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High Early Strength Concrete with Binary and Ternary Blended Cement

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ABSTRACT

Cement Industry is a one of the major sources of environmental pollution therefore the reduction of the cement demand should be improved. GGBS and Bauxite is a raw material and it should be reused to reduce the pollution. Thus, this study investigated the use of GGBS and Bauxite as a cement replacement in ternary and binary blended cement on compressive strength. GGBS is an environmentally friendly product and made from a byproduct of iron manufacturing. It is a high quality, low CO2 material. Because GGBS has low embodied CO2, it allows designing concrete mixes for sustainable construction. The manufacture of GGBS requires less than 20 % of the energy and produces less than 10 % of the CO2 emission compared to Portland Cement production. GGBS helps to form a next generation cement that reduces damage to the environment. GGBS reduces the likelihood of concrete thermal cracking, and it improves concrete's resistances to damage from alkali silica reaction, sulphates and chlorides. Concrete in aggressive environments is much more durable with the use of GGBS as a partial replacement for the cement. Bauxite is used in concrete because the iron and aluminum components of the bauxite residue are valuable additions in the production of both Portland Cement and " special " cement clinkers; and it has been shown at a laboratory scale by several research groups that bauxite residue may successfully replace clinker in blended cement.

Keywords: High early strength concrete, Blended Cement, Binary cement, Ternary Cement, Metakaolin, Silica fume, Bauxite, GGBS, Rebound Hammer, UPV Test, PH Test, Compression Test.

INTRODUCTION

According to IOP Conference Series: Earth and Environmental Science for every 1kg of cement produced, 0.9kg of CO2 is evolved, and this equates to the evolution of about 3.24 billion tons of CO2/year for the current projected 3.6 billion produced annually, and these figures don't take in to account the emissions from the quarrying and transportation of raw materials. Cement is made by firing limestone, clay, and other materials in a kiln. CO2 is emitted from the energy used to fire the material, and the chemical reaction produced from the mixture when it is exposed to heat. Blended cements are cements in which part of the clinker is substituted with other materials. Of particular significance throughout the world are granulated slag from the production of pig iron, FA and uncalcined limestone [4]. The use of blended cements is a particularly attractive efficiency option as introducing these additives not only aids in reducing the amount of energy used, in addition to reducing GHG emissions in clinker production, but Also Directly Corresponds To A Reduction In Carbon Dioxide Emissions In Calcinations.

Blended Cement

Blended Cement is manufactured for use in general purpose concrete applications, cement- based products, mortar sand grouts where the use of fly ash has been approved. Concrete made with fly ash or slag cement delivers improved later-age strength workability and enhances the durability performance of concrete. Why is Blended cement better Than OPC? Smoother [1]: It provide as finer texture than OPC when mixed. Strength: Fly ash and slag cement is significantly stronger than OPC after fully curing (morethan28 days), in both compressive and flexural stress. This depends in part on the proportions and quality fad mixture. Permeability: The lower permeability of blended concrete extends its useful life and hardness by reducing penetration of aggressive water run-off compounds such as sulfates and chlorides, which have increased impact as ordinary cement ages. Silica fume cement allows only 20 percent of the permeability of OPC. Thermal Stress: With ordinary cement, if temperature differences between the concrete surface and its interior are high, structural integrity is weakened and cracking can occur [3]. This can happen with cold weather concreting, when concrete is mixed and poured while temperatures fall below40 degrees. Adding blended concrete mixes can reduce peak temperatures and reduce the risk of thermal stress.

Binary Blended Cement

Binary cements contain OPC and one CM. In this project, the term binary cement is used to refer to blended cements containing OPC and other materials like fly ash as follows:

Combinations:

• Cement GGBS	+	Potential Benefits of Blended Cements
• Cement bauxite	+	• Improved concrete workability.
• Cement flyash	+	Lower risk of thermal cracking.
• Cement RHA	+	• Improved concrete durability and long-term strength.
• Cement metkaolin	+	• Reduced overall concrete cost.

