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AN INVESTIGATION ON ALKALI ACTIVATED GEO POLYMER STRUCTURAL ELEMENT

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ABSTRACT

In order to address the environmental issues caused by the production of Portland cement, several researches have looked at several alternatives as binder material in concrete production. The development of alkali activated binder with superior engineering properties and longer durability have emerged as alternative to ordinary Portland cement (OPC). It is possible to use alkali activated natural Pazzolonic to synthesize environmental friendly geo polymeric cementitious construction materials. In this present paper fly ash is partial replacement with different amounts of soap stone the alkali activation on geo polymer concrete in structural element. The fly ash is partial replacement with different amounts of soap stone 0- 30 percentages the alkali activation on geo polymer concrete in structural element. The addition of naphthalene based (Gelenium B233) super plasticizer to increases the workability of fresh geo polymer concrete. The concrete specimens are heat curing (oven dry) at 70^{O}C for 40 hours. And analytically prove the flexural strength on structural element beam by using FEM Software. Expected result is more or less similar strength attain the geo polymer concrete for using Geological waste binder material

Keywords : Geo polymer concrete, Fly ash, alkaline activator solution, naphthalene based super plasticizer, FEM Software.

I. INTRODUCTION

Utilize the geological waste materials as a binder classification to produce the geo polymer concrete removing cement. Members of Family of inorganic polymer are the geo polymers. Normally Calcium silicate hydrate (CS H) gel formation of hydration process in conventional concrete. But the chemical reaction of geo polymer concrete is produced alumino silicate gel formation by intercourse the materials are alkaline solutions, like a sodium hydroxide (NaOH) OR Potassium hydroxide (KOH), Sodium silicate (Na_2SiO_3) OR potassium silicate (K_2SiO_3) that results polymerization process of three dimensional polymeric chain and ring structure consists of –Si-O-Al-O- bonds. Curing process of geo polymer concrete in ambient temperature or elevated temperature and different molar concentration of NaOH Solutions have studied at many past researches. This paper highlights the fly ash partial replacement with the different percentages of soap stone used and found the mechanical strength at elevated (oven dry) temperature and 10M concentration of NaOH solutions.

II. HISTORY OF STUDY

In the recent past, with the rapid industrialization and urbanization across the globe, demand for infrastructure development is increasing. With the development of infrastructure, demand for concrete as construction material also increasing and so as the demand for ordinary Portland cement. In generally production of cement 1 tone generates 1 tone Co2 gas. Annually the cement industries generating approximately 2.8 billion tons of greenhouse gas emission, either concerning of 7% of total man-made greenhouse gas emission to earth atmosphere [1-2]. Another way to make the concrete environmentally friendly produce replace the OPC concrete with by-product material fly ash. In this concrete development of inorganic alumina-silicate polymer is called geo polymer [3-7]. Geo polymer binder is produced by the base Minerals are rich in silica and aluminium react with the alkaline

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solution [8]. The base minerals such as fly ash [1-8], kaolin[1] ground granulated blast furnace slag (GGBS) [20-26], cotton fabric[26], ground bottom ash [27], Metakaolin[23], Valcanic ash has also used the Pazzolonic minerals for geo polymer. The effect of properties of geo polymer concrete with the ratio of base minerals to alkaline solution and different molar concentrations of alkaline solution 8M, 10M, 12M, 14M, & 16M with the various curing temperature Centigrade for 24 hour to 48 hours and ambient curing has been studied.

III. EXPERIMENTAL PROGRAM

3.1 Materials

Fly ash which is geological waste product obtained from the silos of Tuticorin thermal power station the combustion of pulverized coal are used as binder. According to the IS 383-1970, River sand having specific gravity of 2.56 and fineness modulus of 2.67 was used. Crushed angular aggregate of size 12.5mm (50%) and 20mm (50%) was used as coarse aggregate of specific gravity 2.66 and 2.72 correspondingly. Preparation of Alkaline solutions are dissolving either the flakes or pellets 97% purity in water and sodium silicate are used. The ratio of sodium hydroxide to sodium silicate is 1:2.5 was used in the alkaline solution. The ratio of alkaline solution to fly ash is 0.35. In this experimental work NaOH solution with the concentration of 10M used and 2% of super plasticizer of Gelinum B 233 is been used for increase the workability.

