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Research paper

Investigation on Strength Characteristics of Geopolymer Concrete with M-Sand and Construction Waste

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Abstract

Geopolymer concrete are totally inorganic based ceramic that balanced by oxide. The manufacturing of ordinary Portland cement contributes 5 -7% of total greenhouse gas by reducing Co_2 emission. It also consumes large amount energy. Hence it is essential to find alternative to cement. silica fume is an ultrafine powder product collected by ferrosilicon and silicon alloy production. It alumina and silica are also rich. In this furnace slag, fly-ash, silica fume is material are used to manufacture a geopolymer concrete. Geopolymer material be caused by reaction obtain from source material are silica and alumina with alkaline solution. Geopolymer is a completely replacing material of cement. Geopolymer (fully replacing) construction waste (10%, 15%, 20% replacing)) and alkaline activator undergo geopolymerization process to produce alumino silicate gel. Alkaline solution is a mix of sodium silicate and sodium hydroxide with relative amount (2.0). A grade has selected for the investigation were M30.The mix were designed.

Keywords: *Geopolymer Concrete, M-Sand, Construction waste, Alkaline Activator*

1. Introduction

Geopolymer concrete is a made with Geocement powder and Geoactivator. Its reduce the global warming by reducing Co_2 emission using industrial waste, thus make it environment eco-friendly. Natural properties like cement, sand, rocks, etc. are majorly used under construction industries The construction engineers are stressed to reduce the unit cost of the production as the ingredients of concrete is high. In industrial they are manufacture a large amounts of fly ash, blast furnace slag and silica fume dust with consequential disposal problem. The environmental must be protected by preventing dumping of waste material in uncontrolled manner by stopping carbon di oxide (CO_2) emission. Hence it is required to find various material or partial replacement of cement. Geopolymer technology is an aluminum (al) and silicon (Si) material are react with chemical reaction that take place in case of polymerization method and hence product is called Geopolymer. In alkaline activator is the usually form of concentrated aqueous solution of alkaline hydroxide, silicate and sulphate. The chemical reaction between silica and alumina along with alkaline solution produce three dimensional structures, an alkaline silico aluminate hydrate gel. The source of material with alkaline activator is curing at temperature 60ºC to 80ºC to increases the compressive strength. The compressive strength of geo-concrete at 28thdays is 40MPa and 90MPa. The harder interface between aggregates binder with geopolymer concrete leads to the mechanical properties and extended durability of concrete.

1.1. Geopolymer Concrete

Geopolymer concrete is an environmentally friendly construction waste and alternative material of Portland cement. It's made of Geocement powder and Geoactivator. It's a totally inorganic based ceramic that balanced by oxide. It's made by reacting aluminate and silicate bearing material with alkaline activator. The geopolymer is coined by Joseph Davidovits and the polymerization method involves substantially fast chemical reaction below alkaline activator. In this study M-sand and partial replacement of construction waste.

2. Experimental

2.1. Ingredient Material of Geopolymer Concrete

The geopolymer was prepared by using following materials:

i. Alkaline Activator
ii. M-Sand
iii. Construction waste
iv. Coarse aggregate

2.1.1. Alkaline Activator

The alkaline activator is mixture of sodium hydroxide, and sodium silicate. It has purchased from KIRAN GLOBAL, Chennai. It is polymerization materials of geopolymer is replacing cement completely with process low calcium which flyash which is chemically activated by alkaline activator like sodium silicate and sodium hydroxide.

Fig. 1: Alkaline Activator

2.2. M-Sand

M-Sand is an artificial material of fine aggregate. The manufacture sand is crushed aggregate products from granite stone it to be used as a replacement of river sand. Now-days good sand is not readily presented. The fine aggregate day by day demand in Construction sector. The specific gravity of M-sand is 2.87 using pyconometer and grading was done by sieve machine. M-sand is an alternative material for natural sand.

2.3. Construction Waste

Construction waste are used as replacing material of coarse aggregate. In Construction waste material like ceramic material crushed into combination of 20mm (10%, 15%, 20%) is used present work. It's can use partial replacement material of coarse aggregate in construction. The specific gravity of construction waste is 2.32 and fineness modulus is 3.2 respectively. The calculation as shown in Table I.