Ternary Blended Cement

A ternary mixture is simply a mixture of three components. Eg cement+ 2 cementations' materials. Combinations

- Cement+ GGBS+ Bauxite
- Cement+ fly ash + limestone filler
- Cement + metakaolin + sugarcane Bagasse ash
- Cement +RHA+ Coconut husk ash Technical advantages:
- Lower heat of hydration and less risk of thermal cracking.
- Reduces heat of hydration and thermal stresses.
- Reduced overall concrete cost.
- Contribute to the long-term strength gain of concrete. Silica fumes can has ten strength developments and reduce curing time.

MATERIALS AND METHODS

Cement - A cement is a binder, a chemical substance used for construction that sets, hardens, and adheres to other materials to bind them together. Cement is seldom used on its own, but rather to bind sand and gravel together. Cement mixed with fine aggregate produces mortar for masonry, or with sand and gravel, produces concrete. Cement is a binder material. We are used ordinary Portland cement for making ternary and binary cement concrete blocks.

Sand - Sand is a granular material composed of finely divided mineral particles. Sand has various compositions but is defined by its grain size. Sand grains are smaller than gravel and coarser than silt. Sand can also refer to a textural class of soil or soil type; i.e., a soil containing more than 85 percent sand -sized particles by mass. the composition of sand varies, depending on the local rock sources and conditions, but the most common constituent of sand is silica usually in the form of quartz.

Aggregate - Concrete aggregate are composed of geological materials such as gravel, sand and crushed rock. The size of the particles determines whether it is a coarse aggregate (e.g. gravel) or a fine aggregate (e.g. Sand). the resulting concrete can be used in its natural stateor crushed, according to its use and application.

Water - water is a key ingredient, which when mixed with cement, forms a paste that binds the aggregate together. The water causes the hardening of concrete through a process called hydration. We are using portable water for casting blocks.

GGBS - Ground granulated blast furnace slag is obtained by molten iron slag from a blast furnace in water or steam, to produce a glassy, granular product than is then dried and ground into a fine powder. Ground- granulated blast furnace slag is a latent hydraulic binder forming calcium silicate hydrates after contact with water.

It is a strength- enhancing compound improving the durability of concrete. It is a component of metallurgic cement. Its main advantage is its slow release of hydration heat allowing to limit the temperature increase in massive concrete components and structure during cement setting and concrete curing, or to cast concrete during hot summer.

Bauxite - bauxite is a naturally occurring, heterogeneous material composed primarily of one or more aluminum hydroxide minerals, plus various mixtures of silica, iron oxide, titania, alum inosilicate, and other impurities in minor or trace amounts. The principal aluminum hydroxide minerals found in varying proportions with bauxites are gibbsite and the polymorphs boehmite and diaspore.

Admixture - An admixture is defined as "a material other than water, aggregates, cementitious materials, and fiber reinforcement, used as an ingredient of a cementitious mixture to modify its freshly mixed, setting, or hardened properties and that is added to the batch before or during its mixing".

CONVENTIONAL TEST CONDUCTED ON MATERIAL

PH Test: In chemistry pH, historically denoting "potential of hydrogen'' is a scale used to specify the acidity or basicity of an aqueous solution. Acidic solutions are measured to have lower pH values than basic or alkaline solutions. The pH scale is logarithmic and inversely indicates the concentration of hydrogen ions in the solutions. Solutions with a pH less than 7 are acidic, and solutions with a pH greater than 7 are basic.

Slump Test: Bitumen's are viscoelastic materials without sharply defined melting points; they gradually become softer and less viscous as the temperature rises. The softening point of bitumen can be determined through the use of a ring-and-ball apparatus immersed in distilled water (30 to 80°C) or glycerin (above 80 to 157°C).

