International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 06 Issue: 03 | Mar 2019 www.irjet.net p-ISSN: 2395-0072

A STUDY ON MECHANICAL PROPERTIES OF GEOPOLYMER CONCRETE

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Abstract – *The major problem the world is facing today is the environmental pollution. In the construction industry mainly the production of Portland cement will causes the emission of pollutants results in environmental pollution. We can reduce the pollution effect on environment by increasing the usage of industrial byproducts in our construction industry. Fly ash is one of the major waste material obtained from thermal power plants. Geopolymer concrete is such a one and in the present study, to produce the geopolymer concrete the Portland cement is fully replaced with fly ash and alkaline liquids are used for the binding of materials. The alkaline liquids used in this study for the polymerization are the solutions of sodium hydroxide(NaOH) and sodium silicate(Na_2SiO_3).Different molarities of sodium hydroxide solution i.e, 16M,18M,20M are taken to prepare different mixes. The geopolymer concrete is designed for a grade of M30 in this study. The geopolymer concrete specimens are subjected to sunlight curing and tested for their mechanical properties(compressive strength, split tensile strength, flexure strength)at the age of 7days,28 days. Mixes of varying sodium hydroxide molarities i.e, 16M, 18M and 20M are prepared.*

Key Words: **fly ash, geopolymer, sunlight curing, sodium hydroxide, sodium silicate**

1 .INTRODUCTION

For the construction of any structure, Concrete is the main material. . The main ingredient to produce concrete is Portland cement. The production of cement means the production of pollution because of the emission of CO2 during its production The cement industry contributes about 5% of total global carbon dioxide emissions. And also, the cement is manufactured by using the raw materials such as lime stone, clay and other minerals. . Quarrying of these raw materials is also causes environmental degradation. So to overcome this problem, the concrete to be used should be environmental friendly.

Geopolymer concrete was introduced to reduce environmental pollution that causes by production of Portland cement. In 1978, Professor Joseph Davidovits introduced the development of mineral binders with an amorphous structure, named geopolymers. Davidovits (1988; 1994) proposed that an alkaline liquid could be used to react with the silicon (Si) and the aluminium (Al) in a source material of geological origin or in by-product materials such as fly ash and rice husk ash to produce binders.

2.MATERIALS USED

- Fly ash (class F)
- Alkaline liquids: Sodium hydroxide (NaOH)
  Sodium silicate (Na_2SiO_3)
- Coarse aggregates
- Fine aggregates

2.1 Fly ash

Fly ash is manufactured by the burning of coal in an electrostatic precipitator, a byproduct of industrial coal. The cementitious properties of fly ash were discovered in late 19th century and it has been widely used in cement manufacture for over 100 years. fly ash is supplied as a separate component for concrete and is added at the concrete at the mixer. It generally replaces between 20 and 80 per cent of the normal Portland cement. Two types of fly ash are commonly used in concrete: Class C and Class F. Class C are often high calcium fly ashes with carbon content less than 2%; whereas, Class F are generally low-calcium fly ashes with carbon contents less than 5% but sometimes as high as 10%.In this present study, class F fly ash is used.

2.2 ALKALINE LIQUIDS

Sodium hydroxide(NaOH) was acquired in the form of pellets which are used for commercial purpose and sodium silicate(Na_2SiO_3) is used in the form of gel.

2.3 COARSE AGGREGATES

Locally available 10mm and 20mm crushed aggregates are used as coarse aggregates.

2.4 FINE AGGREGATES

Locally available river sand is used as fine aggregate.

3. PREPARATION OF ACTIVATOR SOLUTION

In this project the compressive strength of geo-polymer concrete is examined for the mixes of varying molarities of Sodium hydroxide (16M, 18M, and 20M). The molecular weight of sodium hydroxide is 40. To prepare 16M i.e. 16 molar sodium hydroxide solution, 640g of sodium hydroxide flakes are weighed and they can be dissolved in distilled water to form 1 liter solution. For this, volumetric flask of 1 liter capacity is taken, sodium hydroxide flakes are added slowly to distilled water to prepare 1litre solution. The weights to be added to get required molarity are given in Table.1

Required molarity	Weight of sodium hydroxide in gm
16M	640
18M	720
20M	800

4.TRAIL MIX PROPORTION

As there is no proper mix design and codal provisions, a trial mix design is adopted and the density of geopolymer concrete is assumed as 2400Kg/m^3. The mix proportion is shown below

CONSTITUENTS	DENSITY (Kg/m^3)
FLYASH	380
FINE AGGREGATES	680.2
COARSE AGGREGATES	1263
NaOH	44.33
Na_2SiO_3	88.66
ADDITIONAL WATER	23.66

5. EXPERIMENTAL PROCEDURE

5.1 CASTING

The fly ash and aggregates were first mixed together for about 3 to 4 minutes and then the prepared activator solutions with required additional water are added to the mix. The mixing is continued for another 3-4 minutes.

