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PERFORMANCE OF GEOPOLYMER CONCRETE WITH COMBINED USE OF SODIUM HYDROXIDE & POTASSIUM HYDROXIDE

[1]ELURI VINAY, [2]DR. M. POTHARAJU, [3]ANUSURI UMA MAHESWARI
[1,]Assistant Professor, [2]Professor, [3]Assistant Professor
[1]Department of Civil Engineering
[1,3]Chaitanya Engineering College, Andhra Pradesh, India
[2]GITAM, Andhra Pradesh, India

Abstract: Geopolymer concrete has the potential to reduce the carbon emission which in result lead to a sustainable development and growth of the concrete industry. This technology can save up to 80% of CO_2 emissions caused by the Construction Industry. In this study an attempt is made to find the Compressive strength and durability properties of Geopolymer concrete produced by activating fly ash with Alkaline activators like Sodium hydroxide (NaOH), Potassium hydroxide (KOH) and combination of both (50%NaOH +50%KOH) using various molarities of 8M, 10M & 12M along with Sodium Silicate solution .

Index Terms – **Geopolymer Concrete, flyash, Sodium Hydroxide, Potassium Hydroxide, Sodium Silicate, compressive strength, permeability test.**

I. INTRODUCTION

Geopolymer is a type of amorphous alumino Hydroxide product that exhibits the ideal properties of rock-forming elements, i.e., hardness, chemical stability and longevity. Geopolymer binders are used together with aggregates to produce geopolymer concretes . This technology can save up to 80% of CO_2 emissions caused by the cement. Alternative binder system with fly ash to produce concrete eliminating cement is called "Geopolymer Concrete". The manufacture of geopolymer concrete is carried out using the usual concrete technology methods. As in the case of OPC concrete, the aggregates occupy about 75-80 % by mass, in geopolymer concrete. The silicon and the aluminum in the low-calcium (ASTM Class F) fly ash react with an alkaline liquid that is a combination of sodium silicate and sodium hydroxide solutions to form the geopolymer paste that binds the aggregates and other un-reacted materials.

II. LITERATURE SURVEY

(A) Effect of alkaline activator on the strength and durability of geopolymer concrete

D B Raijiwala, H S Patil, I U Kundan (2012) "Effect of alkaline activator on the strength and durability of geopolymer concrete" Studied the influence of alkaline activators on the strength and durability properties of Geo polymer concrete. Sodium Hydroxide is available in plenty and Potassium Hydroxide is more alkaline than NaOH. The results show that the Compressive strength, Split Tensile Strength and Flexural Strength of GPC increases over controlled concrete by 1.5, 1.45 and 1.6 times respectively. The combination of the above constituents (Na_2SiO_3, 50% NaOH and 50% KOH) at 80^0C has a positive impact on the strength and durability properties of geo polymer concrete.

(B) Effect of concentration of alkaline liquid and curing time on strength and water absorptionof geopolymer concrete

Anurag Mishra et al (2008) studied the effect of concentration of alkaline liquid and curing time on strength and water absorption of geo polymer concrete. Results of the investigation indicated that there was an increase in compressive strength with increase in Noah concentration. Strength was also increased with increase in curing time. Compressive strength up to 46 MPa was obtained with curing at 60^0C.

III. MATERIALS USED

In this chapter different materials and methods has been use for preparation of moulds.

1. Cement
2. Flyash (Class –F)
3. Aggregates (Fine , Coarse(20mm))
4. Alkaline Activators (Sodium Hydroxide, Potassium Hydroxide, Sodium Silicate)
5. Water

IV. METHODOLOGY

(i)To develop the concrete with the usage of sodium hydroxide , potassium hydroxide and combination along with sodium silicate as activators.
(ii)To arrive the best combinations of the alkaline activators to achieve the desired strength.
(iii)To assess the Permeability of Geopolymer concrete.
(iv)To compare the performance of GPC with the conventional concrete.

4.1Material Characterization

Fine Aggregate and Coarse Agggregate was tested according to IS 2386-Part III (1963). Mix Design Calculations has been carried out as per IS 10262:2019.

4.2 Molarity Calculations

Sodium Hydroxide solution (Noah) 50% :

It was concluded in the preliminary investigations that the concentration of Noah considered is 8M, 10M, 12M for ordinary grade GPC.One molar of Noah solution consists of 40 grams of Noah solids. Hence, Noah solution of 8 Molar concentration consists of 320 grams of sodium hydroxide solids per one liter of water to make a solution. It is equivalent to 26.23% of NaOH solids by mass. Similarly, for 10M it is 400 gms of NaOH solids and for 12M it is 480 gms of NaOH solids per one litre of water.

