Durability Study on Lignite Fly Ash Based Geo Polymer Concrete

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Abstract*: The geopolymer concrete is considered as a third generation concrete after lime and cement the using of high calcium fly ash in concrete is significant and considered as the suitable option for the next generation in terms of strength and durability aspects. Normally the usage of fly ash in concrete can reduce the cost and increase the long term aspects in durability. Here the fully replacement of cement with high calcium fly ash was done. The replacement of high calcium fly ash was done with changing the percentage of total aggregate content in the total density of the concrete. The replacement was done with 60% 65% 70% 75% 80% .an alkali liquid ids used as a by product to react with fly ash to produce binder. The sodium hydroxide and sodium silicate solutions with 14M were used as a source material.

***Index Terms*: geopolymer concrete, durability, sorptivity, lignite fly ash, cement replacement**

I. INTRODUCTION

By using up the fly ash and various waste products as the replacement materials will make a powerful positive impact on environment pollution. The manufacture of cement involves equal amount of carbon di oxide emission into the environment. As a engineers, one effort to combat the shortfall of usage of cement is to be taken. Geopolymer is considered as third generation cement after lime and Portland cement. Geopolymer,a concrete which has been made without cement is known as geopolymer concrete or green concrete.
The manufacturing of the Portland cement is result in production of harmful gases and green house gases. Because of the cement production it is difficult to maintain the environment balance. One possible solution is use of submission.pozzolanic materials is to replace the ordinary cement. The strength properties of geopolymer concrete are comparable with the conventional concrete. The geopolymer concrete is a concrete which has been made up by the some waste by products such as fly ash rice husk ash fibre steel slag etc. Fly ash is the material that is from the combustion of the coal and the components of the fly ash will vary depending upon the coal. Researchers developed the statement that the geopolymer concrete possesses low carbonation than the ordinary concrete. The cementitious material produced from an alumino silicate activated in a high alkali solution were developed and termed as a geopolymer concrete. The performance of the geopolymer concrete enhances less porosity in the concrete. The compressive strength and split tensile strength of the concrete showing that the concrete can be a load bearing and the uptake of water by unsaturated, concrete might posses to sorptivity and this parameter is used to expose the concrete in an aggressive environment. The mix design has done on the basis of percentage of total aggregate content in concrete to the total density of the concrete. The test specimens for the geopolymer mixture were prepared. It has been decided to go with 60% 65% 70% 75% 80% on total density of concrete which is 2400 kg/m³.

Revised Manuscript Received on June 05, 2019

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II. MATERIALS AND METHODS

A. Materials for Concrete

The various materials used to prepare concrete for the test specimens are mentioned below.

Table 1 Amount of Materials Replaced

Percentage replacement(Kg/m³)	60	65	70	75	85
Fly ash(Kg/m³)	640	560	480	400	320
Coarse aggregates (Kg/m³)	1008	1014	1092	1080	960
fine aggregates (Kg/m³)	432	546	588	720	960
Sodium silicate(Kg/m³)	213.3	186.6	160	133.3	106.6
Sodium hydroxide (Kg/m³)	106.6	93.3	80	66.6	53.3
water	320	280	240	200	160

B. Fly ash

The Fly ash obtained from Neyveli Lignite Corporation (NLC Ltd), Neyveli, India was used in this experimental work.the specific gravity of the fly ash is determined as 2.80.

C. Coarse Aggregate

The maximum size of coarse aggregate used in the project is 16mm. The specific gravity of coarse aggregate is experimentally determined as 2.5.

D .Fine Aggregate

Indian standard sieve is used as fine aggregate.M-sand or manufactured sand is used for the experimental work. The M-sand which is passing through 4.75mm is used.The specific gravity of fine aggregate is found experimentally as 2.59.

E. Water

The water which does not contain any form of acids, alkalis, sewage and other organic impurities is used to prepare the concrete mix.

