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Experimental Study of M Sand Based Geopolymer Concrete in Construction Industry

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ABSTRACT

For the construction of any structure, Concrete is the main material. Concrete usage around the world is second only to water. The main ingredient to produce concrete is Portland cement. On the other side global warming and environmental pollution are the biggest menace to the human race on this planet today. The production of cement. means the production of pollution because of the emission of CO2 during its production. There are two different sources of CO2 emission during cement production. Combustion of fossil fuels to operate the rotary kiln is the largest source and other one is the chemical process of calcining limestone into lime in the cement kiln also produces CO2.In India about 2,069,738 thousands of metric tons of CO2 is emitted in the year of 2010. The cement industry contributes about 5% of total global carbon dioxide emissions. In this study we are designing M30 grade of concrete considering M-Sand as an replacement of Natural Sand, and preparing Geopolymer concrete using flyash waste product. In this study it is observed that utilization of M-sand and Sodium hydroxide solution with Supper-plasticizer (silicon-oxo-aluminate) enhances compressive strength and durability of concrete.

Keywords : Concrete, Geoploymer, Plasticizer, Compressive Strength, M-Sand, Experimental, Carbon Emission

I. INTRODUCTION

The wood and concrete is the most often used material by the community. Concrete is conventionally produced by using the Ordinary Portland cement (OPC) as the primary binder. The environmental issues associated with the production of OPC are well known. The amount of the carbon dioxide released during the manufacture of OPC due to the calcination of limestone and combustion of fossil fuel is in the order of one ton for every ton of OPC produced. In addition, the amount of energy required to produce OPC is only next to steel and aluminium.

On the other side, the abundance and availability of fly ash worldwide create opportunity to utilize this by-product of burning coal, as partial replacement or as performance enhancer for OPC. Fly ash is itself does not possess the binding properties, except for the high calcium or ASTM Class C fly ash. However, in the presence of water and in ambient temperature, fly ash reacts with the calcium hydroxide during the hydration process of OPC to form the calcium silicate hydrate (C-S-H) gel. This pozzolanic action happens when fly ash is added to OPC as a partial replacement or as an admixture.

Geopolymer concrete

To deliver ecological well-disposed concrete, we need to supplant the cement with some different binders which ought not to make any terrible impact on the earth. The utilization of modern side-effects as folios can lessen the issue. In this regard, the new innovation geo-polymer cement is a promising strategy. As far as diminishing an unnatural weather change, the geopolymer innovation could lessen the CO2 emanation to the environment brought about by cement and aggregates industries by about 80% (Davidovits, 1994c). And furthermore, the best possible use of modern industrial waste can diminish the problem of disposing the waste products into the atmosphere.

Fly Ash

Fly ash is fabricated by the consuming of coal in an electrostatic precipitator, a secondary product of industrial coal. The cementitious properties of fly ash were found in the late nineteenth century and it has been generally utilized in the manufacturing of cement for more than 100 years. In the United Kingdom, the fly ash is provided as a discrete element for concrete and is included at the concrete at the blender. It by and large replaces somewhere in the range of 20 and 80 percent of the ordinary Portland bond. Fly ash generally replaces Traditional Portland cement in the range between 20- 80 per cent.

Objectives of the study

1. To determine the compressive strength of geopolymer concrete.
2. To determine the flexural strength of geopolymer concrete.
3. To determine the young's modulus of geopolymer concrete.
4. To determinethe deflection behavior of beam.
5. Replacement of concrete with advance Geopolymer binder constituing of Flyash and alkaline liquid.
6. Fine aggregate is replaced with M-sand.

II. LITERATURE REVIEW

V. L. S. Srinvas et al (2019) [17] In this research paper, Sodium Hydroxide arrangement course of action on mechanical properties of Geopolymer concrete was fragmented around fluctuating the molarity of NaOH by ground granulated effect warmer slag based geopolymer concrete. The molarity of NaOH can be changed from 6M to 16M. In any case, NaOH and Na2SiO3 give quality by polymerization. All GPC mixes were set up for different molarities and soothed under incorporating reestablishing conditions since GGBS altogether influence the setting time and the quality headway of GPC when reestablished at encompassing temperature or in the prompt light. Geopolymer concrete samples were analyzed for compressive quality at different time intervals with functionality tests like L-box, V-channel, and droop stream. It was discovered that GGBS based Geopolymer concrete has extremely low utility, it is exceptionally durable and stiffened and it tends to be dealt with for 10-15 minutes simply after the blend starts setting. It was seen that greatest quality was cultivated with 16M molarity course of action. GGBS based geopolymer concrete provided premium quality at 10M, 12M molarity of NaOH marshalling.