Potassium Hydroxide solution (KOH) 50% :

It was concluded in the preliminary investigations that the concentration of KOH considered is 8M, 10M, 12M for ordinary grade GPC.One molar of KOH solution consists of 56.1 grams of KOH solids. Hence, KOH solution of 8 Molar concentration consists of 448.8 grams of potassium hydroxide solids per one liter of water to make a solution. Similarly, for 10M it is 561gms of KOH solids and for 12M it is 673.2 gms of KOH solids per one liter of water.

Sodium Silicate Solution (Na_2SiO_3) :

The Sodium Silicate solution consists of 55.9% of water.
Hence, the Mass of Water = (55.9/100) x (116.43) = 65.08 Kg
Mass of solids = 116.43 – 65.08 = 51.35 Kg

Total mass of water:

The total mass of water in the mix is the sum of water present in Sodium hydroxide Solution, Potassium hydroxide solution, Sodium silicate and extra water added (if any). In Ordinary grade GPC, it was concluded from literature that an amount of 22 kg of water is required to achieve the desired strength.
The total mass of water = 34.35 + 65.08 +22= 121.43 Kg.

4.2 Development of Concrete Cubes and Cylinders

A mould of standard dimension was used to prepare the blocks. A Set of 48 cubes and 48 cylinders were prepared with different molarites of NaOH and KOH.

Table 1: Proportions of Blocks

S.No	Types of mix G20	
	NaoH	KoH
Mix 1	12m(100%)	--
Mix 2	--	12m(100%)
Mix 3	12m(50%)	12m(50%)
Mix 4	8m(50%)	12m(50%)
Mix 5	10m(50%)	12m(50%)
Mix 6	12m(50%)	8m(50%)
Mix 7	12m(50%)	10m(50%)
Mix8	NPC	NPC

4.3 Testing of Cubes and Cylinders

4.3.1 Compressive Strength Test

Compressive strength of a material is defined as the value of uniaxial compressive stress reached when the material fails completely. In this investigation, the cube specimens of size 150 mm x 150 mm x 150 mm were tested in accordance with IS: 516 – 1969 [Method of test for strength of concrete]. The chemical solution consisted of 50% NaOH , 50% KOH and sodium silicate, extra water was prepared approximately 24 hours before the mixing process. In this process, the fly ash and aggregates were blended for three minutes. The tests were also conducted on specimens of GPC and OPC Concrete for 7 and 28 days.

Fig 1: GPC Casted Moulds

Fig 2: Heat Curing of GPC Moulds

4.3.2 Permeability Test

After specified duration of curing of 7 and 28 days , the specimens were placed in the permeability cells. The annular space between the specimen and cell was filled with molten sealing compound (honeybee wax and Resine) level with the top of the specimen) on the circular side to prevent water penetration from that side during the test. The permeability was defined by Darcy's Law as follows:

$$k = QL / AH$$

where k = permeability coefficient ,Q = flow rate (m3/s), A = area (m^2), L = depth of specimen , H = head of water

Fig 3: Demoulding

V.RESULTS AND DISCUSSION

It was observed that the combination of NaOH and KOH with 12M concentrations exhibited highest compressive strengths at both the ages. It was also observed that the early strength was more in all combinations of GPC compared to OPC concrete.

Table 2: Compressive Strength of GPC & OPC Concretes

S.No	Types of mix G20		Compressive strength(MPa)	
	NaoH	KoH	7 days	28 days
Mix 1	12m(100%)	--	26.73	31.05
Mix 2	--	12m(100%)	27.89	32.15
Mix 3	12m(50%)	12m(50%)	31.25	37.25
Mix 4	8m(50%)	12m(50%)	25.84	30.23
Mix 5	10m(50%)	12m(50%)	28.10	33.54
Mix 6	12m(50%)	8m(50%)	26.87	31.90
Mix 7	12m(50%)	10m(50%)	27.70	32.25
Mix8	NPC	NPC	19.75	28.36

