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Study on geopolymer concrete with quarry dust

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ABSTRACT

In order to address environmental effects associated with Portland cement, there is need to develop alternative binders to make concrete. An effort in this regard is the development of Geopolymer concrete, synthesized from the materials of geological origin or by product materials such as fly ash, which are rich in silicon and aluminum. This paper presents results of an experimental study on the compressive strength of Geopolymer concrete. The experiments were conducted on three types of different mixes (M_1,M_2,M_3) containing different amount of sand and Quarry Dust with sunlight curing. The replacement of cement with fly ash is 100%with 10 Molarity of alkaline solution. The ratio of alkaline liquid to fly ash was fixed as 0.4. For all the samples the rest period was kept as 2 days. The compressive strength test was conducted for each sample and the results showed that there is an increase in compressive strength with the increase in age of specimens. The mix M_1 containing 40% sand 60% Quarry Dust shows higher compressive strength as it may replace our conventional concrete.

Keywords: *Fly Ash, Alkaline Liquid, Quarry Dust, Compressive Strength*

1. INTRODUCTION

Cement is important constituent in concrete and use of cement is increases with the increase in development of infrastructure all over the world. Every year tons of cement required and the quantity will be increased by 3% every year. For producing one ton of cement almost one ton of carbon dioxide emitted so for environmental crisis it's very important to find alternative. On the other hand industries produce lot of fly ash as waste material so we need to manage this solid waste. To overcome this two problems Geopolymer concrete is great option to solve both the problems in one shot. In Geopolymer concrete cement is replace by fly ash with the combination of alkaline solution. Alkaline solution and fly ash combine together to produce cement like paste which holds sand and aggregate together to form concrete. To gain maximum compressive strength we need to activate the alkaline solution for that we have to go for sunlight curing without presence of water. The alkaline solution is mixture of sodium hydroxide and sodium silicates.

Now a days we face sand scarcity and use of quarry stone dust is increase so to make so to make Geopolymer concrete more ecofriendly and sustainable Fine sand is replace with quarry dust.

2. MATERIALS

2.1 Fly ash

Fly Ash is industrial waste product and obtain by burning of coal. Geopolymer concrete is great idea to manage this industrial solid waste and solve disposal and environmental issues. Fly ash is used as replacement of cement in Geopolymer concrete. There are two types of fly ash class C and F .In this experiment Class F fly ash is utilized.

2.2 Coarse aggregates

The coarse aggregate is same as we used is conventional concrete of size varying from 10mm to 20mm were procured from the local approved crusher unit

2.3 Fine sand

In this project we can use the locally available fine sand .It was first sieved through 4.75mm sieve to remove any particles greater than 4.75mm.

2.4 Quarry stone dust

The concept of substitution of normal fine aggregate by Quarry Dust which is featured in this investigation could help the utilization of quarry dust produced from quarries. By substitution of quarry stone residue, the prerequisite of land fill territory can be decreased and can likewise tackle the issue of regular sand shortage.

2.5 Chemicals

In this project chemicals are the very important constituents. Sodium Silicate and Sodium Hydroxide liquid are obtained commercially from local suppliers. This chemicals combine together and form alkaline solution

2.6 Water:

In this work Tap water is used. It should be free from organic materials

3. EXPERIMENTAL WORK

3.1 Preparation of Geopolymer Solution:

Sodium hydroxide: Sodium hydroxide (NaOH) locally available in solid form. In this experiment we have to prepare sodium hydroxide solution in with 10 molarity. The molecular weight of sodium hydroxide is 40 gram so to prepare solution with 10 molarity (molarity x molecular weight i.e., 10 x 40=40 gram) therefore we have to dissolve 400g of flakes in 1 liter of water to achieve 10 molarity.

Sodium silicate: The Sodium silicate taken in this experiment in 2.5 times the amount of sodium hydroxide. Sodium silicates are directly dissolve in the sodium hydroxide solution. It is very important chemical because sodium silicate react with sodium hydroxide to give maximum alkaline solution. The sodium hydroxide solution thus prepared is mixed with sodium silicate solution one day before because alkaline solution produces lot of heat in initial time so we used this solution after 24 hours.