RESULTS AND DISCUSSION

Workability property of binary and ternary blended cement mortar was evaluated through the measurement of flow table. Flow table of binary blended cement mortar with SF decreased with increasing SF replacement especially at 10%SF by weight [5]. However, flow table of ternary blended cement mortar with FA and SF replacement was increased, compared to binary blended cement mortar with only SF replacement. Moreover, flow table of ternary blended cement mortar increased with increasing FA replacement. Thus, the workability of blended cement mortar with only SF replacement can be improved by incorporating FA replacement. The apparent density, volume of permeable pore space (voids) and water absorption of binary and ternary blended cement mortar under autoclaved curing for 9 h are shown in Table 4. It was observed that the apparent density of binary blended cement mortar with FA tend to increase with increasing FA replacement. In addition, the apparent density of all binary and ternary blended cement mortar was higher than PC control. In high temperature and pressure curing, the α-dicalcium silicate hydrate (α-C2SH) is formed in PC control mixture while tobermorite is formed in blended cement. Tobermorite phase has a larger volume of structure than α-C2SH phase which cause a decrease in porosity and increase in the density of blended cement mortar [10]. Thus, the present of tobermorite lead to increased apparent density of binary and ternary blended cement mortar. Voids and water absorption of binary blended cement mortar with FA replacement was higher than PC control while voids and water absorption of binary blended cement mortar with FA replacement was lower than PC control. In ternary blended cement mortar, voids and water absorption increased with increasing FA replacement. However, voids and water absorption of ternary blended cement mortar tend to decreased with increasing FA replacement [6]. This is due to the filler effect by hydration products and SF particle. Furthermore, voids and water absorption of all ternary blended cement mortar was higher than PC control. This may cause the distribution and agglomerated of unreacted FA and SF.

Fig. 1 shows the compressive strength of binary blended cement mortar under autoclaved curing for 9 h. It was found that compressive strength of binary blended cement mortar with FA tends to decrease with increased FA replacement. In addition, binary blended cement mortar with FA shows compressive strength lower than PC control (OPC mix). This is due to the dilution effect and low pozzolanic reaction of FA [8]. However, compressive strength of binary blended cement with SF increase with increased SF replacement and show compressive strength higher than that of PC control (OPC mix). This is due to higher pozzolanic reaction of SF and to bermorite formation.

Table 1: Rebound Hammer Test Results

Mix	1stday oundNo.	7thday Rebound No.	14thday oundNo.	28thday Rebound No.
Control specimen	15	20	23	25
G10	15	17.11	19	20.99
B20	11	13.10	15	17.11
G10,B20	13	16.99	18	20

Table 2: Rebound Hammer Test Results

Mix	Compressive strength (MPa)				Strength
	1day	7day	14day	28day	%
Control Specimen	4	17	23	25	100
G10	14	15	15	32	128
B20	13	14	18	31	124
G10,B20	14	16	19	30	120

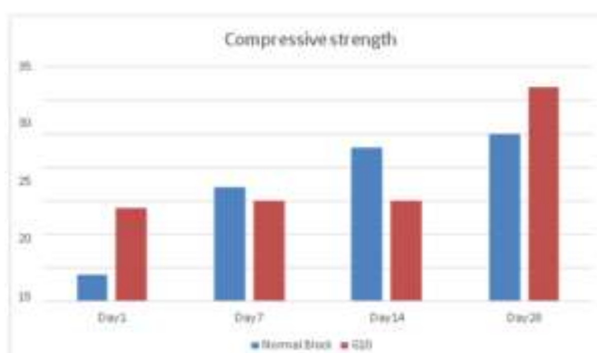

Fig.1: Variation in Compressive strength

CONCLUSION

- This study provided a detailed understanding of concrete properties of high early strength concrete with binary and ternary blended cement.
- In this study we partially replaced the cement with cementious materials which the properties are nearby similar to the cement like fineness of cement, specific gravity of cement and bulk density of cement.
- From this study we are selected the two materials 1. GGBS (Ground Granite Blast Furnace Slag) 2. Bauxite. By using these two materials we are making the no of concrete blocks like G10(GGBS replaced 10%), B20 (Bauxite replaced 20%)and G10, B20 (GGBS replaced 10 % and Bauxite replaced 20%).
- Various test conducted on this blocks 1. Ultrasonic Pulse Velocity test.2. Rebound Hammer Test.3.Compressive strength.
- The main moto of our project is to Increase the Compressive Strength % of concrete by using raw material.

From this study it is found that:

1) The Strength % of GGBS (Binary) is increased 28% than the Normal Concrete Block.
2) The Strength % of Bauxite (Binary) is increased 24% than the Normal Concrete Block.
3) The Strength % of GGBS and Bauxite (Ternary) is increased 20% than the Normal Concrete Block.

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