STUDY OF MECHANICAL PROPERTIES OF CONCRETE WITH DOUBLE BLENDING OF FLY ASH AND GGBS

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ABSTRACT

High Performance Concrete (HPC) is that concrete which meets special performance and uniformity requirements that cannot always be achieved by conventional materials, normal mixing, placing and curing practices. Special performance requirements using conventional materials can be achieved only by adopting low water binder ratio, which necessitate the use of high cement content. But the addition of chemical and mineral admixtures can reduce the cement content and this result in the economical HPC. The effect of a mineral admixture on the strength of concrete varies significantly with its properties and replacement levels.

The use of mineral admixtures (Fly ash and GGBFS) in concrete production improves the compressive strength, pore structure, and permeability of the concrete this is attributed to the pozzolanic reaction. This approach will have the potential to reduce costs, conserve energy, and waste minimization.

In this experimental investigation the strength properties of concrete for M40 grade concrete at various replacement levels of Fly ash and GGBS (20%, 30%, 40%) was done. The effect of variation in strength parameters i.e., Compressive Strength, Split Tensile Strength and Flexural Strength were studied for different replacement proportions was done. The test results showed that higher tensile strength and flexural strength than conventional concrete and almost same compressive strength as conventional concrete.

Keywords: Fly ash , GGBFS, Cement, Strength Comparison

INTRODUCTION

GENERAL

Concrete is the key material used in various types of construction, from the flooring f a hut to a multi-storied high rise structures form pathway to airport runway, from an underground tunnel and deep sea platform to high-rise chimneys and TV Towers. In the last millennium concrete has demanding requirements both in terms of technical performance and economy while greatly varying from architectural masterpiece to the simplest of utilities. It is the most widely used construction material of construction which is as versatile as concrete.

HIGH PERFORMANCE CONCRETE

Concrete is considered as durable and strong material. Reinforced concrete is one of the most popular materials used for construction around the world. Reinforced concrete is exposed to deterioration in some regions especially in coastal regions. There for researchers around the world are directing their efforts towards developing a new material to overcome this problem. Invention of large construction plants and equipment's around the world added to the increased use of material.

ADVANTAGES OF USING HPC

The advantages of using high strength HPCs often balance the increase in material cost. The following are the major advantages that can be accomplished.

•Increase in Girder spans.

•Increasing the spacing between girders.

•Permeability of concrete decreased (increased durability)..

•Reduction in member size, resulting in increase in plinth area or useable area and direct savings in the concrete volume saved.

MATERIALS AND THEIR PROPERTIES

GENERAL

The term fly ash was first used in the electrical power industry 1930. The first comprehensive data of its use in concrete, in North America, was reported the major practical application in 1937 by DEVIS et al. The United States bureau of data reported the major practical application in 1948, with the publication on the use of fly ash in the construction of Hungary Horse dam.

Worldwide acceptance of fly ash slowly followed these early efforts, but the interest has been particularly noticeable in the wake of the rapid increase in the energy costs that occurred during the 1970's and then a number of investigations were carried out both within and outside of this country on flyash concrete. Conservation of natural resources is the need of the hour throughout

FLY ASH

Fly ash is the finely divided residue that results from the combustion of pulverized coal and is transported from the combustion chamber by exhaust gases. Fly ash is produced by coal-fired electric and steam generating plants. Typically, coal is pulverized and blown with air into the boiler's combustion chamber where it immediately ignites, generating heat and producing a molten material residue. Boiler tubes extract heat from the boiler, cooling the flue gas and causing the molten mineral residue to harden and form ash. Coarse ash particles, referred to as bottom ash or slag, fall to the bottom of the combustion chamber, while the lighter fine ash particles, termed as fly ash, remain suspended flue gas.

REACTION MECHANISM OF FLYASH

Reaction mechanism for Fly ash can be basically explained as pozzolanic reaction mechanism Fly ash is considered to be a Pozzolan. Pozzolans are materials which, though not cementitious in themselves, contain certain constituents, which at ordinary temperatures in the presence of water, will combine with lime to form stable insoluble compounds with cementitious properties behaves as a more or less inert material and serves as a precipitation nucleus for lime {Ca(OH)2} and calcium-silicate hydrate-gel originating from the cement hydration. The subsequent pozzolanic reaction appears to be a slow process.