F. Solution

The alkali solution is used for making the bonding between the fly ash and fine aggregate .by making the proper solution will enhance the result. The pellet form of sodium hydroxide were used which is 97% purity. The sodium silicate which is having the chemical composition of SiO2=29.4%, Na_2o=14.7%, and water 55.9%. The sodium hydroxide solution and sodium silicate solution were mixed one day before the casting of the concrete.

G. Specimens for the Experiments

G.1. Standard Cube Specimens

For each mixes it was decided to go with 3 cubes for compression strength 2 cubes for water absorption test. The cubes are in standard size of 10cm x 10cm x10cm were prepared and used.

G.2. Standard Cylinder Specimen

The cylinder of size 100mm diameter 200mm height were used for the split tensile strength 3 cylinders for each mixes were casted. For sorptivity test 100mm diameter and 60 mm height cylinder were used. For each mixes 1 specimen were casted. One standard specimen for each mix was prepared for accounting the corrosion resistance. The cylinder of specimen 60 mm diameters and 200mm 12mm diameter rod is inserted in it.

K. Tests on the Hardened Concrete

L. Water absorption Test

This test is used to account how much of water is absorbed by the concrete. The percentage of the water absorbed by the concrete can be found out.

M. Corrosion resistance Test

The test is to find out the amount of corrosion takes place in the concrete after the concrete is cured at the ambient temperature. Multimeter is used to record the amount of corrosion.

N. Sorptivity Test

Sorptivity is the transferring of liquid in porous voids which is present in the concrete due surface tension acting in capillaries. The measurement of the sorptivity with respect to time and to get the amount voids present in it.

III. RESULTS AND DISCUSSION

The test results of specimens with varied with the percentage of the volume aggregates. The following results were obtained with respect to durability tests.

A Water absorption test

The test value signifies the amount of water absorbed by the concrete when one half of the specimen is exposed to water.

Table 2 Percentage of Water Absorption with Percentage Replacement

S.NO	Percentage of aggregates	Wet weight (gms)	Dry weight (gms)	Percentage of absorption
1	60	974.67	970.90.	0.41
2	65	962.33	952.17	1.07
3	70	910.17	894.67	1.51
4	75	900.33	875.67	2.82
5	80	912.5	878	3.45

B Corrosion resistance test

The amount of corrosion which occurs on the concrete was measured. The test value signifies the amount of water absorbed by the concrete when one half of the specimen is exposed to water. Multimeter is the instrument is used to measure the amount of corrosion. This measurement is takes place as milli volt (mV).the average range of amount of corrosion lies 100 to 250 mV to signify the quality of the concrete.

Table 3 Amount of Corrosion with Percentage Replacement

S.no	Percentage of aggregates	Amount of corrosion (mV)
1	60	464
2	65	378
3	70	198
4	75	174
5	80	269

C Sorptivity

Sorptivity is determined as the measurement absorption of the rate of water and capillary rise. Sorptivity characterises the tendency of porous of the material. The optimum value for classify the quality of concrete, if it <1.60 then it is good, 1.60 to 2.60 is good enough and the value over 2.60 is poor.

Table 4 Sorptivity Value with Percentage Replacement

Percentage of aggregates	Wet weight(gms)	Dry weight(gms)	Sorptivity value In 10^{-5}mm/min$^{0.5}$
60	979	979.5	1.16
65	949	949.83	1.94
70	885	885.93	2.13
75	871.5	872.75	2.91
80	880.22	881.67	3.29

IV. CONCLUSION

The study indicates the durability performance of the geopolymer concrete with high calcium fly ash as binder.In the experimental works the results were obtained.

1. The durable properties of lignite fly ash based geo-polymer concrete are observed under suitable curing methods and ambient temperature conditions.
2. The results of water absorption test, it shows that the 60% of aggregate replacement is satisfying because the quantity of fly ash content in that mix high compared to the other mixes. The increasing of fly ash content will results in less number of voids.

3. The corrosion results show that the 70% replacement is satisfying the amount of corrosion which is having the reference value by 100 to 250 mV.
4. The sorptivity results also stating that the 60% replacement is optimum because of having the fly ash content.
5. By having these values and performance of the concrete, we can conclude that, for water absorption and sorptivity 60% replacement is more.

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