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STUDY ON BEHAVIOUR OF GEO POLYMER CONCRETE

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***Abstract*: Vigorous construction activity and manufacture of cement has increased carbon dioxide emissions into the atmosphere. This has become an important environmental issue. Hence, there is a need for eco-friendly cement or greener concrete/geo polymer concrete. Present work selects two industrial by products such as fly ash and ground granulated blast furnace slag (GGBS) to manufacture geo polymer concrete. Geo polymer concrete is cement less concrete gaining popularity globally towards the sustainable development. It is environmental friendly which involves a different chemical reaction in aluminum and silicon system, which involves reactive alumino silicates materials such as fly ash and GGBS. The geo polymer concrete has low CO_2 foot print and provide an alternative to normal conventional concrete.**

***Keywords:* GGBS; Geo polymer; concrete; compressive strength.**

1. INTRODUCTION

In the modern world, the most used material for construction buildings and to build infrastructure the most ctio used material is concrete. and concrete is normally manufactured by mixing with ingredients such as cement , cores aggregates ,fine aggregates ,water ,and mineral admixtures for latent concrete nowadays such as , fly ash ,GGBS and also usage of super plasterers for improving strength of concrete .The materials used for concrete manufactures such as fine aggregates are found in nature and used by trimming them into required shape &size .Water is also available in nature and clan water is used ,but cement is manufactured for raw materials available in nature .Normally the process of manufacturing of cement is very much energy consuming process .As some of the surveys said one tonne manufacturing of cement produces nearly one tonne of carbon dioxide .And which in turn produces green house gases which cause global warming .So if mainly cement could be replaces there may be some reduction in consumption of cement & which in turn reduces carbon dioxide production .So this will reduce global warming

Instead of cement some cementitious material can be used to replace cement ,Some of the materials which can be replaces is that fly ash and GGBS .So using fly ash and GGBS potential replacement can be done with cement, But it is not possible to do replacement without cement. So some study is been made by replacing cement completely with fly ash and GGBS.

2. MATERIALS

The materials used in the experiment are:

a. Fine aggregate

b. Coarse aggregate

MINERAL ADMIXTURES

a. GGBS

b. Fly ash

CHEMICAL ADMIXTURES

a. Sodium hydroxide

b. Sodium silicate solution

c. Alkaline solution

3. METHOD OF NEXT INVESTIGATION STEP

A) Collection GGBS, Flyash and required chemicals

B) Physical Tests to be conducted on Materials

C) Trial and error test and fixing optimum mix

D) Making number of samples of concrete cubs

F) Testing of cubes and beams is to be done for 1, 3, 7 days

4. COMPRESSION TEST

Compression test is the most common test conducted on hardened concrete, partly because it is an easy to perform, and partly because most of the desirable characteristic properties of concrete is related to its compressive strength. The compressive strength of concrete is one of the most important and useful properties of concrete. In most structural applications concrete is employed primarily to resist compressive stresses. In those cases where strength in tension or in shear is of primary importance, the compressive strength is frequently used as a measure of these properties.

Compression test is carried on specimens of cubical in shape. The cube specimen is of the size 150mmX150mmX150mm. The cube moulds were coated with mould oil on their inner surfaces and were placed on Plate. Concrete was poured in to the moulds in three layers each layer being compacted using mechanical vibrator. The top surface was finished using trowel. After 24 hours concrete cubes were de-moulded and the specimens were kept for curing under water.

5. CASTING AND CURING

Mix is prepared by fixing proportion of alkaline solution. Mixing is done and casted in normal cubes of having the size of 150x150x150mm and normal beams size of 100x100x500mm. Curing is done by sun drying instead of water curing

Experimental work:

Experimental work carried out in the production of Geo polymer concrete and properties & method used for the mix proportion, casting and curing of specimens. Experimental work consists of studying the variation of strength properties of Geo polymer concrete made with combination of fly ash and Ground granulated blast furnace slag (GGBS) which is used as binder.