In the beginning of cement hydration, the composition of the pore water is dominated by a saturated lime solution with gypsum. The pH of the pore solution is lower than 13. After about one week the pH increases. The lime and sulphate concentration decreases to very low level and concentrations of hydroxyl, potassium and sodium ions increase rapidly. This may be due to the following reasons.

Various factors influencing the Flyash reaction :

Cement Type:

Rapid hardening cements develop high alkalinity faster than ordinary cements. Consequently, Flyash reaction starts earlier. Similarly different cements effect accordingly.

Temperature:

Development of hydroxyl concentration appears to be much slower at 2°C. At 40°C the pH reaches a high value within one day of hydration so that the reaction of Flyash can start from the first day. Temperature also affects the reactivity of Flyash itself. That means at a higher temperature the reaction will be initiated at lower alkalinity.

Water Cement Ratio:

Temperature is a strong relation between Fly ash activity and water/cement ratio. Higher the W/C ratio, lower the alkalinity and slower the reaction.

Types of Flyash:

Pozzolanic activity or reaction of Flyash depends upon parameters such as fineness, amorphous matter, chemical and mineralogical composition and un-burnt carbon contents

PROPORTIONING OF FLYASH CONCRETES

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one or more of the following objectives.

•Reduction in cement content,

•Reduced heat of hydration,

•Improved workability and

•Gaining levels of strength in concrete beyond 90 days of testing.

Flyash is introduced into concrete by one of the following methods.

•Cement containing Flyash may be used in place of OPC.

•Flyash is introduced as an additional component at the time of mixing.

The first method is simple and problems of mixing additional materials are not there, there by uniform control is assured. The proportions of Flyash and Cement are predetermined, and mix proportion is limited.

The second method allows for more use of Flyash as a component of concrete. Flyash plays many roles such as, in freshly mixed concrete, it acts as a fine aggregate and also reduces water cement ratio in hardened state, because of its pozzolanic nature, it becomes a part of the cementitious matrix and influences the strength and durability.

GGBS AND ITS SOURCE

COMPOSITION

Physical and chemical properties of GGBS

TYPICAL CHEMICAL COMPOSITION		TYPICAL PHYSICAL PROPERTIES	
Calcium oxide	40%	Colour	Off-white
Silica	35%	Relative gravity	2.9
Alumina	13%	Bulk density	$1200 kg/m^3$
Magnesia	8%	Fineness	$>350 m^2/kg$

Ground granulated blast furnace slag is by-product from the blast furnaces used to make iron. These operate at a temperature of 1500oC and are fed with a carefully controlled mixture of iron ore ,coke and lime stone. The iron-ore is reduced to iron and the remaining materials form a slag that floats on top of the iron. This slag is periodically tapped off as a molten liquid and if it is to be usedfor the manufacture of GGBS it has to be rapidly quenched in large volumes of water.

EFFECT OF GGBS ON CONCRETE

GGBS PROPORTIONS

On its own, GGBS hardens very slowly and, for use in concrete, it needs to be activated by combing it with Portland cement. The typical combination is 50% GGBS with 50% Portland cement, but percentages of GGBS anywhere between 20 and 80% are commonly used. The greater the percentage of GGBS, the greater will be the effect on concrete properties.

Consistency:

While concretes containing GGBS have a similar, or slightly improved consistence to equivalent Portland cement concretes, fresh concrete containing GGBS tends to require less energy for movement. This makes it easier to place and compact, especially when pumping or using mechanical vibration. In addition, it will retain its workability for longer

Early age temperature rise:

The reactions involved in the setting and hardening of concrete generate significant heat and can produce large temperature rises, particularly in thick-section pours. This can result in thermal cracking. Replacing Portland cement with GGBS reduces the temperature rise and helps to avoid early-age thermal cracking. There are a number of factors which determine the rate of heat development and the maximum temperature rise. These include the percentage of GGBS, the total cementitious content, the dimensions of the structure, the type of formwork and ambient weather conditions.

Colour:

GGBS is off-white in colour and substantially lighter than Portland cement. This whiter colour is also seen in concrete made with GGBS, especially at addition rates of 50% and above. The more aesthetically pleasing appearance of GGBS concrete can help soften the visual impact of large structures such as bridges and retaining walls. .

