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# Study on mechanical properties of alkali activated binary blended binder containing steatite powder and fly ash / GGBS

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**Abstract :** The primary advantage of geo polymeric concrete is the decrease in ecological effect in agreement with the concept of sustainable development. The present investigation thinks about the quality, and transport properties of GGBS–and fly debris based geopolymer mortars with different level of steatite powder. The main variables investigated were the hybrid binder of geopolymer mortar. In this present study fly ash and GGBS is partial replacement with different amounts of steatite powder (soap stone) 0%,10%, 20%, 30%, 40% & 50% to obtained the mechanical properties such as compressive strength and split tensile strength. For comparison, one mixture of ordinary portland cement mortar (OPC) is also studied. The alkali activators are prepared by combining NaOH and Na<sub>2</sub>SiO<sub>3</sub> solution in the ratio of 2.5 and NaOH concentration 10M. The flyash based Geopolymer mortar specimens are heat curing (oven dry) at 70°C for 48 hours and ambient curing was done in GGBS based Geopolymer mortar. Test results were obtained that, when increasing percentages of fly ash partial replaced with the steatite powder is gradually increased the strength and the proportion of steatite powder 30% are the optimum range value.

## 1. INTRODUCTION

Geopolymer is a special concrete which emitted less amount of carbon-dioxide during hydration process compare to the conventional concrete. Geopolymer concrete was used industrial waste as a binder material such as flyash, Ground Granulated Blast furnace Slag (GGBS), metakaolin etc. Geopolymer mortars are normally orchestrated by blending an aluminosilicate reactive material, for example, FA with exceptionally combination of alkaline solution such as KOH, NaOH, potassium silicate or sodium silicate [1]. Mandeepkaur et al., conducted the experiment on the fly-ash based geopolymer mortar under different molarity of NaOH and combination of alkaline activator solution. They investigated result shows 16M of NaOH increase the compressive strength compare other concentration of NaOH activator and also combination of NaOH and Na<sub>2</sub>SiO<sub>3</sub> has 1.2 times more than the specimen activated using only NaOH [2]. Besides, it was demonstrated by Xu and Van Deventer where distinctive source materials of alumina-silicate mineral are utilized to create geopolymer, it required extra silica (Si) for the geopolymerisation procedure [3]. Ashely Russell Kotwall et al., geopolymer mortar test result shows that the flow ability were decreased due to the increase of NaOH component in the mix and the compressive test result shows increasing strength due to increase of NaOH in the mix. But increase of OH<sup>-</sup> ion in the mortar/ concrete decrease or affect the polycondensation process in the mix [4]. Mohammed haloob Al-majidi et al., investigated on the geopolymer mortar under ambient curing on the fly-ash based geopolymer partially replaced by the GGBS in the mix and the specimen were kept in both oven and ambient curing. At 28 days, the

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compressive test result shows that the ambient cured specimen had same strength as compare to the oven cured specimen [5]. For the alkaline solution, the mix of NaOH and  $\text{Na}_2\text{SiO}_3$  prompts higher geopolymerisation rates contrasted with hydroxide alone [6]. It is viewed as that the substitution of FA with GGBS may change the GP microstructure, for example, porosity. For finer binding based materials a solid relationship between's the densification of microstructure and mechanical or solidness properties has been broadly detailed. In any case, such connections for GPs are less detailed. S.K. Saxena et al., MandeepKaur (2018) et al., investigated fly-ash based geopolymer with replacement of nano binder shows increase in compactness and nano structural geopolymer formation. Then it improves the compressive strength and durability properties in sulphuric acid attack [7]. R.Premkumar et al. investigated that, increment in steatite powder exhibits low water retention and low porousness representing to that the material was in a high thick pore structure [8]. Up until now, numerous looks into have surveyed the impact of blending slag in with different materials, including metakaolin, fly ash, and mineral added substances on the durability properties and mechanical properties of geopolymer concrete. The present examination inspected the impact of utilizing different rates of substitution steatite powder in geopolymer mortar with flyash and GGBS. This assessment was finished by breaking down the outcomes acquired from geopolymer mortar.

