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Experimental study on Ternary Blended Geopolymer Mortar

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ABSTRACT: This paper presents an experimental study on the effective usage of GGBS, Alccofine and Metakaolin (MK) in geopolymer mortar. Sodium based alkaline activators were used for different mix proportions of GGBS and Metakaolin. Liquid to solid ratio ranged as 0.48 and 0.50 with an increment of 0.02. M-sand is used as fine aggregate. The proportion of sodium silicate to sodium hydroxide was kept as 2. Ambient curing mode was used to cure mortar ratherthan heat curing mode. The test results indicated that the 3rd mix proportion of GGBS-AF-MK liquid/binder ratio of 0.50 yielded higher compressive strength.

KEYWORDS:GGBS-Ground Granulated Blast Furnace Slag.

I. INTRODUCTION

Portland cement is the most utilized material in the overall development industry. It has high level of CO2 (production of 1 ton Portland cement generates 1ton CO2) and also its use tends to become less competitive when compared to new binders like geo-polymer. Although research in this field has published it as “alkali-activated cement” or “alkaline cement”. The term “geo-polymer” is generally accepted for this technology.

Geo-polymerization includes a synthetic response between different aluminosilicate oxides with silicates under profoundly basic conditions, yielding polymeric Si-O-Al-O securities showing that any Si-Al materials could become wellsprings of Geo-polymerization.

Geopolymer mortar is a cementitious material, better substitute to solidify, as it has the benefits of quick strength acquire, end of water restoring, great mechanical and durablility properties and also the manufacturing of Portland cement emits large amount of CO2 into the atmosphere. The creation of one ton of Portland cement frees around 1 ton of carbon dioxide to the environment . Geopolymer mortar is a cover material, created from an alumino-silicate initiated in a high salt arrangement, created by Joseph Davidovits in 1978. Geopolymer mortar consequences from the reaction of GGBS and alkaline solution. The antacid arrangement utilized for the investigation is the mix of sodium hydroxide and sodium silicate. The test has been led to examine the impact of molarity on compressive strength of geopolymer mortar.The expansion in molar focus brings about expansion in the compressive strength.

Molarity is the concentration of sodium hydroxide in alkaline solution. Soluble base actuated materials are delivered through the response of an aluminosilicate - ordinarily provided in powder structure as a mechanical side-effect or other modest material, which is generally a concentrated fluid arrangement of hydroxide, silicate, carbonate or sulphate. Gopolymerisation offers an attractive option for stabilization of large volumes of industrial wastes.

1.Dissolution of silica and alumina from the solid alumina-silicate source by alkaline hydrolysis and production of Silicate and Aluminate species.
2.Formation of a complex mixture of silicate, aluminate and aluminosilicate species.
3.Rapid dissolution of amorphous aluminosilicates at high values of pH creating a supersaturated aluminosilicate solution.
4.Formation of a gel in concentrated solutions, since the oligomers in the aqueous phase form large networks by condensation .
5.Continuous rearrangement and reorganization of the system due to increase in the connectivity of the gel network resulting in 3D aluminosilicate network commonly attributed to Geopolymer.

Advantange of Geopolymer Mortar

- Reduce CO2 emission.

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- Utilization of by product GGBS from steel industry.
- High tensile and compression strength.
- Excellent chemical resistance.
- Low permeability.
- More durable.