EXPERIMENTAL INVESTIGATIONS

MIXING

Firstly, the weights of Fine Aggregate , Coarse Aggregate , Cement, Fly ash ,GGBS , Water and super plasticizer are weighted according Mixing was carried out in a pan mixer machine. The mixing methodology adopted was as follows:

•25 percent of total water, coarse aggregates and admixtures were added to the mixer machine and allowed to mix for 1 minute.

•Cement and 50 percent water were then added to the mix and mixed for 1 minute.

•Super plasticizer was blended with the balance 25 percentage water and then added to the mix. Mixing was continued for 5 minutes after adding the blend

Curing the specimens:

After casting, the moulded specimens are stored in the laboratory free from vibration, in moist air and at room temperature for 24 hours. After this period, the specimen are removed from the moulds and immediately submerged in the clean fresh water of curing tank. The curing water is renewed after every 5 days. The specimens are cured for 28days in present work.

Compressive strength test:

Testing of cube for Compressive Strength

The compressive strength test the test cube specimen was placed with the cast faces of the cubes at right angles to that as cast in the compression testing machine of capacity 3200 KN. According to the standard specifications the load on the cube was applied at standard constant rate up to the failure of the specimen and the ultimate load was noted. Cube compressive strength was tested and the results were tabulated.

Split tensile strength test:

Testing of cylinder for Spli Tensile Strength

The test is carried out by using the cylindrical specimens. The specimens were placed with the cast faces at right angles to that as cast in the compression testing machines. In order to reduce the magnitude of the high compressive stress near the point of application of load, narrow packing strips of 25mm wide 3mm thick and 100mm long was used.

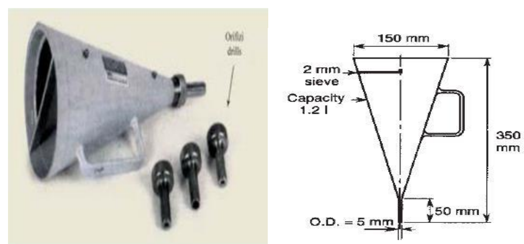
Flexural strength test:

This test was conducted on the flexural resting machine. The load was applied at the middle third points of the effective span of the flexural beam. Special precautionary measures were taken to keep axis of the specimen aligned with the axis of loading device. The load was applied without shock and increased continuously at a uniform rate of loading. The load was increased until the specimen failed and maximum load applied to the specimen during the test was recorded.

Marsh Cone Test:

Optimum fluidizing effect at lowest dosage is an economical consideration. Giving maximum fluidizing effect for a particular super plasticizer and a cement is very complex involving many factors like composition of cement, fineness of cement etc. Marsh Cone Test is a simple field test to find the optimum dose of Super plasticizers.

Marsh cone is a conical brass vessel, which has a smooth aperture at the bottom of diameter 5 mm. Take one litre slurry and pour it into marsh cone duly closing the aperture with a finger. Start a stop watch and simultaneously remove the finger. Find out the time taken in seconds, for complete flow out of the slurry.



Marsh cone viscometer with attachments, 5 mm, 8 mm and 11 mm.

CONCLUSIONS

Based on the extensive experimental investigations carried out on the Fly ash and GGBS as the partial replacements in the cement the fallowing conclusion has been drawn.

It is observed that the

1. Replacements of cement (20%) by Fly Ash and GGBS with individual proportions of (10+10)% (Fly

Ash+GGBS) respectively increases the Compressive Strength, Flexural Strength and Split Tensile Strength of concrete about 1.56 %,11.42 %, 15.85 % respectively at 28 days strength.

2. Replacements of cement (30%) by Fly Ash and GGBS with individual proportions of (10+20)% (Fly Ash+GGBS) respectively increases the Compressive Strength, Flexural Strength and Split Tensile Strength of concrete about 4.25 %,17.14 %, 22.25 % respectively at 28 days strength.

3. Replacements of cement (40%) by Fly Ash and GGBS with individual proportions of (20+20)% (FlyAsh+GGBS) respectively increases the Compressive Strength, Flexural Strength and Split Tensile Strength of concrete about 9.61 %,15.71 %, 42.07 % respectively at 28 days strength.

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