## 2. EXPERIMENTAL INVESTIGATION

### 2.1 Constituent materials

Ground Granulated Blast Furnace Slag (GGBS) was gathered from JSW concrete assembling plant, India. It is the sorts of waste from the steel make plant. Class F fly-Ash was utilized which it was collected from national thermal power plant corporation, tuticorin. The steatite powder is composed of talc-ore which was rich in the magnesium content and waste from type of metamorphic rock. It was collected from the Ultra fine minerals pvt, limited, India. The river sand is utilized as fine aggregate below 4.75mm was utilized and specific gravity is 2.78. The NaOH and  $\text{Na}_2\text{SiO}_3$  were utilized as alkaline solution. The 10M of NaOH were used and the ratio between NaOH and  $\text{Na}_2\text{SiO}_3$  is 1:2.5. Ceraplast 300 was used as a superplasticizer to raise the workability of the geopolymer mortar.

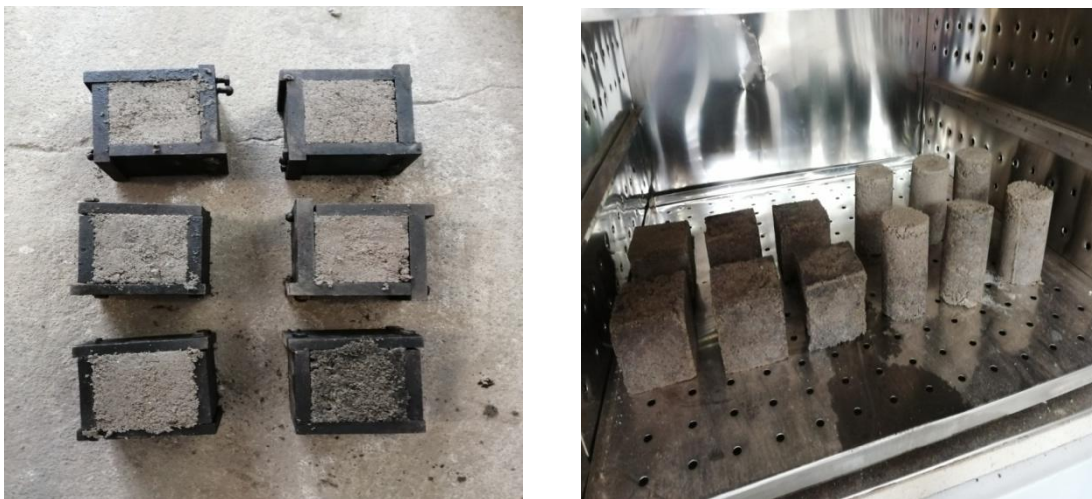
### 2.2 Mix Proportions, preparation of specimens and Testing

Table 1 shows the mix proportions of Geo polymer mortar with different binder. This table incorporates every binder five distinct blends for each steatite powder source utilizing various percentages of 10, 20, 30, 40 and 50 by partial replacement of the mass weight of the fly-ash/ GGBS. The fly-ash/ GGBS, steatite powder was mixed thoroughly for few minutes and the fine aggregate was mixed in the correct proportion of 1:3. Then the alkaline solution of sodium hydroxide and sodium silicate of ratio 1:2.5 were added in the mix [9]. The binder/ alkaline solution ratio were 0.55. The ceraplast 300 was used in the mix to increase the workability of the mortar.

Then the mortar mix was laid in the cube and cylinder mould. The fly-ash based geopolymer mortar specimens were secured with the polythene packs for a time of 24 hours. The fly-ash based specimens were kept in the hot air oven of temperature  $70^\circ\text{C}$  for 48 hours, following 7 and 28 days of restoring the test were completed in figure 1. All GGBS based geopolymer specimens were demoulded following 24 hours and restored at room temperature in the research centre moving forward without any more treatment until the day of testing. Compressive testing was performed with a universal testing machine 1000kN in accordance with ASTM C109. The normal of three specimens was accounted for as the mechanical quality outcomes.