3.2 Mix proportion

Table 1: Mix Proportion as per Hardjito and Rangan (2005) [1]

S no.	Materials	Kg/ m3
1.	Coarse Aggregate	1200
2.	Fine Sand	645
3.	Fly Ash (Class F)	350
4.	Sodium Silicate Solution	103
5.	Sodium Hydroxide Solution (10 Molar)	41
6.	Extra Water (as Superplasticiser)	35

Table 2: Mixture proportions

Mix	Percentage of fine sand	Percentage of quarry dust
1.	40 %	60 %
2.	20 %	80 %
3.	0 %	100 %

3.3 Manufacturing and casting of concrete specimens

The conventional method used in the making of normal concrete is adopted to prepare geo-polymer concrete. Quarry dust, coarse aggregate and fly ash mixed in dry condition for 3-4 minutes. Then the alkaline solution added to the dry mix.Then the mixing is done about 6-8 minutes to get homogeneous solution. After preparing homogeneous mixture fill up the casting cubes and compaction was done then leave for 2 day for settling. After settling Demoulding is done after 2 days.

3.4 Curing of test specimens

After casting the specimens, they were kept in rest period for about2-3 days and then they were demoulded. To get maximum compressive strength and maximize the quality we have to activate alkaline solution to activate alkaline solution we need hot condition so we have to go for sunlight curing. The conventional water curing is not suitable for Geopolymer concrete it can disturb the alkaline solution and reduce strength.

3.5 Test specimens

For each mix proportion three numbers of cubes were cast and tested at the age of 7 days and 28 days.

Table 3: Shows the details of test specimen

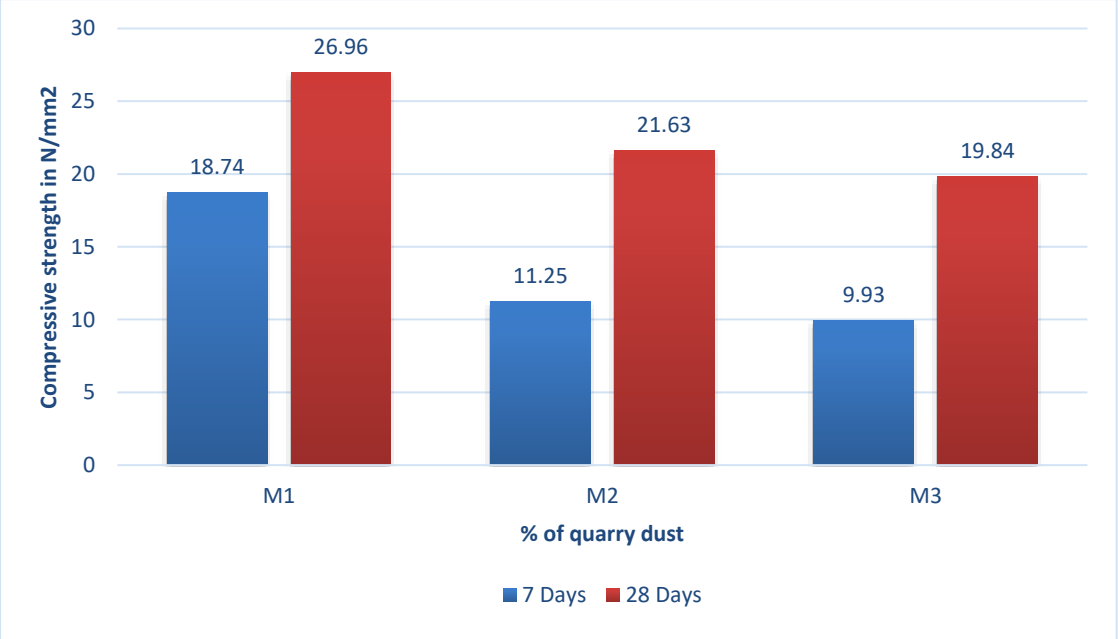
S no.	Name of test	Size Of Specimen (mm)	No. Of Specimen
1.	Compressive Strength	150 x 150x 150	18

4. TEST RESULTS

Compressive Strength

The cube specimens were tested in CTM .The variation of compressive strength at the age of 7th and 28th days for Geopolymer concrete were given below in Table.

Age of specimen in days	Compressive strength in N/mm^2			Cube Mark Mix (M)
	1 Trial	2 Trial	3 Trial	
7 days	18.67	19.33	18.22	M1
	11.11	11.11	11.55	M2
	10.67	9.33	9.78	M3
28 days	27.55	27.11	26.20	M1
	20.44	22.67	21.78	M2
	19.11	21.77	18.66	M3



Graph-1 Average compressive strength

5. CONCLUSION

1. The maximum compressive strength was observed in mixture (M_1) with 40% sand and 60% Quarry Dust as compare to other mixes M_2, M_3.
2. The compressive strength of concrete is decrease in with increase in Quarry Dust beyond 60%.
3. The mix M_1 shows higher compressive strength as it may replace our conventional concrete in construction.
4. We can't replace 100% sand with Quarry Dust as Mix M_3 with 100% Quarry Dust shows lowest compressive strength

6. REFERENCES

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