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Behaviour of Fly Ash based Geopolymer Concrete using Nano-Material

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Abstract: ***In the Construction sector the need of cement is expanding step by step for fulfilling the need of improvement of foundation developments. The creation of Ordinary Portland concrete emanates the enormous amount of CO2 into the climate. Hence, it is basic to discover choices to make the solid eco - neighborly. Low calcium fly ash based geopolymer cement is a substitute choice for bond based cement. It is an inorganic alumina-silicate compound, blended from fly ash remains. The exploratory work on Geopolymer cement is to assess the impact of different parameters influencing its compressive quality and usefulness of cement so as to improve its general execution was extended. Basic arrangement utilized for present examination is mix of sodium hydroxide and sodium silicate. By applying the Nano Technology, expansion of Nano silica is to improve the quality of cement. The essential distinction between geo-polymer cement and Portland bond cement is the binding property. The silicon and aluminum oxides in the low-calcium fly slag responds with the soluble fluid to frame the geo-polymer concrete that ties the free coarse aggregate, fine aggregate, and other un-responded materials together to shape the geo-polymer concrete. As on account of Portland bond concrete, the coarse and fine totals possess around 75 to 80% of the mass of geo-polymer concrete. The impact of totals, for example, reviewing, precision and quality, are viewed as equivalent to on account of Portland bond concrete. Along these lines, this segment of geo-polymer solid blends can be structured utilizing the instruments as of now accessible bond for Portland concrete. The principle goal of this exploration work is to break down the carbon dioxide free cementitious material with its quality, functionality properties and their impacts on Geopolymer concrete for maintainable improvement.***

Key words*: Geopolymer concrete, Nano silica, Fly ash, Strength, workability.*

I. INTRODUCTION

Geo polymer concrete is the combination of Fly ash, alkaline solution and aggregates. Alkaline solution is nothing but mixture of sodium hydroxide and sodium silicates[1,18,19,20]. In the construction field the requirement of cement is increasing day by day. At the same time production of cement will also releases CO_2 which is very harmful to the environment[1,5,7,8,9,11]. So there is a need for replace the cement with an alternative material. For that we have fly ash based geopolymer concrete.

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Geopolymers are alkali activated alumina silicate binders formed by the reaction of silica and alumina with alkali solutions at a relatively low elevated temperature in the environment of about 60-80°C [1-14].It is essentially concrete without cement i.e. cement free concrete. Nano technology is having an important role in construction field. Supplementary cementitious materials has been a good choice for replacing cement and adding nanoparticles improves the performance of concrete.[15,16]. Low calcium fly ash based materials were used in Geopolymer concrete with 2% titanium di-oxide indicates apparent enhances its performance. This paper demonstrates the compressive quality consequences of geopolymer concrete with titanium di-oxide at 7 days and 28 days.

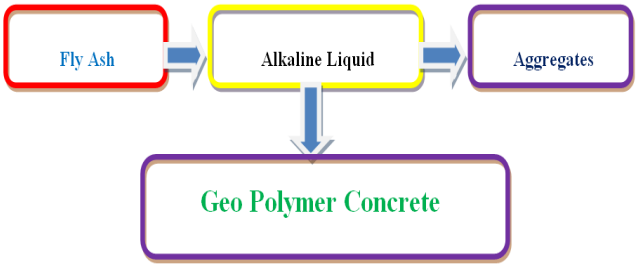

Figure 1 Process of Geopolymer concrete

Table 1 Properties of fly ash (from K.T.P.S)

Properties	Units	Results
Fineness	Sq/kg	324
Bulk density	2mm	<10mm
Silica as Sio_2	%	62.74
Aluminium as al_2o_3	%	12.90
Iron as Fe_2o_3	%	2.24
Iron as Feo	%	0.19
Calcium as Cao	%	6.75
Magnesium as Mgo	%	1.28
Sodium as Na_2o	%	0.96
Potasium as $_{K20}$	%	0.20
Sulphate as SO_4	%	2.01
Loss on Ignition	%	2.20
Titanium as TIO_2	%	0.77
P^H(5% solution)	%	6.85

II. MATERIALS USED

The materials used in the manufacture of geopolymer concrete was shown below.

2.1 Sodium Hydroxide

Physically Sodium Hydroxide is looking like soda which is practically white in shading. In market it is accessible with various virtue content.

Cost of Sodium Hydroxide is additionally differing with the immaculateness of the substance. Since geo-polymer cement is homogeneous in nature and the material is likewise homogeneous and its fundamental work is to enact the sodium silicate, so it is prescribed to utilize a virtue level of 94% to 96% i.e. a minimal cost sodium hydroxide.

