International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Experimental Study of Strength of Geo Polymer Concrete by using Super Plasticizer

Akash Parwar [a], Dr. J. N. Vyas[b], Hussain Hararwala [c]

[a] *M. Tech student Department of civil Engineering MITM Ujjain India*
[b] *Prof civil engineering department & Director MITM Ujjain India*
[c] *Prof civil Engineering department MITM Ujjain India*

A B S T R A C T

In place of cement, geopolymer concrete uses an alternative substance such as fly ash as a binding ingredient. This fly ash combines with alkaline solutions (for example, NaOH) and Sodium Silicate (Na2SiO3) to generate a gel that binds the fine and coarse particles. Because geopolymer concrete is a new sector, the Bureau of Indian Standards has yet to develop criteria. An attempt has been made to determine the best mix for Geopolymer concrete. Concrete cubes 150 x 150 x 150 mm in size were made and hardened in an oven for 24 hours. The compressive strength was determined after 7 and 28 days.The outcomes are contrasted. The best combination is Fly ash: Fine aggregate: coarse aggregate (1:1.5:3.3) with a solution to fly ash ratio of 0.35 (NaOH & Na2SiO3 mixed). The effects of adding PAC 2% by mass of fly ash on compressive strength, flexural strength, and split tensile strength were investigated further. The Geo-polymer concrete mix achieved high and early strength, but strength began to decline in the presence of PAC.

Keywords:

CA: Course aggregate

FA: Fine aggregate

PAC: Poly aluminum Chloride

GC- Geo polymer concrete

S-Sand

NaOH- Sodium hydroxide

1. Introduction

Concrete, a common composition of cement, sand, crushed rock, and water, is currently the primary construction material of choice. 600 billion tons of mortar were produced in the United States alone from 64 billion tons of Portland cement, which is five times the weight of steel. Mortar usage to steel consumption ratios exceed ten to one in a few of nations. The estimated annual global use of mortar is 12 billion metric tons. The only substance that humans use in such large quantities is water.Despite the fact that cement production has a significant influence on the environment, the biggest one is global warming because of CO_2 emissions during cement manufacture. About 4% of the world's greenhouse gas emissions and 6% of the CO_2 emissions are attributed to cement manufacture. Given that burning limestone is responsible for 52% of the CO_2 released during the production of cement, mixing clinker with auxiliary materials is considered to be a very effective method of lowering CO_2 emissions.Industrial waste is frequently used as a blending element in the manufacturing of cement. Since recycling industrial wastes reduces CO_2 emissions from cement manufacture while also having positive technological, economic, and environmental effects. Although the performance of mortar is improved and is anticipated to be more cost-effective when waste and byproducts are used in its production. Due to their pozzolanic activity, fly ash, blast furnace slag, and silica fume are typically used as industrial wastes in the manufacturing of cement and mortar. Other inert waste products and byproducts are utilized in mortar and cement manufacturing in addition to pozzolanic materials as inert filler ingredients. Among these, fly ash-based Geopolymer Cement is suggested by a number of researchers for use in the manufacture of mortar as an alternative to cement. Numerous studies support their beneficial impacts and advantages.

2. Thesis Objective

1. To create geopolymer concrete from fly ash as a raw material.
2. To investigate the influence of superplasticizer concentration on the strength and durability qualities of geopolymer concrete based on fly ash.

3. Creation of thesis

Stage-I

In stage-I:-In stage-I, the cement is completely replaced by fly ash in four batches of varying proportions, including ordinary concrete mix. At 28 days, cubes, beams, and cylinders are cast to determine the compressive and flexural strengths, split tensile strength, and stress strain curve test of concrete.

Table 1: Material composition of GC

Batch Mix	fly ash(kg/m3)	Sand(kg/m3))	Coarse Aggregates (kg/m3)	Sodium meta silicate solution(kg/m3)	Sodium hydroxide solution(10M) (kg/m3)
1	408	591.60	1326.00	103	41
2	408	632.40	1366.80	103	41
3	408	673.20	1407.60	103	41
4	408	714.00	1448.40	103	41

Stage-II

Super-plasticizer is added to Mix III at a rate of 2% of the quantity of fly-ash, and this 2% is then blended in the proportions of 20%, 40%, 60%, 80%, and 100%. At 28 days, cubes, beams, and cylinders are cast to determine the compressive and flexural strengths, split tensile strength, and stress strain curve test of concrete.