Fig. 2: Construction Waste

2.4. D.Coarse Aggregate

Coarse aggregate is a construction material made of rock quarries. The coarse aggregate is 20mm diameter and its specific gravity is 2.66 respectively. The calculation as shown in Table I.

Table 1: Material Test

Tests	Construction waste	Coarse aggregate
Specific gravity	2.32	2.66
Water absorption	0.54	1.3
Impact value	20.6%	11.6%
Finenesses modulus	3.2	2.57

2.5. Experimental Method

The M_{30} design mix ratio we have used for this project. Mix design is followed and percentage of material are taken from different ratio. Were requires for achieving cohesive mix providing better result. The following given below steps.

2.6. Casting

Geopolymer concrete, M-sand, construction waste, coarse aggregate was mixed manually container in laboutary in dry form. Alkaline solution is combined ratio of 2.0. The geopolymer concrete has prepared and placed in Cube, Beam, Cylinder are molded. A totally 12 cubes, 8 beam, 8 cylinder are taken different ratio replacing construction waste (0%, 10%, 15%, 20%).

2.7. Curing

Hardjito and *et al*. (2004) have been resulted that geopolymer concrete not achieve any strength by H_2O curing. The Geopolymer concrete specimens minimum curing time 24 hours at temperature of 60ºC.

Fig. 3: Casting Specimen

3. Test Results

3.1. Compressive Strength

Out of the 12 cubes cast, were tested 4cubes per day like 7th day, 14th day and 28th day another for compressive strength. Based on that tested result was prepared for 7 days, 14 days and 28days reading are shown in Table 2. The graph is shown in fig 1. It was observed from ratio 1:1.9:2.9 are given maximum compressive strength at considered as optimum Mix. The quanties of material 1 cubic meter of geopolymer mix was work out are shown in below.

Table 2: Compressive strength test

Replacement material	7th days	14th days	28th days
Nominal mix	23	26	33.6
10% construction waste	27.5	29.5	36.9
15% construction waste	25.3	31.6	41.3
20% construction waste	24	27.6	34.3

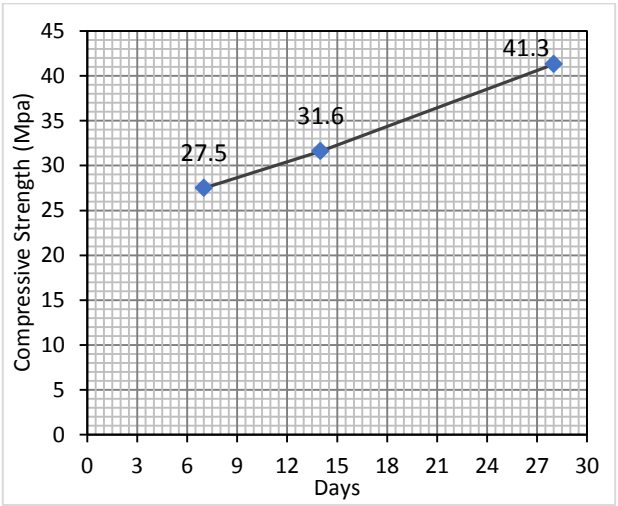

Fig.3: Compressive strength graph

3.2. Flexural Strength

The strength is determining by tensile strength of concrete. Its measure of unreinforced concrete to resist failure in bending

Table 3: Flexural strength

Replacement material	14^{th} days	28^{th} days
Nominal mix	3.2	3.62
10% construction waste	3.35	3.75
15% construction waste	3.59	4.21
20% construction waste	3.45	3.69