Disadvantage of Geopolymer Mortar

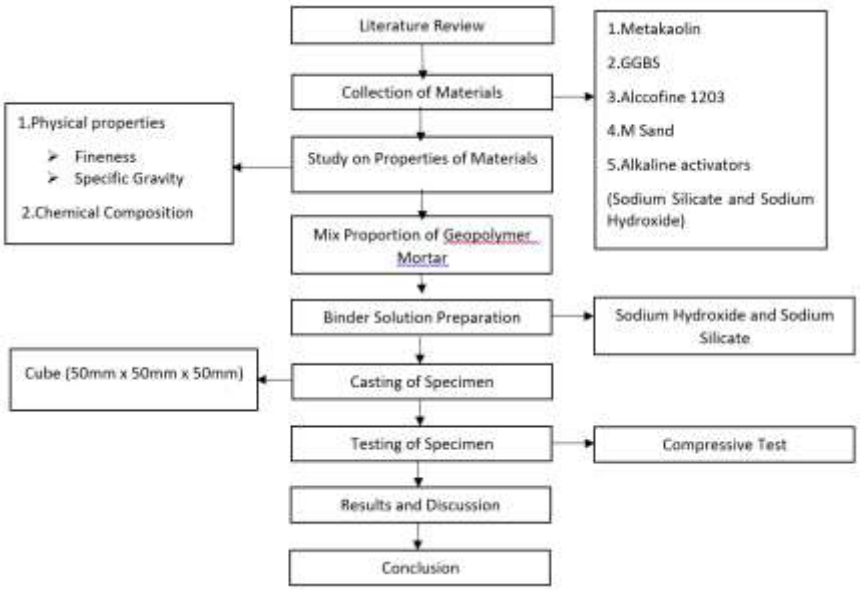
- Require different source materials like (Metakaolin, alccofine, alkaline solution and aggregates).
- Handling of chemicals is difficult it can cause harmful effects.
- Available as premix or precast material due to mixiung is dangerous.

Objective

- To find out the optimum proportion of Metakaolin, Alccofine and GGBS to make a geopolymer mortar.
- To arrive a suitable mix proportion of MK-AF-GGBS mortar.
- To reduce CO2 emission and produce an eco-friendly mortar.

II. METHODOLOGY

The methodology clearly shows the process which have been carried out in this project work. The step by step process of this project is explained below.



III. MATERIALS USED

METAKAOLIN

It is an item that is made for use as opposed to a side-effect and is shaped when china earth, the mineral kaolin, is warmed to a temperature somewhere in the range of 600 and 800ºC. Its quality is controlled during fabricate, bringing about a significantly less factor material than mechanical pozzolans that are side-effects. Metakaolin is a silica-based item that, on response with Ca(OH)2, produces CSH gel at encompassing temperature.

ALCCOFINE

It is an alccofine with low calcium silicate. Alccofine 1200 arrangement is of 1201, 1202, 1203 which addresses fine, miniature fine, ultrafine molecule size separately. Alccofine 1203 is a slag based SCM having ultra-fineness with advanced molecule size appropriation. Alccofine 1203 gives decreased water interest to a given usefulness, even up to 70% substitution level according to prerequisite of mortar execution.

GGBS

GGBS is gotten by extinguishing liquid iron slag (a side-effect of iron and steel making) from a shoot heater in water or steam, to create a polished, granular that is then dried and ground into a fine powder.In this exploratory work, GGBS from the JSW Steel Ltd of Tiruchengode was utilized.

SODIUM HYDROXIDE

Sodium Hydroxides are accessible in strong state through pellets and chips. The expense of the Sodium Hydroxide is primarily shifted by the virtue of the substance.In this examination the sodium hydroxide pellets were utilized. The substance property and actual properties are given

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by maker as follows for strong sodium hydroxide pieces.

SODIUM SILICATE

Sodium Silicate is otherwise called water glass or fluid glass, accessible in fluid (gel) structure.

MSAND

Fine total delivered by squashing hard stone. M-Sand is utilized in our undertaking which is taken from test going through 4.75 mm in dry condition to abstain from draining issue because of blending. It ought to be appropriately evaluated to give the base voids proportion and will be liberated from pernicious materials like earth, sediment substance and chloride defilements.

IV. MIX PROPORTION

The mix id for the various mix proportions of the geopolymer mortar is given in the Table 1 and Table 2

Table 1: Mix Proportion for L/B ratio 0.48

S.No	Mix Code	Metakaolin	GGBS	Alccofine 1203	Fine Aggregate	Sodium Silicate	Sodium Hydroxide
1	M1	50	50	0	1705	182	92.2
	M2	45	50	5	1705	182	92.2
	M3	40	50	10	1705	182	92.2
	M4	35	50	15	1705	182	92.2
	M5	50	45	5	1705	182	92.2
	M6	50	40	10	1705	182	92.2
	M7	50	35	15	1705	182	92.2