**Table 1.**Mix Proportions

Designation	Fly ash Kg/m <sup>3</sup>	GGBS Kg/m <sup>3</sup>	Steatite Powder kg/m <sup>3</sup>	Sand kg/m <sup>3</sup>	Sand / Binding	NaOH / Na <sub>2</sub> SiO <sub>3</sub>	W/B Ratio	SP
FS0	450	-	0	1350	3	2.5	0.5	2%
FS10	405	-	45	1350	3	2.5	0.5	2%
FS20	360	-	90	1350	3	2.5	0.5	2%
FS30	315	-	135	1350	3	2.5	0.5	2%
FS40	270	-	180	1350	3	2.5	0.5	2%
FS50	225	-	225	1350	3	2.5	0.5	2%
GS0		450	0	1350	3	2.5	0.5	2%
GS10		405	45	1350	3	2.5	0.5	2%
GS20		360	90	1350	3	2.5	0.5	2%
GS30		315	135	1350	3	2.5	0.5	2%
GS40		270	180	1350	3	2.5	0.5	2%
GS50		225	225	1350	3	2.5	0.5	2%

**Figure 1.**preparation of specimens

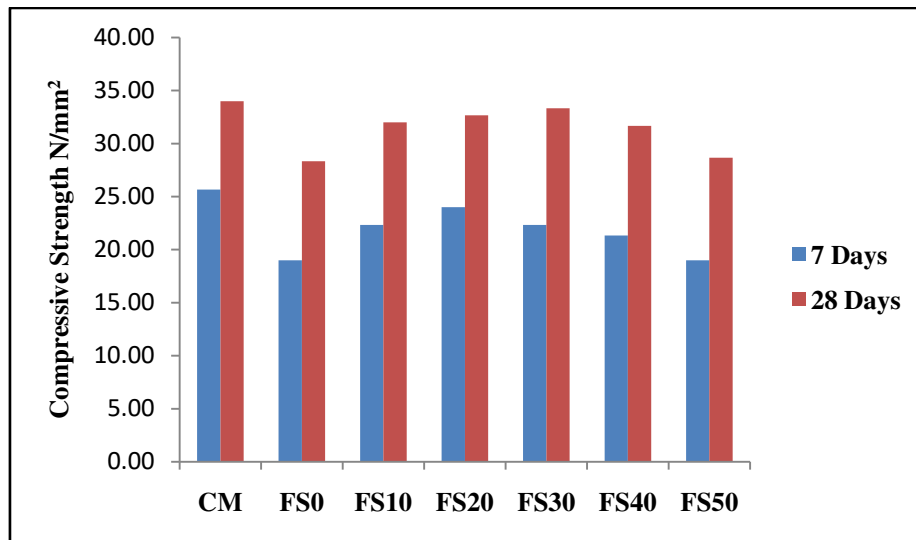
### 3. RESULTS AND DISCUSSION

#### 3.1 Mechanical Properties in Flyash with Steatite Powder

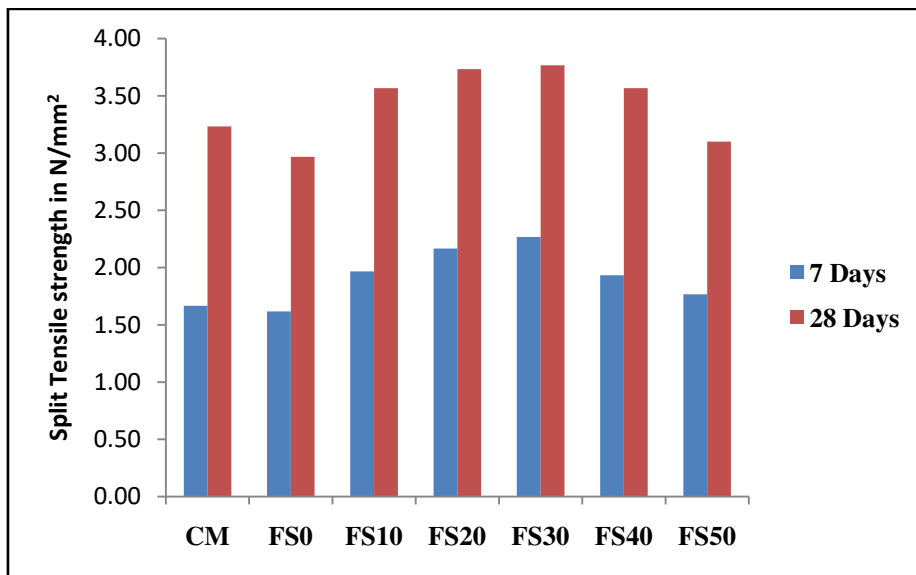
Figure 2 shows the 7 and 28 days compressive strength for normal mortar was 25.67 N/mm<sup>2</sup> and 34 N/mm<sup>2</sup>, by replacement of fly ash with steatite powder up to 50 %. Fly ash with the steatite powder of geo polymers 7day and 28day strength were gradually increased the strength. From the experimental investigation it is clear that the increased the steatite content as well as increasing the strength also, because steatite have a nano size particles its filled in the pores in the concrete