Table 2 Chemical Properties of Sodium hydroxide

SNO	Chemical name	Percentages
1	Assay	97%
2	Carbonate(Na_2CO_3)	2%
3	Chloride(Cl)	0.01%
4	Sulphate(so2)	0.05%
5	Lead(pb)	0.001%
6	Iron(Fe)	0.001%
7	Potassium(K)	0.01%
8	Zinc(Zn)	0.02%

2.2 Sodium Silicate

Physically it would appear that a gel like fluid, which is otherwise called water glass or fluid glass. It is the most significant material in the soluble base arrangement. On account of various level of Na2O, the quality of geo-polymer cement fluctuates. With 8% Na2O in sodium silicate gives great outcome for example just about 45 MPa with a restoring temperature of 45^0C.

Table 3 Properties of Sodium silicate

SNO	Chemical formula	Percentages
1	Na_2O	15.9%
2	SiO_2	31.4%
3	H_2O	52.7%
4	Appearance	Liquid(gel)
5	Boiling point	102 ^{0} c
6	Molecular weight	122.06g/mol
7		1.25

2.3 Alkaline liquid

This quantitative relation was fastened at a pair of.5 for many of the mixtures as a result of the water glass answer is significantly cheaper than the hydrated oxide solution.

- Molarities of hydrated oxide (NaOH) answer within the vary of 8M to 16M. we tend to are taking 8M for this experiment.
- Quantitative relation of matter answer ash, by mass, within the vary of zero.3 and 0.4.
- Coarse and fine combination of roughly fifty to sixty five of the whole mixture by mass.

2.4 Nano Silica

It is taking part in one among the foremost vital roles to extend the compressive strength of Geopolymer concrete. It sets early and therefore usually needs admixtures throughout combine style. Nano silicon dioxide mixed cement will generate nano crystals once association.

2.3.1 Properties of Nano silica:

Density-2.4g/cm³
Specific gravity-2.20-2.40
Mean particle size-15.0nm,
Chemical composition of Nano Silica : Silicon-46.83% Oxygen-53.33

III. METHODOLOGY

First step for this experiment is preparation of alkaline content and taking spare magnitude relation of ash, Aggregates, and Water cement magnitude relation. to work out the compressive strength of geopolymer concrete for various mixes with Nano material and while not nano material addition, one hundred fifty millimetre × 150 mm × 150 mm size specimens were casted and cured. All the specimens were tested for seven days and twenty eight days once casting to work out the compressive strength at completely different ages.

Figure 2 Cubes Mixing & Testing

IV. RESULTS AND DISCUSSION

4.1 Workability

The workably of freshly concrete, compaction issue check is allotted. This check works on the principal of deciding the degree of compaction achieved by standard quantity of labor done by permitting the concrete to fall flat a typical height the degree of compaction issue is that the magnitude relation of weight partly compacted concrete to the wt of totally compacted concrete.

Compaction issue =Wt of partly compacted concrete / Wt of totally compacted concrete

The compaction for given concrete combine is found to be = 0.89

4.2 Compressive strength

Compressive strength is one amongst the vital properties of concrete. Concrete cubes of size 150mmx150mmx150mm were casted with and while not of ash. when twenty four hours, the specimens were demoulded and subjected to water solidifying. when twenty eight days of solidifying specimens were taken and allowed to dry and tested in compressive strength testing machine.

Table 4 Comparison of Compressive strength of 7days,14 days &28 days conventional concrete &GPC with 70% and 90% FA replacement

Days	Conventional concrete (N/mm^2)	GPC(N/mm^2) with 70% fly ash replacement	GPC(N/mm^2) with 90% fly ash.
7	22.15	24.53	20.40
14	26.62	27.12	24.32
28	31.62	36.37	29.20

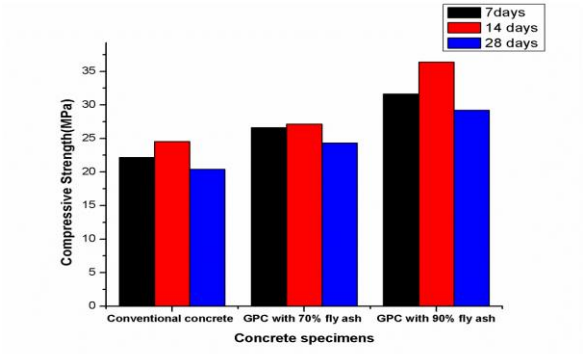

Figure 3 Bar chart shows Comparison of Compressive strength for Conventional concrete & GPC with 70% and 90% FA replacement

Table 5 Comparison of Compressive strength of GPC with 70% & 90% FA replacement & GPC with 70% and 90% FA replacement with Nano silica

Days	GPC(N/mm^2) with 70% fly ash replacement	GPC (N/mm^2) with 90% fly ash replacement	GPC (N/mm^2) with Nano silica with 70% FA	GPC(N/mm^2) with Nano silica with 90%FA
7	24.53	20.40	26.20	21.70
14	27.12	24.32	32.15	25.12
28	36.37	29.20	41.21	30.32