4. Ingredients of Geo-polymer Concrete

4.1 Fly ash

Fly ash is the finely divided residue that arises from the combustion of pulverized coal and is carried away by exhaust gases from the combustion chamber.

4.2 Water

The most vital and least expensive component of concrete is water. A portion of the mixing water is used in the hydration of cement to form the binding matrix, which holds the inert aggregates suspended until the matrix hardens. The leftover water acts as a lubricant between the coarse and fine particles, making concrete workable, that is, easily placed and compactable in forms.

4.3 Aggregates

The majority of a concrete mixture is composed of fine and coarse particles. Sand, natural gravel, and crushed stone are commonly utilized for this purpose.

4.4 Sodium Hydroxide

Sodium NaOH (Sodium Hydroxide) is a base that is also known as lye or caustic soda. It collects moisture from the air and, when combined with carbon dioxide, produces sodium carbonate.

4.5 Sodium meta silicate

The usual term for compounds with the formula $Na_2(SiO_2)_nO$ is sodium silicate. The sodium meta-silicate, Na_2SiO_3, is a well-known member of this class. These materials, often known as water-glass or liquid glass, are accessible in both aqueous solution and solid form.

4. 6 Poly aluminum chloride

Polyaluminium chloride (PAC) is available in liquid and powder forms. The substance is utilized in deodorants and antiperspirants, as flocculants in water purification, drinking / potable water treatment, wastewater treatment, and paper sizing.

5. A concrete's hardened properties

5.1 Strength

5.1.1Compressive strength

Concrete has a high compressive strength but a much lower tensile strength. On testing equipment, compressive strength is often determined using cubes with 150mm sides and cylinders with 150mm dia and 300mm height test specimens.

Procedure:-

1) The cubes are removed from the water after 28 days.
2) Tested in the compression testing machine. When a cube is placed in a compression testing machine, its weight carrying capacity is examined.
3) A load is applied to the specimens until the specimen does not fail.
4) Record the maximum load and any unusual alternatives within the type of failure.

Fig.1 Compressive strength test

5.1.2Tensile strength

Because of the challenges in conducting the direct tension test, an indirect approach such as the splitting test is used to determine the tensile strength of concrete, also known as the splitting tensile strength of concrete. The splitting test is applicable to cylinders and prisms. Concrete's splitting tensile strength is around 11-16% of its compressive strength.

If the tensile strength of concrete is the most important and necessary property. The tensile strength of concrete splits is determined by casting a concrete cylinder 150mm×300mm in size.

As a result of the concrete's low tension, it cannot withstand direct tension. When fractures form in concrete, they are subjected to tensile stresses. As a result, thestrength must be examined.

6 Mix Design

Using earlier investigations on Geopolymer concrete (Van Chanh Bui; Wallah&Rangan) as a guide, we employed a fly ash: The fine aggregate: coarse aggregate ratio is 1.35:3.17, with a solution (NaOH& Na_2SiO_3mixed) to fly ash ratio of 0.35. Four trail mixes were created by varying the amounts of fine and coarse particles. Mix I is 1:1.45: 3.25; Mix II is 1:1.55: 3.25; Trial III is 1:1.65: 3.45; and Mix IV is 1:1.75: 3.55. The solution to fly ash ratio was kept constant across all four experimental mixtures at 0.35. The precise amounts for $1m^3$ are shown in the table below.

Materials	**Mix I(Kg/m^3)**	**Mix II(Kg/m^3)**	**Mix III(Kg/m^3)**	**Mix IV(Kg/m^3)**
Flyash	408	408	408	408
Sand	591.60	632.40	673.20	714.00
Coarse Aggregate	1326	1366.80	1407.60	1448.40
Sodium meta silicate solution	103	103	103	103
Sodium Hydroxide Solution (10M)	41	41	41	41

Table 2:Material proposition of different Mix

7. Mixing of Geo-polymer concrete

The fly ash, fine aggregates, and coarse aggregates were manually mixed in a container before the alkaline solution was added to produce the geopolymer concrete. The geopolymer concrete was put in three layers in 150 mm cube moulds, and each layer was compacted with 25 blows using a 25mm tamping rod.