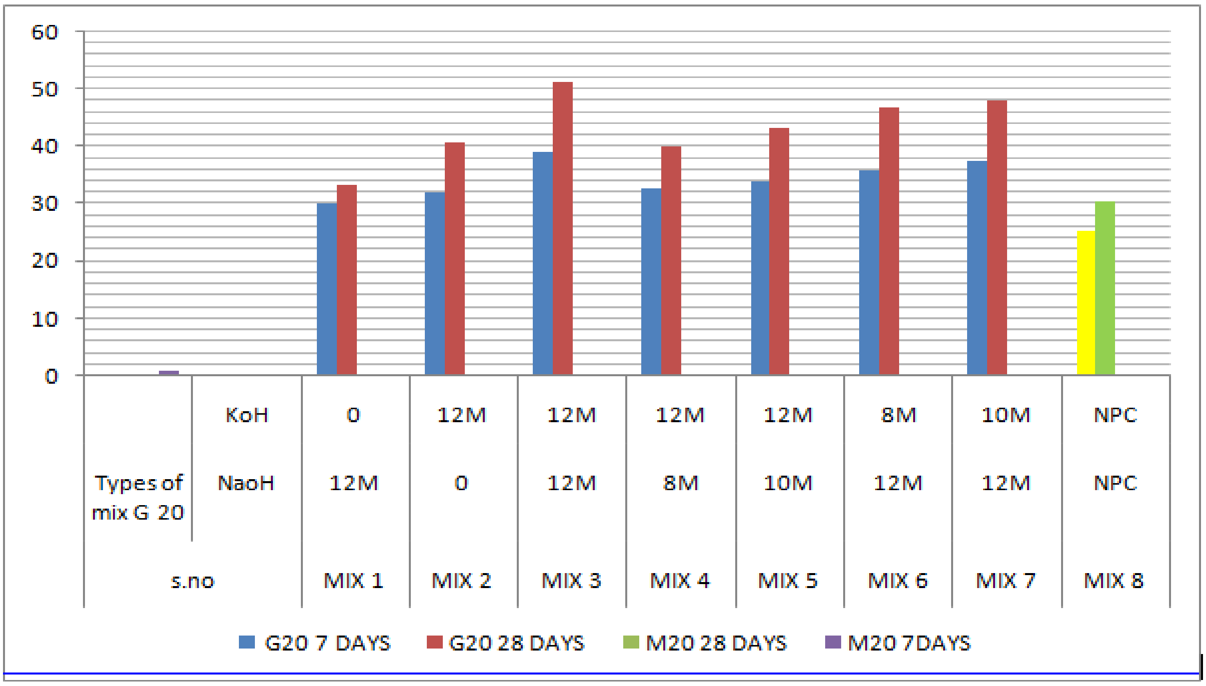

Fig 4: Variation of Compressive Strength of GPC

It is clear that the GPC shows better performance compared to OPC concrete as the permeability coefficients are lower for GPC. It was also observed that GPC with combination of NaOH and KOH with 12M concentrations exhibit lowest permeability coefficient compared to any mix.

Table 3: Coefficient of Permeability for GPC & OPC concretes

S.No	Type of mix G20		Volumeof watercollected(ml)	Time (hr)	Pressure applied kg/m ^{2}	Coeff.of permeability (m/s)	Average coefficient of permeability (m/s)
	NaoH	KOH					
Mix 1	12m(100%)	--	167	24	3	0.79 0.81 0.80	$0.81x10^{-11}$
Mix 2	--	12m(100%)	177	24	3	0.85 0.87 0.86	0.87×10^{-11}
Mix 3	12m(50%)	12m(50%)	168	24	3	0.80 0.79 0.78	0.80×10^{-11}
Mix 4	8m(50%)	12m(50%)	190	24	3	0.90 0.88 0.87	0.90×10^{-11}
Mix 5	10m(50%)	12m(50%)	184	24	3	0.86 0.88 0.88	0.88×10^{-11}
Mix 6	12m(50%)	8m(50%)	186	24	3	0.88 0.84 0.89	0.89×10^{-11}
Mix 7	12m(50%)	10m(50%)	179	24	3	0.89 0.87 0.90	0.85×10^{-11}
Mix8	NPC	NPC	209	24	3	1.13 1.32 1.27	1.32×10^{-11}