specimens. When the results are showing at the compressive strength of normal cement mortar and substitution of fly ash, the quality was diminished for supplanting of fly ash with steatite powder after 30% substitution. It shows the 28 days compressive strength for geopolymer with FS0 is 28 N/mm<sup>2</sup> and geopolymer with FS30 is 33 N/mm<sup>2</sup>. When contrasted 0% with 30% of fly ash based mortar strength is 15% expanded. When thought about 50% and 30% replacement of steatite powder polymer concrete the 10% quality is diminished. The outcome shows that most noteworthy compressive quality was acquired at FS30%.

Figure 3 shows the 7 and 28 days split tensile strength for typical mortar was 1.67 N/mm<sup>2</sup> and 3.23 N/mm<sup>2</sup>, by supplanting of fly ash with steatite powder up to 50 %. When looking at the split tensile of different mix proportion with substitution of fly ash, the strength was diminished for supplanting of fly ash with steatite powder after 30% substitution. It shows the 28 days elasticity for geopolymer

with FS0 is 2.97 N/mm<sup>2</sup> and geopolymer with FS30 is 3.73 N/mm<sup>2</sup>. When contrasted 0% with 30% of fly ash based geopolymer mortar strength is 15% expanded. The outcome shows that most elevated compressive quality was acquired at FS30%