Volume of cube = $.15\times.15\times.15\ m^3$

$= 3.375\times10^{-5}\ m^3$

Volume of 3 cubes = $3\times3.375\times10^{-5}\ m^3$

$= \mathbf{0.010125m^3}$

Materials	Mix I(Kg)	Mix II(Kg)	Mix III (Kg)	Mix IV(Kg)
Flyash	4.131	4.131	4.131	4.131
Sand	5.98	6.40	6.81	7.22
Coarse Aggregate	13.42	13.83	14.25	14.66
Sodium meta silicate solution	1.04	1.04	1.04	1.04
Sodium Hydroxide Solution (10M)	0.41	0.41	0.41	0.41

Table.3 Quantity of materials consumed in preparation of specimens of each group.

8. Compressive strength test

This test was carried out to evaluate the performance of concrete made by each mix.

Cubes with dimensions of 150mm×150mm×150mm were produced for compressive strength. To ensure that the results were repeatable, three cubes of each combination were made and evaluated in a compression testing machine for 7 and 28 days strength.

Mix	Samples code	Compressive strength in N/mm^2		average strength in 28 days in N/mm^2
		7 days	28 days	
I	S1	30.9	36.23	38.61
	S2	35.71	38.32	
	S3	36.64	41.30	
II	S1	42.64	46.25	46.62
	S2	41.74	47.24	
	S3	39.83	46.38	
III	S1	46.14	50.69	51.37
	S2	47.32	52.15	
	S3	46.84	51.28	
IV	S1	40.56	47.44	45.74
	S2	40.71	42.54	
	S3	39.05	47.25	

Table 4 Compressive strength in N/mm^2

Materials	Mix I	Mix II	Mix III	Mix IV	Mix V	Mix VI
Flyash	29.89	29.89	29.89	29.89	29.89	29.89
Sand	49.32	49.32	49.32	49.32	49.32	49.32
Coarse Aggregate	103.13	103.13	103.13	103.13	103.13	103.13
Sodium meta silicate solution	7.54	7.54	7.54	7.54	7.54	7.54
Sodium Hydroxide Solution (10M)	3.00	3.00	3.00	3.00	3.00	3.00
Poly Aluminium chloride	-	0.59	0.47	0.35	0.23	0.11

Table 5.Material composition of final mix

Strengths achieved on adding PAC with standard mix.						
Mix	**% of addition of PAC**	**Samples code**	**Compressive strength in N/mm2**		**Flexural strength in N/mm2**	**Split tensile strength in N/mm2**
			7 days	**28 days**		
Mix I	**0%**	S1	46	50.8	4.98	5.37
		S2	47.5	52.7	4.84	5.56
		S3	47	51.6	4.70	5.46
Mix II	**20**	S1	39.6	43.9	4.37	4.51
		S2	40.4	44.2	4.52	4.71
		S3	38.6	43.5	4.49	4.56
Mix III	**40%**	S1	40.8	44.6	4.54	4.84
		S2	40.6	45.3	4.57	4.96
		S3	41.2	46	4.59	4.92
Mix IV	**60%**	S1	41.5	46.6	4.63	5.14
		S2	42.6	47.8	4.64	5.18
		S3	42.2	47.2	4.67	5.28
Mix V	**80%**	S1	43.6	48.5	4.53	5.27
		S2	42.5	47.5	4.58	5.16
		S3	43.6	48.10	4.70	5.20
Mix VI	**100%**	S1	44.3	49.90	4.58	5.38
		S2	44.9	49.70	4.54	5.36
		S3	45.3	50.2	5.00	5.33

Table 6 : Indicates the values of strengths achieved when PAC is added to each mix

9. RESULT ANALYSIS

The entire experimental program revealed that:

- In terms of strength, the Geo-polymer concrete performed admirably.
- The Geo-polymer concrete was a practical mixture.
- The Geo-polymer concrete mix achieved a high early strength.
- The increase in fine and coarse aggregate percentages enhanced compressive strength to the optimal level. This might be because of the strong connection between the aggregates and the alkaline solution.
- The compressive strength was discovered to be lowered above the optimal combination. This might be attributed to an increase in the amount of voids between the aggregates.

