, indicated by USPV value for up to 100% replacement, lying above 3500 m/s.activity. Consequently, the compressive strength increased.

III. METHODOLOGY

The study follows a clear and planned methodology. The first step is to conduct the literature survey. Cement is partially replaced with GGBFS and flyash in varying proportions and optimized. Optimum value is obtained and the mix is fixed as control specimen. Foundry sand is used as fine aggregate in varying proportions. Cubes, cylinders and beams for three trials for all mixes are to be casted. The various tests to be done are Compressive tests, flexural test and Splitting tensile tests.

IV. EXPERIMENTAL RESULTS

The compressive strengths for different mixes are graphically represented in Fig1. Compressive strength of concrete increased with the increase in sand replacement with various replacement levels of foundry sand. However, at each replacement level of fine aggregate with foundry sand, an increase in strength was observed with the increase in age. Decrease in compressive strength shown when 40% replacement done. The maximum compressive strength is obtained for 30% replacement and this is due to high density in specimens. Consistent increase in strength of concrete with WFS, when added upto 30% as sand replacement, attributing to densification of concrete matrix due to finer WFS particles and also presence of silica content which would have helped in the formation of C-S-H gel.

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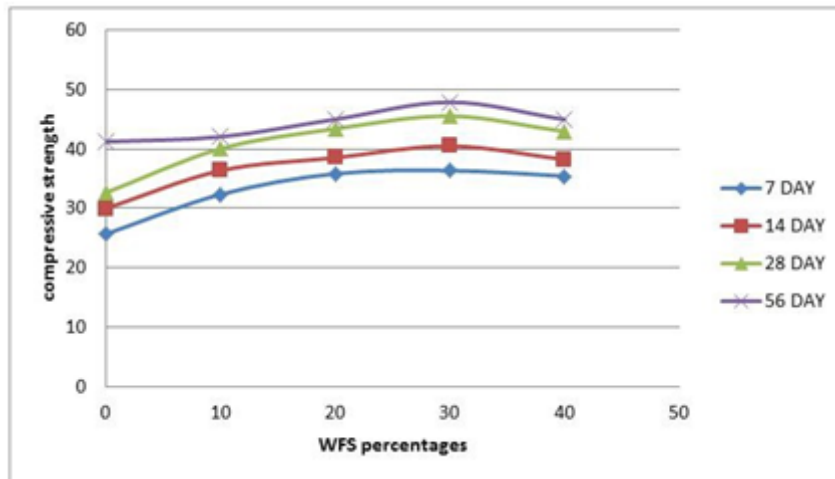


Fig. 1. Graph for Compressive Strength Results

The split tensile strengths for different mixes are graphically represented in Fig. 2. Test showed an increase with 10% 20% and 30% replacement levels of foundry sand with fine aggregate but sudden fall in 40% replacement seen. Split Tensile Strength also increased with increase in age. The maximum strength was achieved with 30% replacement of fine aggregate with waste foundry sand.

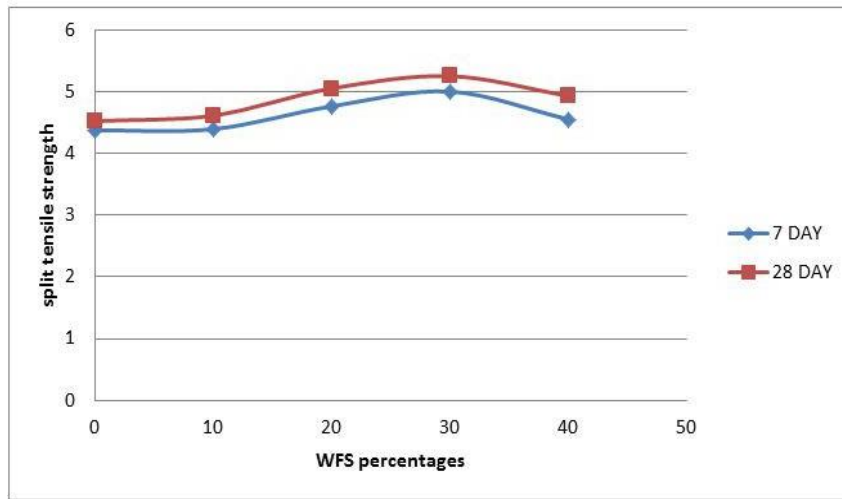


Fig. 2. Graph for Split Tensile Strength Results

The flexural strengths of different mixes are graphically represented in Fig.3. There is considerable increase in the flexural strength of concrete with the inclusion and increase in the percentage of waste foundry sand upto 30%. However after 30% there was decrease in strength.

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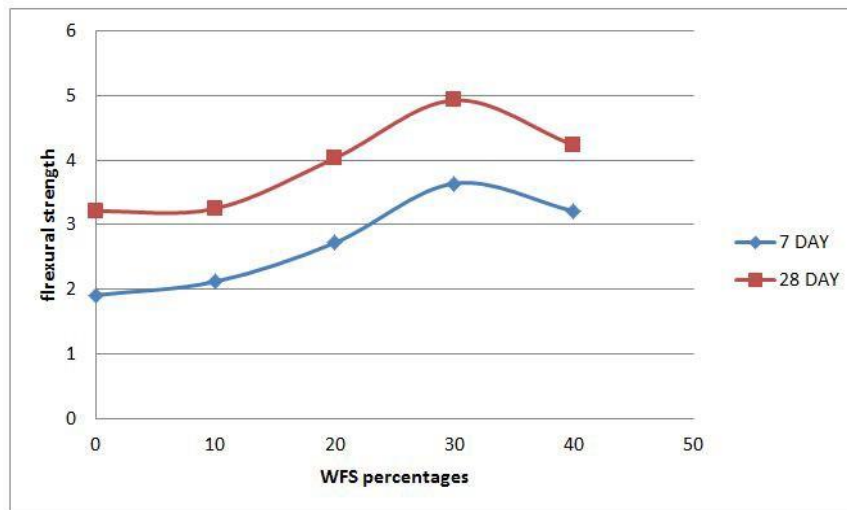


Fig.3. Graph for Flexural Strength Results

V. CONCLUSION

From the results obtained it is suggested that WFS with a substitution rate up to 30% can be used effectively as a fine aggregate in good concrete production. Compressive strength of concrete increases with increase in percentage of waste foundry sand as compare to regular concrete. It was maximum for 30% replacement. Split tensile strength increases with increase in percentage of waste foundry sand up to 30% replacement. Flexural strength increases with increase in percentage of waste foundry sand up to 30 % replacement. Use of waste foundry sand in concrete reduces the production of waste through metal industries. It is an eco- friendly building material. The problems of disposal and maintenance cost of land filling is reduced.

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