**Figure 2.**Compressive strength in Flyash with steatite powder

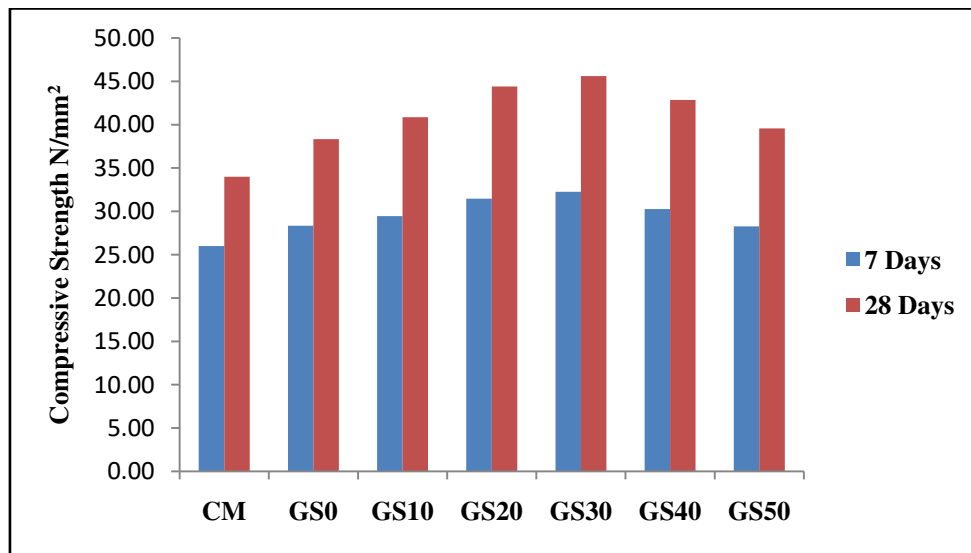


**Figure 3.**Split Tensile strength in Flyash with steatite powder

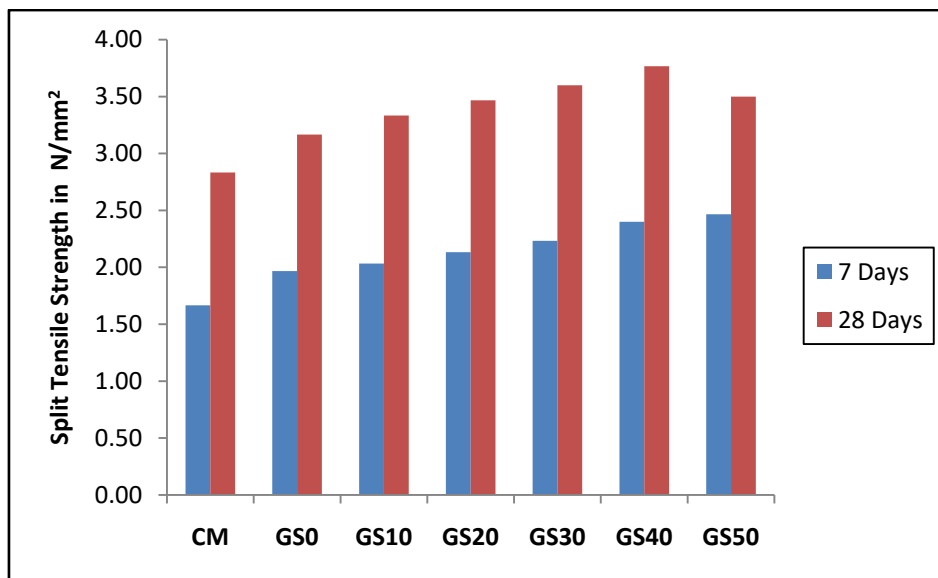
**3.2 Mechanical Properties in GGBS with Steatite Powder**

The results obtained from figure 4 shows the compressive strengths of various ratio sample cubes in the volumetric fraction of 1:3. CM gives the nominal compressive strength of 34 N/mm<sup>2</sup>. The GS0 sample achieves 38 N/mm<sup>2</sup> after 28 days. The GS0 increases its strength to 10% attainment of nominal value. From the test examination plainly the expanded the steatite content just as expanding the strength likewise up to 30% supplanting of steatite powder with GGBS. Further the quality was diminished up to half substitution however fulfillment of ostensible value of mortar specimen. The result shows that most huge compressive quality was gotten at 30% of substitution of steatite powder. Figure 5 shows variety of split rigidity at 7 years old and 28 days were given. From the test results, it was seen that with the development in assembly of sodium hydroxide, the split rigidity of geopolymer mortar increments for all cases. The most extreme elasticity of geopolymer mortar was seen in GS40

at 28 days.



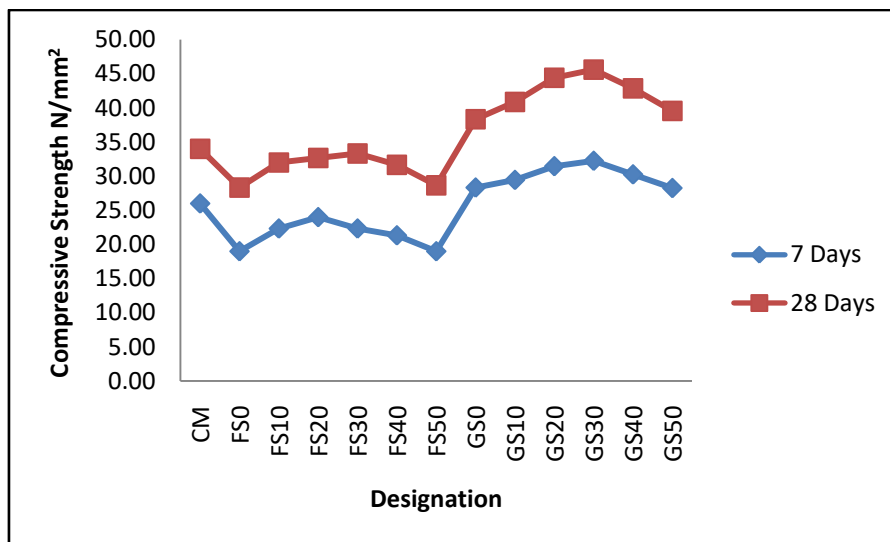
**Figure 4.** Compressive strength in GGBS with steatite powder