Table 1. Chemical composition of fly ash

FLY ASH	SiO_2	Al_2O_3	Fe_2O_3	SiO_2+ Al_2O_3+ Fe_2O_3	CaO	SO_3	Loss on ignition (LOI)	Color	Specific gravity	Average size (D50)	Fineness (Blain) (cm2/gm)
TUTICORIN	26.4	25.8	25.8	76.0, 70 (min)	16.8	1.0, 6 (max)	1.4, 6(max)	gravy	2.62	0.02 µm	4140

Table 2. Physical and Chemical composition of soap stone powder

Blaine surface area (m^2/Kg)	Particle Mean Dia (µm)	Density	Loss of Ignition	SiO_2	Al_2O_3	MgO	Fe_2O_3	CaO
750	< 5	2.7	3.33%	62.67%	0.24%	33.26%	0.30%	0.20%

Table 3. Replacement of fly ash with soap stone powder

S. No.	Fly Ash	Soap stone Powder	Ratio of NaOH & Na2Sio3	NaOH	Super Plasticizer (Gelenium B233)
FS0	100%	0%	1:2.5	10M	2%
FS10	90%	10%	1:2.5	10M	2%
FS20	80%	20%	1:2.5	10M	2%
FS30	70%	30%	1:2.5	10M	2%

Fig.1 curing specimens

Table 4. Materials Required For M40 Grade Geo Polymer Concrete

Ingredients Of Geo Polymer Concrete	Fly ash	NaOH	Na_2SiO3	Sand	Coarse Aggregate	W/GPB (lit)	Extra Water (lit)
Quantity (kg/m3)	505	50.5	126.25	586.76	1247.32	120	12.619
Proportion	1	0.35	0.35	1.162	2.47	0.24	0.025

Table 5. Details of mixtures

Mix No.	Quantity of ingredients (Kg/m^3)								
	Fly ash	Soap stone powder	Alkaline solutions		Fine aggregate	Coarse aggregate		W/GPC (lit)	Extra water (lit)
			NaOH	Na_2SiO_3		20mm	10mm		
FS0	505	0	50.5	126.25	586.76	623.66	623.66	120	12.619
FS10	454.5	50.5	50.5	126.25	586.76	623.66	623.66	120	12.619
FS20	404	101	50.5	126.25	586.76	623.66	623.66	120	12.619
FS30	353.5	151.5	50.5	126.25	586.76	623.66	623.66	120	12.619

IV. ANALYTICAL PROGRAM

In this paper describes flexural behavior of reinforced structural element beam by using nonlinear finite element modeling the ANSYS. Analytical method to solving the behavior of reinforced concrete beam to calculate the cracking load and displacement curves. ANSYS is finite element modelling using this present work to analyzing the discrete model in transverse and longitudinal steel and all the directions was already available in ANSYS library. Structural element beam was simply supported by giving the load pattern is two point

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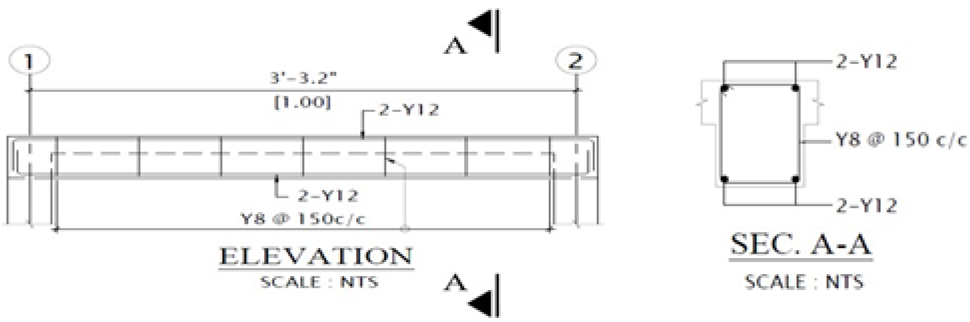
loading, analyzing the member with cracking load and displacement curves by various codes such as IS and ACI. Concrete and steel are designed as a separate materials, but the finite element modelling is combining both reinforced materials and analyzing the deflection curves