Table 2: Mix Proportion for L/B ratio 0.5

S.No	Mix Code	Metakaolin	GGBS	Alccofine 1203	Fine Aggregate	Sodium Silicate	Sodium Hydroxide
1	M1	50	50	0	1705	189	95
	M2	45	50	5	1705	189	95
	M3	40	50	10	1705	189	95
	M4	35	50	15	1705	189	95
	M5	50	45	5	1705	189	95
	M6	50	40	10	1705	189	95
	M7	50	35	15	1705	189	95

COMPRESSIVE TEST OF CUBE

The most fundamental property that surveys the strength of mortar is compressive strength and it fills in as a significant boundary to associate with other mechanical properties. 3D squares of size 50 mm x 50 mm x 50 mm were tried in compressive testing machine of 1000 kN limit and the tests were completed according to the method suggested by IS: 516-1959.

V. RESULT AND DISCUSSION

The cubes are tried in compressive testing machine to decide their compressive strength at 28 years old long periods of surrounding relieving. There is a progressive expansion in strength at the 28 days of encompassing room temperature relieving. The NaOH molarity is kept steady as 8M. The compressive strength was tried to decide the ideal blend extent having higher compressive strength. The compressive strength of geopolymer mortar cube examples at encompassing restoring for fluid cover proportion 0.48 was plotted underneath in the Figure 1.

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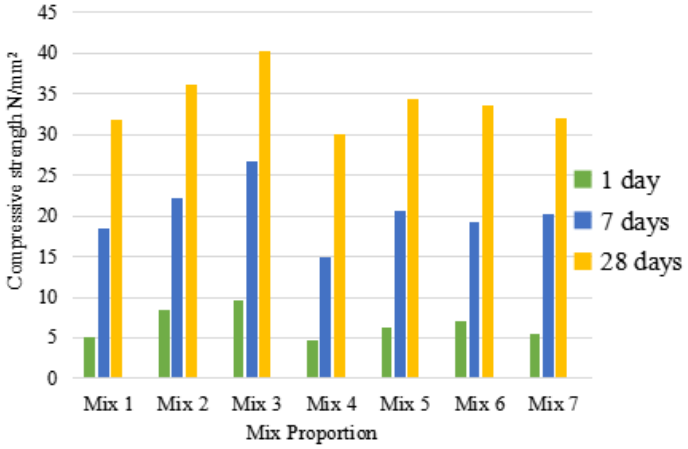

Figure 1: Compression strength for L/B ratio 0.48

The compressive strength of geopolymer mortar cube specimens at ambient curing for liquid binder ratio 0.50 was plotted below in the Figure 2.

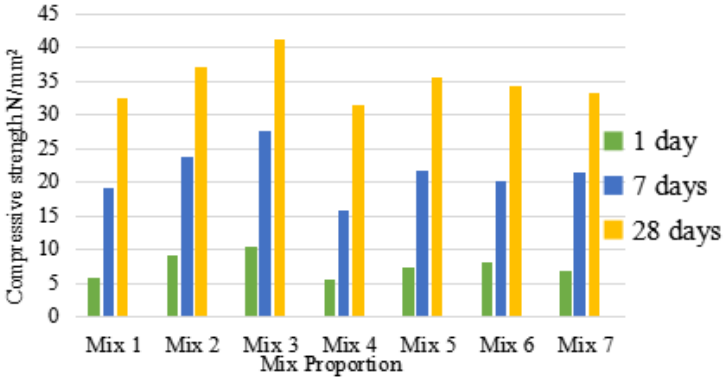

Figure 2: Compression strength for L/B ratio 0.50

CONCLUSION

- An experimental study has been carried out to find the strength of mortar with chemical admixture. The details of the experimental are given in the previous chapter. Based on the experimental studies the following conclusions are drawn.
- It is seen that the geo-polymer mortar compressive strength expanded by 3% in 28 days when contrasted with customary mortar compressive strength.
- The mix M3 in liquid binder ratio of 0.48 produced signifificantly higher compressive strength at ambient curing temperature at all ages than other mortar mixes. Also, strength gained by M3 in liquid binder ratio of 0.50 at ambient curing temperature at very early age is much higher than any other mixes.
- The decision of restoring temperature and relieving time might be influence the last strength of geo-polymer mortar.
- It is seen that substitution of cement in mortar invigorates the better properties to mortar then that of the traditional mortar.

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