10. Conclusion

1. The physical and chemical parameters of class F fly ash were determined to be appropriate for the planned purpose.
2. There is no unwanted concentration of any of the mineral elements in fly ash.
3. Geo-polymer concrete has a higher workability than cement concrete.
4. Geopolymer concrete based on fly ash has high compressive strength and is appropriate for structural applications.
5. Geopolymer concrete is particularly adapted to the production of precast concrete products.
6. When PAC was added to the mix, the compressive strength of cubes, flexural strength of beams, and splitting tensile strength of cylinders were all reduced.
7. Geopolymer concrete manufacture need highly specialized staff.
8. It will assist to improve environmental concerns by preventing the indiscriminate dumping of enormous amounts of garbage created by companies and reducing CO_2 emissions.

9. Because there is no stated process for producing Geopolymer Concrete, the establishment of a code for Geopolymer Concrete is required.

Reference:

1. S. V. Joshi and M. S. Kadu“Role of Alkaline Activator in Development of Eco-friendly Fly Ash Based Geo Polymer Mortar”International Journal of Environmental Science and Development, Vol. 3, No. 5, October 2012
2. P.Vignesh, A.R.Krishnaraja, N.Nandhini“Study on Mechanical properties of Geo Polymer Mortar Using M-Sand and Glass Fibers”Second National Conference on Trends in Automotive Parts Systems and Applications (TAPSA-2014)
3. B. Rajini, A.V. NarasimhaRao“Mechanical Properties of Geopolymer
4. Mortar with Fly Ash and GGBS as Source Materials”International Journal of Innovative Research in Science,Engineering and Technology Vol. 3, Issue 9, September 2014
5. 11Y.M. Liew, H. Kamarudin, A.M. Mustafa Al Bakri, M. Luqman, I. KhairulNizar& C.Y. Heah“Investigating The Possibility Of Utilization Of Kaolin And The Potential Of Metakaolin To Produce Green Cement For Construction Purposes – A Review”Australian Journal of Basic and Applied Sciences, 5(9): 441-449, 2011 ISSN 1991-8178
6. Anuar K.A, RidzuanA.R.M,Ismail S. “ Strength Characteristics of Geopolymer Mortar Containing Recycled MortarAggregate”International Journal of Civil & Environmental Engineering IJCEE-IJENS Vol: 11 No: 01
7. ChiragGarg&Aakash Jain “green mortar: efficient & eco-friendly construction materials” International Journal of Research in Engineering & Technology (IMPACT: IJRET) ISSN(E): 2321-8843; ISSN(P): 2347-4599 Vol. 2, Issue 2, Feb 2014, 259-264
8. D Hardjito S E Wallah, D M J Sumajouw, B.V. Rangan“introducing fly ash-based geopolymermortar:manufacture and engineering properties” 30th Conference on Our World In Mortar& Structures: 23 - 24 August 2005,Singapore
9. Nguyen Van Chanh,Bui Dang Trung, Dang Van Tuan “Recent Research Geopolymer Mortar”The 3rd ACF International Conference-ACF/VCA 2008
10. AbhijeetBaikerikar“ A Review on Green Mortar” JETIR (ISSN-2349-5162) Nov 2014 (Volume 1 Issue 6)
11. Raijiwala D.B. Patil H. S. “Geopolymer Mortar: A Mortar Of Next Decade” Journal of Engineering Research and Studies E-ISSN 0976-7916
12. Chandan Kumar, Krishna Murari, C.R.Sharma“Strength Characteristics of Low Calcium Fly Ash Based Geopolymer Mortar.” IOSR Journal of Engineering (IOSRJEN) www.iosrjen.org ISSN (e): 2250-3021, ISSN (p): 2278-8719 Vol. 04, Issue 05 (May. 2014), |
13. S. E. Wallah and B. V. Rangan“low-calcium fly ash-based geopolymermortar: long-term properties.