Initially trial mixes were made to achieve a proper mix for Geo polymer concrete with proper workability to cast Geo polymer concrete beams and cylinders. In this aspect cubes were casted for the two binder proportions i.e., 375 kg/m3 and 420 kg/m3 by varying the ratio of water to Geo polymer solids from 0.30 to 0.40 for different ratios of alkaline to binder content i.e., from 0.60 to 0.80, the cubes were sun dried before testing for its compressive strength by allowing a rest period of 1 day. Then the cubes are tested for strength in the compressive testing machine for 1, 3 and 7 days. Based on the above results and the performance criteria (compressive strength and workability) optimum f_{ck} is selected from the respective binder proportion.

With the same mix proportion of optimum fck, three simply supported Geo polymer concrete beam specimens and nine cylinders were casted, cured and tested. the dimensions of a member is based on the, practical limitations, as per IS 516-1975.

6. MIXTURE PROPORTIONING OF GEO POLYMER CONCRETE FOR M70 GRADE

The different concrete mixes were obtained by based on the previous literature available.

The following procedure was adopted for this study.

Step 1:

The wet density of Geo polymer concrete = 2400 Kg/m3

Step 2:

Ratio of sodium silicate to sodium hydroxide solution = 2.5

Step 3:

Amount of binder content was taken as 375 kg/m^3.

Step 4:

Ratio of water to Geo polymer solids was taken as 0.30.

Step 5:

Ratio of alkaline solution to binder content was taken as 0.6.

Step 6:

The water content in sodium silicate = 39.42%

(Na_2SiO_3/ NaOH) Solution = 2.5

For 1M sodium hydroxide solution, 40g of sodium hydroxide pellets are dissolved in 1 liter

of water.

i.e. for 1M: 40g of pellets → 1000 ml of water

For 8M: 8X40g of pellets →1000 ml of water

Therefore mass of NaOH required in 1 litre of water is 262gms for 100% purity

For 97% purity NaOH solution consists of 26% solids and 74% water.

Step 7:

Alkaline solution required for 1 m^3 of concrete = 0.6 * binder content. = 0.6 * 375

= 225 kg/m3.

Quantity of NaOH solution = alkaline solution/ 3.5

= 225/3.5

= 64.28 kg/m3

Quantity of Na2SiO3 solution = 64.28 * 2.5

= 160.72 kg/m3

Step 8:

Water to Geo polymer solids required = 0.30

Water to Geo polymer solids obtained = 0.22

Therefore extra water added = 32.71 kg/m3

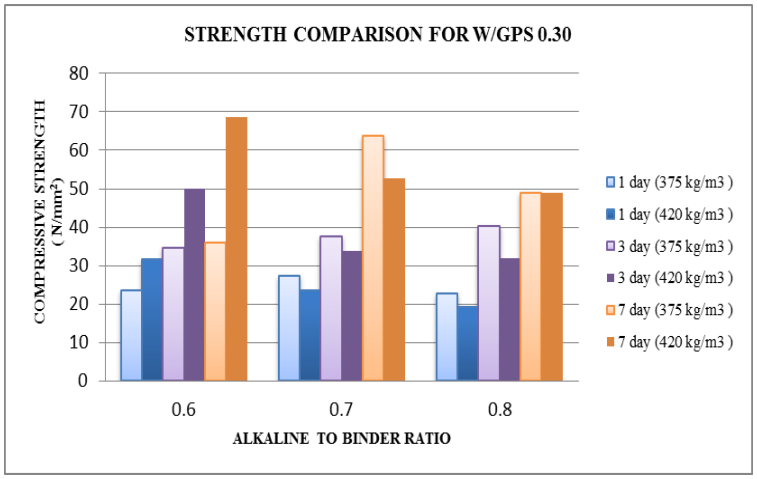
Step 9:

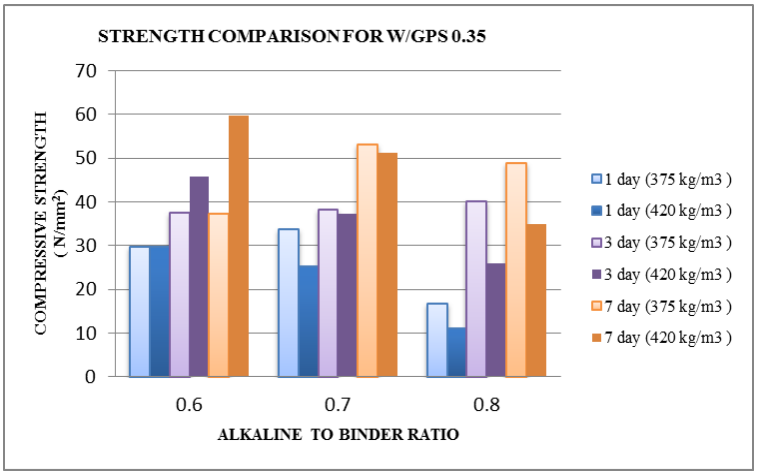
Total aggregates = density - binder content – alkaline solution – extra water

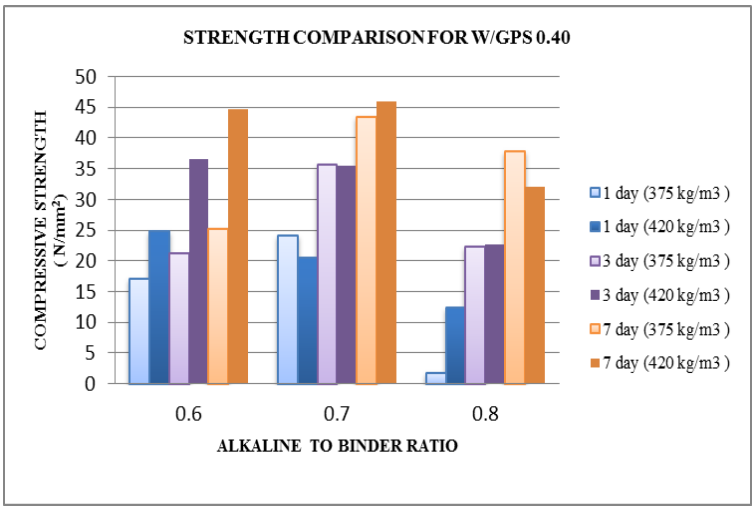
= 2400 – 375 – 225 – 32.71

= 1767.28 kg/m3

7. RESULTS AND DISCUSSION







8. DISCUSSION

i. From the above graph, it shows that with the increase in alkaline to binder ratio the slump value increased whereas the strength drastically decreased

ii. It can also be seen that with the increase in the binder content slump value decreases and also the strength.

iii. The mix with ratio of water to Geo polymer solids of 0.40 gave a good workable mix with flow (ratio of alkaline to binder as 0.80). whereas the strength achieved is less.

By considering all these mixes, Geo polymer concrete with water to Geo polymer solids of 0.30, having the binder content of 375 kg/m^3 and alkaline to binder ratio of 0.70 are selected as effective/optimum mix because this mix is having good workability and compressive strength. This mix is used for casting cylinders, cubes, beams for finding split tensile strength, compressive strength and flexural strength respectively

9. CONCLUSIONS

In the present experimental work, an attempt has been made to study the performance of Geo polymer concrete in terms of properties like workability, compressive strength, 18 types of mix of Geo polymer concrete were prepared for three different water to Geo polymer solids, for two different Binder proportions of 375 kg/m^3 and 420 kg/m^3 by keeping the Molarity constant (alkali solution 8M), optimum fck was selected to cast the plain Geo polymer concrete beam specimen and cylinders. Low-calcium fly ash (ASTM Class F) and Ground granulated blast furnace slag (GGBS) is used as the source material (Binder) to make Geo polymer concrete.

Based on the experimental results following conclusion were made:

- The average density of Geo polymer concrete is very similar to that of normal conventional concrete.
- The slump value of the fresh Geo polymer concrete decreases with the increase in total binder content of the mixture.
- The experimental investigation have shown that using Fly ash along with GGBS as source material, it is possible to produce Geo polymer concrete of compressive strengths (7 days) in the range of 44-70 N/mm2.
- GGBS as a source materials results in early initial strength and it makes possible to de-mould the specimen's very early. This is an important application of Geo polymer concrete in the industry.
- As the total binder content increases the compressive strength decreases.
- By using 35% GGBS (65% fly ash) in the total binder content The early strength development of geo polymer concrete under SUN DRYING showed better strength properties.

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