Ahmed A. Alalikhan et al (2018) [2] In this research paper, the geopolymer concrete blend and alkaline concrete with reprocesses aggregate were utilized inside the compressive structural components be regarded by hollow steel columns having an equivalent square section. The designed columns were treated with and without grouted green concrete as a stiffer material. As a rule, the antacid concrete is delivered dependent on certain sub-atomic proportions that administer the quality of the concrete mix in addition to the role of aggregate ratio. Henceforth, two estimations of sub-atomic proportions were embraced here as factor parameters in the concrete mix. Both of the geopolymer concrete blends were contrasted against the traditional concrete mix as strengthening materials grouted inside the hollow steel columns.

The analytical results of specimen wit axial loads presented the use of geopolymer which was alkaline concrete along with recycled aggregate and various molecular ratios were able to intensify the strength of the steel columns when addressed under compressive loads.

Results prompted the conclusion that Failure load limit was raised for the strengthened columns with GPC to 62.8% for the 8M GPC blend while it was raised to 149% for the 14M GPC blend contrasted with the ordinary load limit of the empty steel columns. Utilizing 14M GPC with recycled aggregate blend displayed better improvement for the steel segments failure loads contrasted and the failure load upgrade utilizing NC created from the raw aggregate. Contrasted and the NC blends, GPC mix delivered better execution when utilizing to quality steel segments because of the better interconnection between GPC material and the body of a steel section. GPC materials could be reenacted in ANSYS as grouted materials inside hollow steel segments delivering hypothetical outcomes near the relating test results. For viable purposes, curing under room temperature simple, practical and sufficient GPC compressive strength which upgrades the exhibition of sections under axial loading.

Shaswat Kumar Das et al (2018)[12] This research paper presented the recent advances made in “Geopolymer Concrete” which presented its new properties, with new settling time and workability along with its hardened concrete properties as compressive strength and durability.

This research paper concluded that geopolymer cement gives the enormous potential to be utilized as a development material in future structures. Setting time, usefulness and solidness attributes of Geopolymer concrete demonstrated to be superior in comparison to OPC based cement. Till time certain restrictions should be defeated which will prompt a superior acknowledgement of geopolymer concrete among structure proprietors and directors, architects, specialists, administrative leaders, and the end-users.

To manufacture geopolymer concrete mix, the M-Sand is utilized as a fine aggregate and it was spotted from local vendors. It has following properties stated as below.

Table 1. Physical Properties of M-Sand

Property	M-Sand	Test method
Specific gravity	2.60	IS2386 (Part III) 1963
bulk relative density (KG/M^3)	1700	IS2386 (Part III) 1963
Absorption (%)	1.30	IS2386 (Part III) 1963
Moisture content (%)	Nill	IS2386 (Part III) 1963
Fine-particles less than 0.075mm (%)	14	IS2386 (Part I) 1963
Sieve analysis	Zone III	IS 383-1970

Preparation of alkaline liquids

(Molarity = moles of solute/litre of solution)

The compressive strength of geopolymer cement was analyzed for the blends of differing molarities of Sodium hydroxide (8M, 10M, and 12M). The atomic load of sodium hydroxide is 40. In order to prepare 8M, it constitutes 8 molar sodium hydroxide solution, 320g of sodium hydroxide chips are gauged and they can be broken up in refined water to frame 1-litre arrangement. For this, a volumetric container of 1-litre limit was used, sodium hydroxide chips are added gradually to refined water so as to prepare 1liter solution. The quantity to be added to get required molarity are given in Table.4.2.

Table 1 Weights of NaOH chips

Required molarity	Weight in g. of sodium hydroxide chips
8M	320
10M	400
12M	480

The mixture of sodium silicate arrangement and the sodium hydroxide arrangement were blended at any rate one day before use to set up the soluble fluid. Upon the arrival of the casting of all the specimen, the soluble fluid was blended in with the superplasticizer and the additional water (assuming any) to set up the fluid segment of the blend.

Figure 1 Sodium hydroxide in pellets form

Figure 2 Sodium hydroxide in flakes form

Manufacturing and casting of geo-polymer concrete

The traditional technique utilized in the preparation of typical cement is embraced to prepare geopolymer concrete. The procedure starts with, the M-Sand, coarse aggregate and Flyash blended in a dry condition for 3-4 minutes and later the basic arrangement which is a mix of Sodium hydroxide arrangement and Sodium silicate arrangement with super-plasticizer was added to the dry blend. The blending was done for almost 6-8 minutes for the appropriate bonding of the considerable number of materials. After the blending, the shapes were cast with the blends GP1 to GP3 by giving legitimate compaction. The extents of the Blocks utilized were in size 150mm X 150mm X 150mm.