V. RESULTS & DISCUSSION

5.1 Mechanical properties

The effect of different soap stone powder contents on compressive strength of geo polymer concrete is shown in Fig 2. It can be seen that the compressive strength of geo polymer concrete containing 100% fly ash is increased by increasing in soap stone powder from 10 to 30%. From the table 4, after 24h of heat curing, the average compressive strength of concrete for 10 % soap stone powder is 30.48MPa. The soap stone powder 20% average compressive strength is 35.88MPa which is 17.78% greater than 10 % soap stone powder. When soap stone powder is added 30% average compressive strength is greater than 40 % soap stone powder.

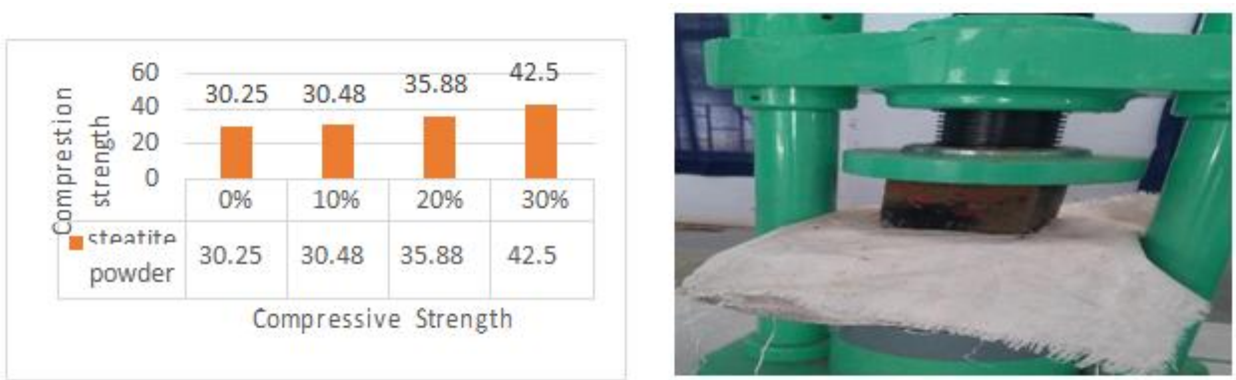


Fig. 2 compressive strength

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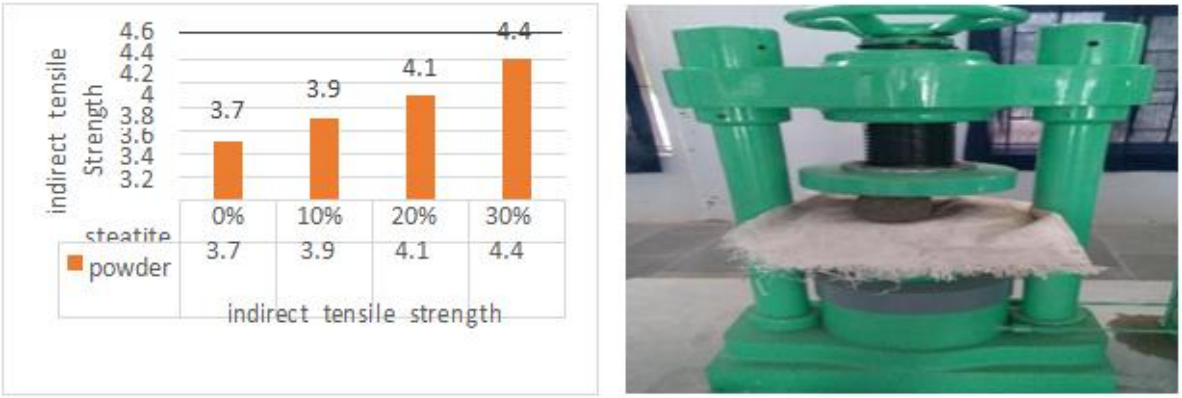