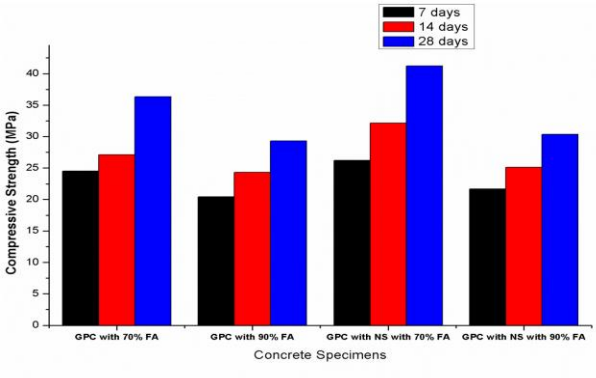

Figure 4 Bar chart shows Comparison of Compressive strength for GPC with 70% and 90% FA replacement & GPC with 70% and 90% FA replacement with Nanosilica

V. CONCLUSION

- Compressive strength properties of the Geo-polymer concrete with 70% fly ash replacement have been increased by an average of 15.2%, than Conventional concrete.
- Compressive strength properties of the Geo-polymer concrete with 90% fly ash replacement have been decreased than the control mix.
- Compressive strength properties of the Geo-polymer concrete with Nano silica with 70% fly ash replacement for 28 days have been increased by an average of 27%, than the control mix.
- Compressive strength properties of the Geo-polymer concrete with Nano silica with 90% fly ash replacement has been decreased than the conventional concrete.
- Geo-polymer concrete using Nano silica has an high compressive strength and is suitable for structural applications.
- By using Geo-polymer concrete the consumption of cement is reduced, so that the CO_2 released to the atmosphere is reduced and greenhouse effect is reduced.

REFERENCES

1. Davidovits, J. Properties of geopolymer cements. In: Proceedings of First International Conference on Alkaline Cements and Concretes, vol. 1. SRIBM, Kiev, Ukraine, pp. 131—149,1994.
2. SudiptaNaskar, Arun Kumar Chakraborty Effect of nano materials in geopolymer concrete, Perspectives in Science (2016) 8, 273—275.
3. Pal, S., Mandal, S., Different thermal activation effect on fly ash based geopolymer concrete. Indian Concr. Inst. J. 12, 23—25. 2011.
4. MM Vijayalakshmi, K.chiranjeevi.Review on Performance of Fly Ash based Geopolymer Concrete Using Nano Technology, Volume 2, Issue 6, June – 2017
5. Shaikh, F.U.A., Supit, S.W.M., Sarker, P.K., 2014. A study on the effect of nano silica on compressive strength of high volume fly ash mortars and concretes. Mater. Des. 60, 433—442.
6. Hardijito, D.Wallah, S.E., Sumajouw, D.M.J., Rangan, B.V., 2004. On the development of fly ash based geopolymer concrete. ACI Mater. J. 101 (6), 467—472
7. Rangan, B.V. 2008 Low-Calcium Fly Ash-Based Geopolymer Concrete Chapter 26, "Concrete Construction Engineering Handbook" Second Edition, Editor-in-Chief: E.G. Nawy, CRC Press, New York, pp. 26.1-26.20
8. SofiYasir et.al, Study of Properties of Fly Ash Based Geopolymer Concrete "International Journal of Engineering Research", Vol. 3, Issue 1, ISSN: 2321-7758, January 29, 2015.
9. J.Y. Shih, T.P. Chang, T.C. Hsiao, Effect of nano silica on characterization of Portland cement composite, Cement Concrete Research, 36, 697-706, 2006
10. N.L.N. Kiran Kumar,K.V.S. Gopala Krishna Sastry Effects Of Nano Sili Strengths Of Geo polymer Concrete Cured At Ambient Temperature,Volume 8, Issue 8, August 2017.
11. T. Bakharev, Geopolymeric materials prepared using Class F fly ash and elevated temperature curing, Cement and Concrete Research, Volume 35, 2005, pp. 1224–1232.
12. FadhilNuruddin, M., Samuel Demie, Fareed Ahmed, M. and NasirShafiq, Effect of superplasticizer and NaOH molarity on workability, compressive strength and microstructure properties of self-compacting Geopolymer concrete, International Journal of Environmental, Chemical, Ecological, Geological and Geophysical Engineering, 5(3), 2011, 187-194
13. Rangan, B.V., Geo polymer concrete for environmental protection, The Indian Concrete Journal, 88(4), 2014, 41-48, 50-59.
14. T.R.Praveen Kumar, Sudheesh.C, SasiKumar.S, Strength Charecteristics of Saw Dust Ash Based Geopolymer Concrete, International journal of chemtech ,Vol.8, No.2, pp 738-745, 2015.
15. T.R.Praveenkumar, M.M.Vijayalakshmi, Effect of Nano particles on the properties of concrete, International journal of chemtech, Vol.8, No.7, pp 50-55, 2015

16. T.R. Praveenkumar , M.M. Vijayalakshmi , M.S. Meddah, Strengths and durability performances of blended cement concrete with TiO_2 nanoparticles and rice husk ash, Construction and Building Materials 217 (2019) 343–351