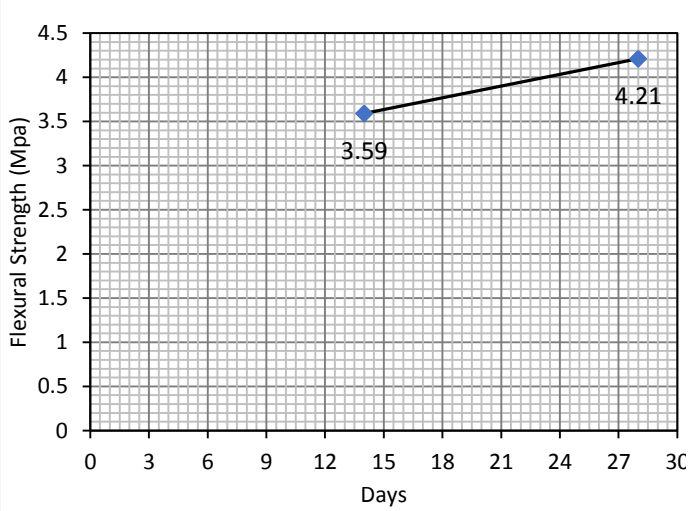

Fig.4: Flexural strength graph

3.3. Split Tensile Strength

The splitting tensile strength test on cylinder is a way to determine tensile strength. Determine the load concrete may crack.

Table 4: Split tensile strength

Replacement material	14^{th} days	28^{th} days
Nominal mix	2.5	3.5
10% construction waste	2.68	3.64
15% construction waste	2.97	3.72
20% construction waste	2..89	3.60

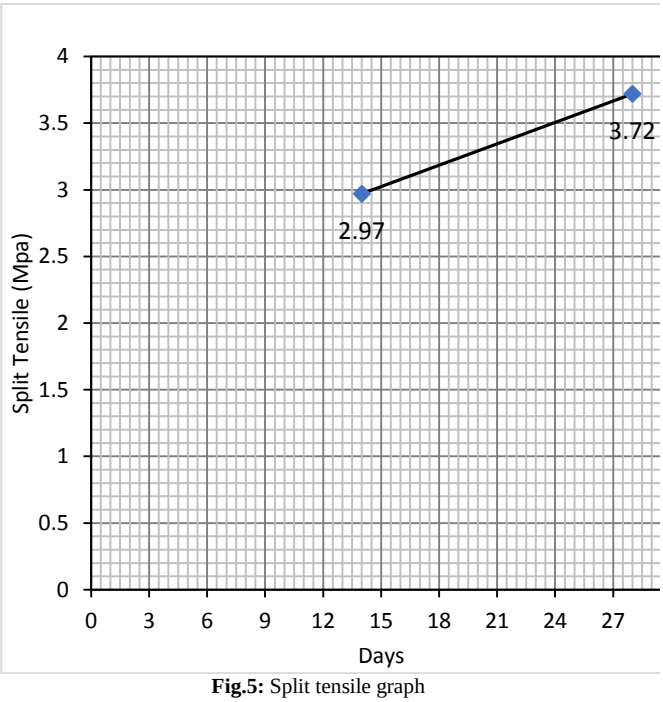

Fig.5: Split tensile graph

4. Result

4.1. Compressive Strength

The cube specimens as tested in compressive testing machine having 1000kn capacity. The result of 7^{th}, 14th, 28th days compressive are shown in figure 1 and table 2. In this 41.3N/mm^2 is maximum strength at 28^{th} days.

4.2. Flexural Strength

The flexural test is used to find out the tensile strength 100mm×100mm×500mm specimen were tested in flexural testing machine. The result of 14^{th} and 28^{th} days are flexural tensile strength is shown in figure 2 and Table 3. In this 4.21N/mm^2 is a maximum tensile strength at 28^{th} days.

4.3. Split Tensile Test

The cylinder specimen was tested in compressive machine having 1000kn capacity. The result of 14^{th} and 28^{th} days determines that the load concrete may crack will happen are shown in table 4 and figure 3. In this 3.72N/mm^2 is maximum strength at 28^{th} days.

5. Conclusion

Geopolymer is an another material of Portland cement. Its reduce CO_2 emission in the world and eco-friendly for construction. It also alkaline activator is good binding material of geopolymer concrete. Geopolymer concrete is a fire resistance taken up to 700ºC. The geopolymer concrete is additional strength after exposure to high temperature. In this project compressive strength is 41.3N/mm^2 at 28^{th} days. Its increase strength and extended durability of concrete. The using waste material is reducing the pollution free environment.

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