Fig. 3 indirect tensile strength

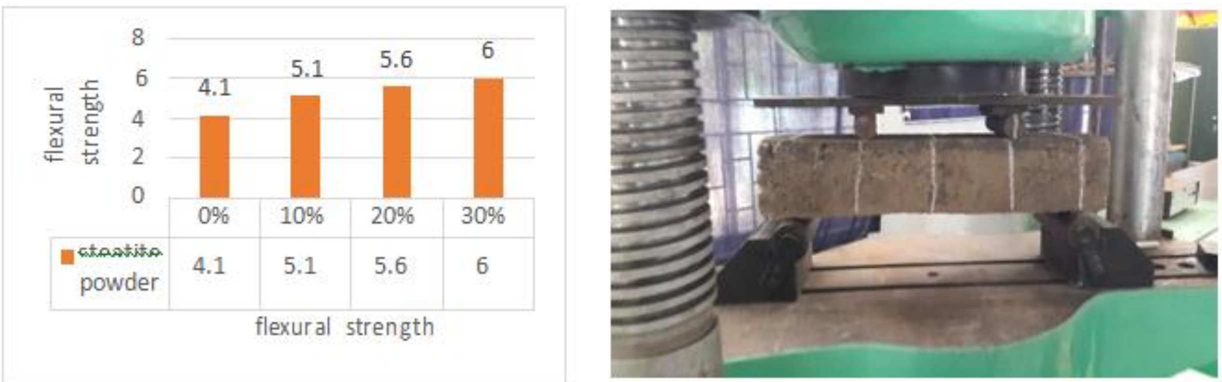

Fig. 4 flexural strength

In the case of indirect tensile strength a very similar trend to that of compressive strength, flexural strength is observed, where it increases tensile strength content with an increase in soap stone powder contents (see Fig.3).

5.2 Durability properties

The tests carried out to study the durability characteristics included the microstructure related properties such as saturated water absorption (SWA), effective porosity, sorptivity, coefficient of absorption, abrasion resistance test, resistance to chemical attack, alternate wetting and drying test and rapid chloride ion penetrability test.

Rapid chloride penetration test

According to ASTM C 1202-97, the test was 60 V DC was applied across the opposite faces of Dia 100x50 mm thick concrete specimens. The test set up is shown in Fig. 5. One face of each specimen was exposed to 3% NaCl solution and the other face was exposed to 0.3 M NaOH solution. The duration of experiment was 6 h. The current between the electrodes was monitored at 30 min intervals of time. The total charge passed through the specimen indicated the chloride ion penetrability of the concrete.

Fig 5. Test setup for RCPT

Table 6. Result of Bulk Diffusion Test and RCPT

Mix	Depth of chloride penetration (cm)	Diffusion coefficient (m^2/sec)	Charge passed (C)	Chloride ion penetrability as per ASTM
FS0	2.42	1.21×10^{-11}	1421	Low
FS10	2.47	1.24×10^{-11}	1431	Low
FS20	2.51	1.27×10^{-11}	1452	Low
FS30	2.56	1.31×10^{-11}	1465	Low

Water Absorption Test

Fig 6. Test setup for water absorption

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Table 3 Results of water absorption

Mix	W1	W2	Initial absorption $\frac{W2-W1}{W1}$ X 100	Concrete quality as per CEB
FS0	2.432	2.456	0.98	Good
FS10	2.441	2.465	0.98	Good
FS20	2.449	2.475	1.06	Good
FS30	2.451	2.480	1.18	Good

VI. SUMMARY & CONCLUSIONS

Based on previous research studies, the molarity based concept that is increasing the molarity will increase the compressive strength was discussed and concluded.

The alkali liquid can act as activators, for binding property when mixed with soap stone powder and induce binding effect in mortar cubes.

Higher the NaOH concentration higher the strength was observed but easily solidified condition during concrete casting specimens.

This study also shows that the current sustainable concrete containing a partial replacement of fly ash with supplementary cementitious materials sacrificing much of the properties of current sustainable concrete.

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