Figure 3. Adding sodium silicate solution to dry mix

Figure 4 Fresh geo-polymer concrete

Figure 5. Casting of geo-polymer concrete cube

Curing of geo-polymer concrete

For the restoring of geo-polymer Blocks of concrete, the Blocks are placed in direct daylight. For the daylight curing, the moulding of Blocks was done following 1 day of casting and later they are placed in immediate daylight for 7 days.

III.EXPERIMENTAL RESULTS

) **Compressive Strength**

Table 3. Compressive strength

Name of the mix	**Compressive in N/mm² of specimens cured by**		
	7 days	14 days	28 days
CC	18.6	23.4	274
GP1	19.23	23.6	27.5
GP2	20.23	24.2	28.2
GP3	21	25.2	29.2

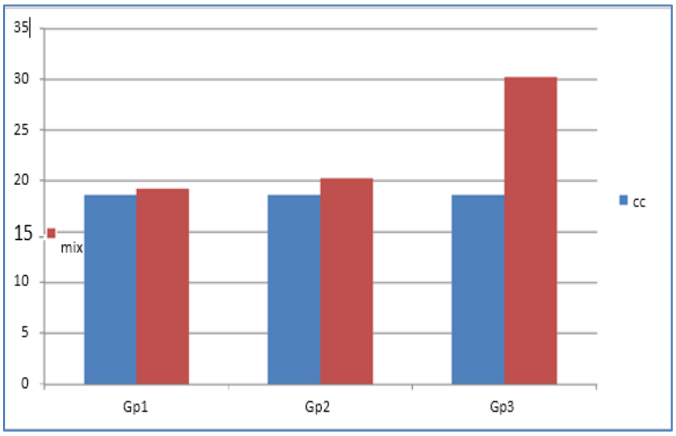

Figure 6 Compressive strength of specimens at the age of 7

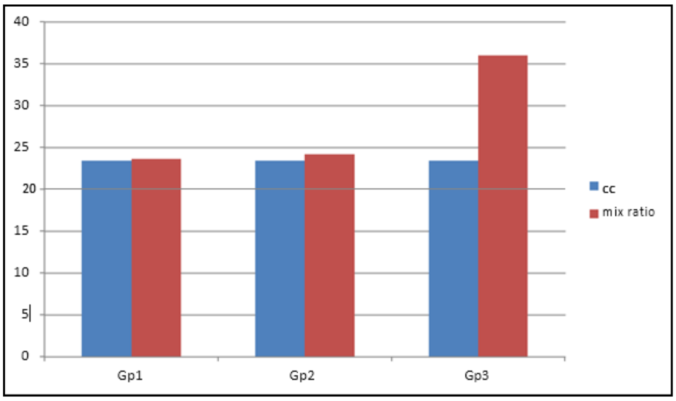

Figure 7 Compressive strength of specimens at the age of 14 days

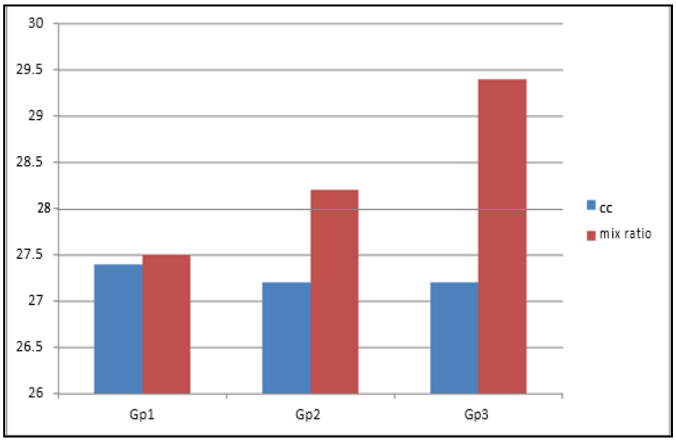

Figure 8 Compressive strength of specimens at the age of 28 days

The chart above demonstrated that the compressive strength increments the strength by 40% in the span of 7days.The other one shows the expansion of the strength by 60% it mirrors that by increment as far as possible the strength of the blend can be expanded. The last one shows the expansion of solidarity by 75%.