The fresh concrete is immediately cast into the moulds in 3layers by doing proper compaction. Each layer should be compacted for 25 times with the tamping rod.

5.2 CURING

The concrete specimens are then placed in sunlight for curing and they were tested after the curing period is over.

FIG-Specimens Subjected To Sunlight Curing

6. TESTS CONDUCTED

- COMPRESSIVE STRENGTH
- SPLIT TENSILE STRENGTH
- FLEXURE STRENGTH

6.1 COMPRESSIVE STRENGTH TEST

The cubes are tested for their compressive strength as per IS specifications IS(519:1959).The obtained results are shown below

S.NO	MOLARITY	COMPRESSIVE STRENGTH (N/mm²)	
		7 DAYS	28 DAYS
1.	16M	**7.77**	**10.64**
2.	18M	**8.28**	**12.15**
3.	20M	**9.62**	**13.24**

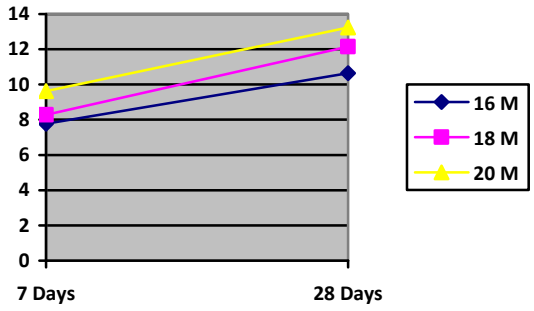
Table -1: COMPRESSIVE STRENGTH OF CONCRETE

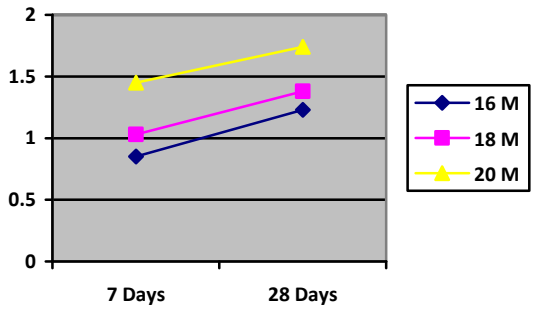
6.2 SPLIT TENSILE STRENGTH TEST

The concrete specimens are tested for their tensile strength on compression testing machine as per IS(5816:1999).The obtained results are shown below:

S.NO	MOLARITY	TENSILE STRENGTH (N/mm²)	
		7DAYS	28DAYS
1	16M	**0.85**	**1.23**
2	18M	**1.03**	**1.38**
3	20M	**1.45**	**1.74**

Table-2: SPLIT TENSILE STRENGTH OF CONCRETE



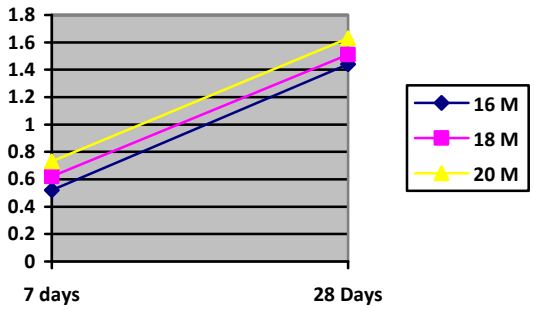


6.3 FLEXURE STRENGTH TEST

The flexure strength of the concrete specimens are tabulated below

S.NO	MOLARITY	FLEXURAL STRENGTH N/mm²	
		7 DAYS	28 DAYS
1	16M	**0.52**	**1.44**
2	18M	**0.62**	**1.51**
3	20M	**0.73**	**1.63**

Table-3: FLEXURAL STRENGTH OF CONCRETE



7. CONCLUSIONS

On the basis of the results obtained during the experimental investigations, following conclusions were drawn:

- The compressive strength, split tensile strength, flexure strength of geo polymer concrete specimens increases with increase in the molarity of sodium hydroxide solution.
- The mix with 18M solution gives higher strengths because increase in the molarity of sodium hydroxide increases the strength of concrete.
- The fresh fly ash based geo polymer concrete is easily handled up to 120 minutes without any sign of setting and without any degradation in the compressive strength.
- Increase in curing temperature gives more strength to concrete.
- As there is increase in curing time, strength of the specimens will improve.
- Sunlight curing is not preferable for geo polymer concrete as it requires high temperature.

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