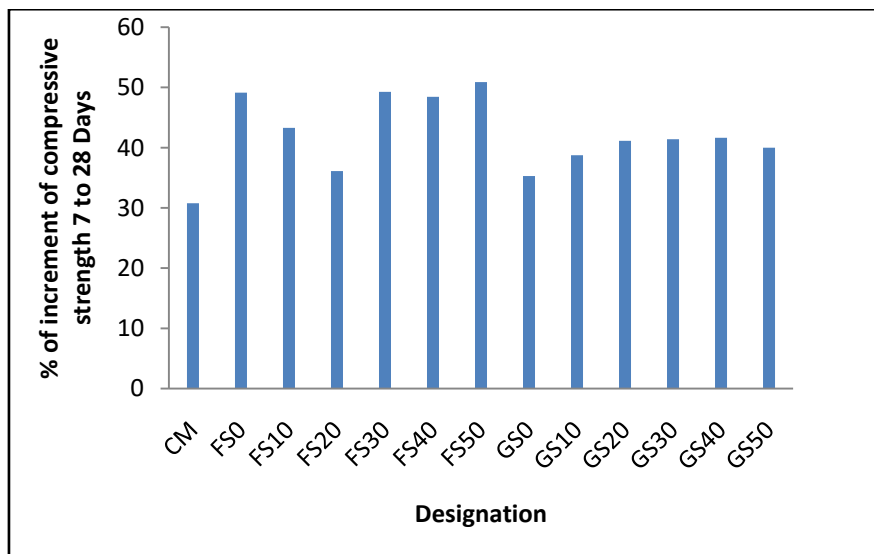
**Figure 5.** Split Tensile strength in Flyash with steatite powder

### 3.3 Development of Compressive Strength

Figure 6 shows the development of compressive strengths for different mortar mixtures with varying proportion at 7 and 28 days strength. The better particles of steatite powder decline the slender pore effectively. Ashtiani et al. [10] detailed that higher pressing variable upgraded the compressive strength. The impact of heat curing on the quality improvement likewise assumes significant job in fly ash based geopolymer mortar as observed from the figure 7. In any case, the pace of solidarity increase from 7 days to 28 days was found between fly ash based and GGBS based geopolymer mortar [11]. The fineness of steatite powder and FA additionally has huge impact on the improvement of strength at 28 days. The better particles have larger surface zone that may expand the reactivity in the geopolymerization procedure.



**Figure 6.** Compressive Strength of Different Mix Proportions



**Figure 7.** Development of Compressive Strength for 7 to 28 days

#### 4. CONCLUSION

The following important conclusions can be drawn based on the study presented above,

- This paper presents research work on the development of steatite powder based geopolymer mortar with different binder fly ash / GGBS.
- The results of the experiment show the increase percentage of steatite powder to various binder fly ash / GGBS increase compressive strength of the specimen up to 30% partial replacement of binder.
- Furthermore the strength has a significant decrease on the 28 days strength but only has marginal effect normal mortar strength.
- In this research, the steatite powder increase the quality content produced the highest split tensile strength while still maintaining good result.
- In GGBS based mortar the split tensile strength increased as the increasing steatite powder from 0 to 40% but decreased at 50%. In this research 30% replacement was the optimum value in both type of binder.
- The blends in with all the more fine particles require more glue to cover the surface area, yet

for the blends in with constant binder content, the impact of the better particles can't be overlooked.

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