Split Tensile Test

Table 4 Split Tensile Test

Name of the mix	**Split tensile in N/mm^2 of specimens cured by**		
	7 days	14 days	28 days
CC	1.7	2.25	2.87
GP1	1.9	2.34	2.74
GP2	2.2	2.47	2.85
GP3	2.3	2.53	2.96

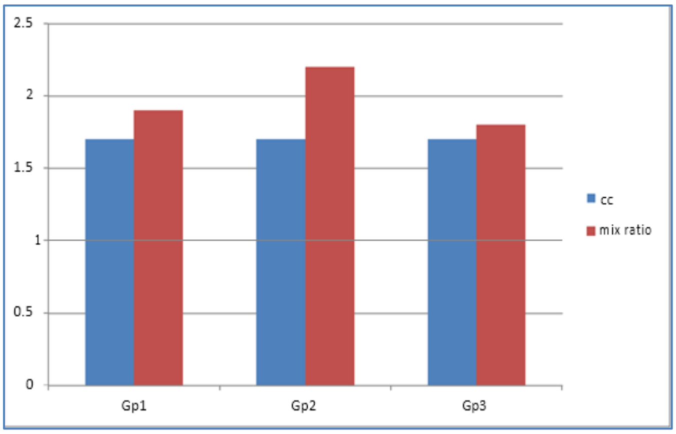

Figure 9 Split Tensile Test of specimens at the age of 7 days

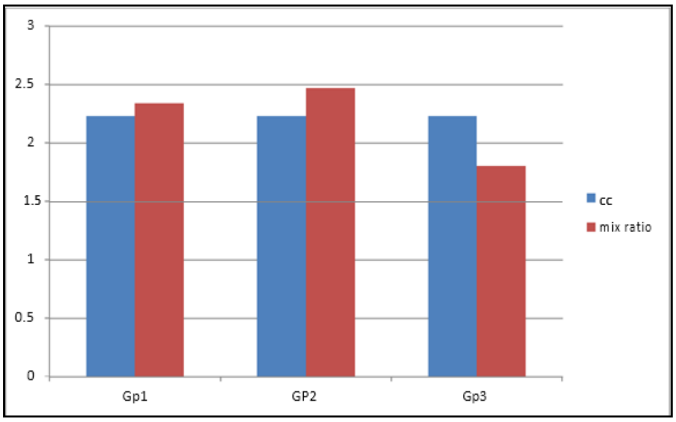

Figure 10 Split Tensile Test of specimens at the age of 14 days

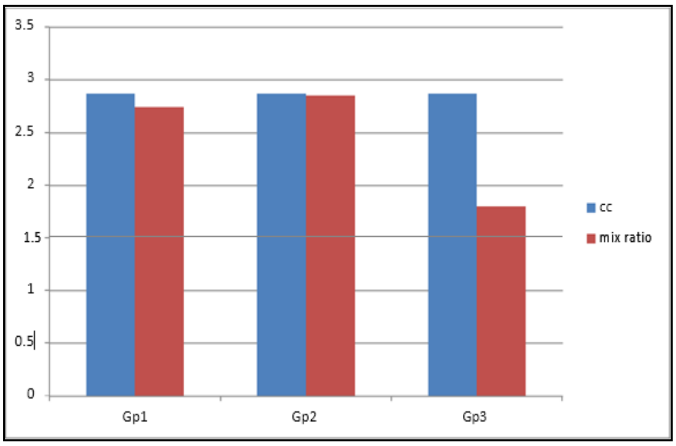

Figure 11 Split Tensile Test of specimens at the age of 28 days

IV.CONCLUSION

1. Higher concentration (in terms of molar) of sodium hydroxide solution results in higher compressive strength of fly ash & M-Sand based geo-polymer concrete.
2. Longer curing time, in the range of 4 to 96 hours (4 days), produces higher compressive strength of fly ash &M-Sand based geo-polymer concrete. However, the increase in strength beyond 24 hours is not significant.
3. 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.
4. The mix GP3 gives higher compressive strength, as it has high molarity of NaOH
5. Results stated that the compressive strength is increased with the increase in the molarity of the sodium hydroxide
6. After three days of curing the increase the compressive strength is not sufficient
7. The geo-polymer concrete shall be effectively used for the beam column junction of the reinforced concrete structure
8. Geo-polymer concrete shall also be used in the Infrastructure works.
9. In addition to that fly ash shall be effectively used and hence no landfills are required to dump the fly ash

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