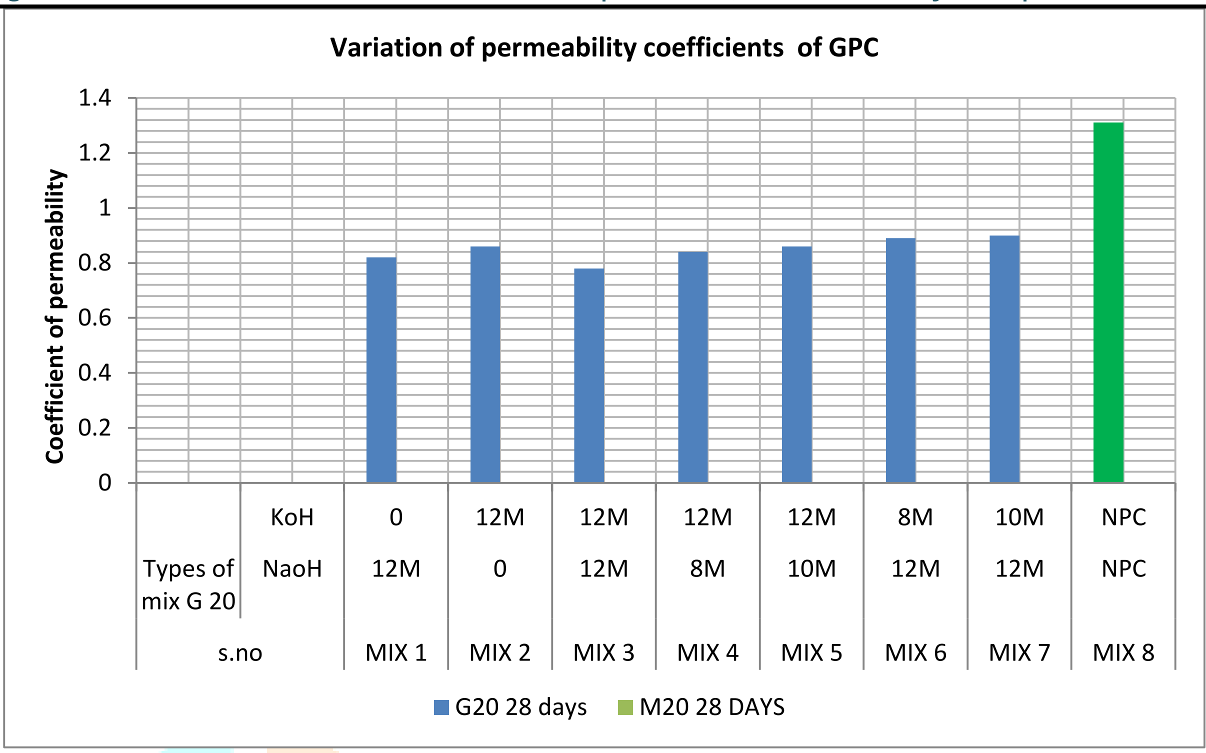

Fig 5: Variation of permeability coefficients of GPC

REFERENCES

[1] Arunangsu Patra, ArnabSinha Roy, ArkaSamanta, D.Dutta, Dr.T.G.Biswas(2016), Effect of Potassium Hydroxide As An Activator on Compressive strength of Activated Class F &Class C Fly Ash ,*Journal of Mechanical and Civil Engineering*, pp 46-52.

[2] Anurag Mishra, DeepikaChoudhary, Namrata Jain, Manish Kumar, Nidhi Sharda and DurgaDutt (2006) , Effect of concentration of alkaline liquid and curing time on strength and water absorptionof geopolymer concrete, journal of engineering and applied sciences, vol. 3, no. 1, pp14-18.

[3] D B Raijiwala, H S Patil, I U Kundan (2012) Effect of alkaline activator on the strength and durability of geopolymer concrete, *Journal of Engineering Research and Studies*, Vol. III, pp18-21.

[4]Djwantoro Hardjito, Steenie E Wallah, Dody MJ Sumajouw, B VijayaRangan (2005), Fly ash-based geopolymer concrete, *Australian Journal of Structural Engineering,*Vol 6, No.1. pp 1-10.

[5] Monita Olivia and Hamid r. Nikraz (2011), Strength and Water penetrability of fly ash geopolymer concrete, *arpn journal of engineering and applied sciences*vol. 6, no. 7.

[6] Sameer ulbashir, (2015)effect of alkali materials on geo polymer concrete, *International Journal of Civil Engineering and Technology (IJCIET),* Volume 6, Issue 1, pp. 01-13.

[7] Siva Konda Reddy. B,Varaprasad. J and Naveen Kumar Reddy.K (2010). Strength and workability of low lime fly-ash based geopolymer concrete. *Indian Journal of Science and Technology*, 3(12), 1188-1189.