Experimental Investigation of Geopolymer concrete 10M By Using Marine sand

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Abstract— This Project presents a detailed experimental Investigation of Geopolymer concrete by Using Marine Sand. The manufacture of ordinary Portland Cement (OPC) releases large amount of Carbon dioxide (CO_2) to the atmosphere that significantly contributes to greenhouse gas emissions. One ton of Carbon dioxide gas is released into the atmosphere for every ton of OPC produced. Therefore there is a need to find alternative type of binders to produce more environmentally friendly concrete. A promising alternative to reduce CO_2 emissions is through the substitution of fly ash for cement. Geopolymers are new promising binder manufactured by activation of a solid alumino silicate source material with a highly alkaline activating solution aided by heat. An Experimental study was conducted to assess the acid resistance of fly ash based Geopolymer concrete specimens. Most of the aggregates used in the manufacture of concrete come from quarries or alluvial rivers. There are bans on the dredging of river sand and are strictly monitored by the government. This Research work examines in the important aggregate for the project work as it was the replacement of regular fine aggregate in 25% , 50%, 75% and 100% of replacement in Geopolymer concrete with 10 M and to evaluation of its Compressive strength , Split Tensile Strength, Flexural Strength Test .

Keywords— Fly ash, Marine sand, NaOH, Na_2Sio_3 ,Conplast SP430.

1. INTRODUCTION

Geopolymer is a type of amorphous alumino-silicate product that exhibits the ideal Properties of rock-forming elements, i.e., hardness, chemical stability and longevity. The properties of geopolymer include high early strength, low shrinkage, freeze-thaw resistance, sulphate resistance and corrosion resistance. These high-alkali binders do not generate any alkali-aggregate reaction. The geopolymer binder is a low-CO_2cementious material. It does not rely on the calcination of limestone that generates CO_2. This technology can save up to 80% of CO_2 emissions caused by the cement and aggregate industries. It is reported that the worldwide cement industry contributes around 1.65 billion tons of the greenhouse gas emissions annually, Due to the production of Portland cement, it is estimated that by the year 2020, the CO_2 emissions will rise by about 50% from the current levels.Therefore, to preserve the global environment from the impact of cement production, it isnow believed that new binders are indispensable to replace Portland cement. In this regard, the geopolymer concrete is one of the revolutionary developments related to novel materials resulting in low-cost and environmentally friendly material as an alternative to the Portland cement. Geopolymer Concrete is an innovative binder material and is produced by totally replacing the Portland cement. It is demonstrated that the geopolymeric cement generates 5–6 times less CO_2 than Portland cement. Therefore, the use of geopolymer technology not only significantly reduces the CO_2 emissions by the cement industries, but also utilises the industrial wastes and by-products of alumino-silicate composition to produce added-value construction materials.

II MATERIALS USED

1.Flyash

According to the American Concrete Institute (ACI) Committee, Fly ash is defined as "The finely divided residue that result from the combustion of ground or powdered coal and that is transported by flue gasses from the combustion zone to the particle removal system". Ash that falls in the bottom of the boiler is called bottom ash. Two classes of fly ash are Class F fly ash and Class C fly ash. The chief difference between these classes is the amount of calcium, silca, alumina, and iron content in the ash.

2.Marine Sand

This is the important aggregate for the project work as it was the replacement of regular fine aggregate in the concrete. Marine sand is available in plenty across the globe in the shores of seas. Main chemical to be checked for is chloride content, as it will be responsible for the corrosion of steel which will be used in concrete. It should be in the permissible limits to be used in the concrete and also alternative methods to be adopted for reducing the chloride content. One of the method is to reduce the chloride content to wash the marine sand in water after it will be used. It should be reduces the chloride content.

3. Sodium hydroxide

Sometimes referred to as lye, sodium hydroxide is a chemical compound with a high alkaline content. The properties of the chemical make it ideal for use in a number of different applications, including the manufacture of cleaning products, water purification, and the manufacture of paper products. Because of the alkaline content, sodium hydroxide is a strong skin irritant, making it necessary to handle the product with great care during commercial use. In its pure form, sodium hydroxide takes on the form of flakes or pellets that are a bright white. In this form, the chemical easily absorbs carbon dioxide from any air in the space; this makes it necessary to house the product in a container that is airtight. The fact that that sodium hydroxide is water-soluble helps to make it ideal for use in a number of liquid-based products.

4. Sodium silicate

Sodium silicate, usually known as "water glass" or "liquid glass", is well-known due to wide commercial and industrial application. It is mostly composed of oxygen-silicon polymer backbone lodging water in molecular matrix pores. Sodium silicateproducts are manufactured as solids or thick liquids, depending on proposed use. For instance, water glass functions as a sealant in metal components. Finally, even though, Sodium silicate manufacture is a mature industry, there is current research for a new application given its heat conductive properties.Sodium silicate is a versatile, inorganic chemical made by combining various ratios of sand and soda ash (sodium carbonate) at high temperature. This process yields a variety of products with unique chemistry that are used in many industrial and consumer applications.

5.Alkaline solutions

The common materials used as alkaline solution in producing fly ash-based geopolymer are sodium silicate and sodium hydroxide. Usually either of this material was mixed with sodium hydroxide to produce the alkaline solution and the molarity (M) of alkaline solution is 10 M. The alkaline solution was prepared a day before it is mixed with fly ash.

III PRELIMINARY TEST ON MATERIALS

1.Specific gravity of fly ash

The equipment was dried thoroughly and weighed as W_1 g. The 50 gm of the fly ash was taken and weighed W_2 g. 50gm of the fly ash and Oil is filled in the mark and weighed W_3 g. The instrument was completely filled with a clean cloth . Then the equipment was completely filled with Oil and it was weighed as W_4 g.

Result= Specific Gravity of fly ash = 1.88

2. Specific gravity test of coarse aggregate

The pycnometer dried thoroughly and weighed as W_1 g. one third of the coarse Aggregate were taken and were weighed again with pycnometer as W_2 g. Then sufficient water was added to cover the coarse aggregate half full and was screwed on the top. It was tremble well and stirred thoroughly with the glass rod to entrapped air. After the air has been removed, pycnometer was completely filled with water up to mark. They weighted at W_3 g. The pycnometer was cleaned thoroughly. The container was completely filled with water up to the top. The outside of the container was dried with a clean cloth and was weighed W_4 g.

Result: Specific Gravity of coarse aggregate=2.60

3.Specific gravity test of fine aggregate

The pycnometer was dried thoroughly and weighed as W_1 g. one third of the sand was taken in the pycnometer and weighed as W_2 g. The pycnometer was filled with water upto the top. Then it was shacked well and stirred thoroughly with the glass rod to remove the entrapped air. After the air has been removed, the pycnometer was completely filled with a clean cloth and it was weighed as W_3 g. The pycnometer was cleanly thoroughly. The pycnometer was completely filled with water up to the top. Then of the pycnometer was dried with a clean cloth and it was weighed as W_4 g.

Result= Specific Gravity Fine Aggregate= 2.64

IV. MIX DESIGN

This experimental study is intended to identify the mix ratios for different grades of Geopolymer Concrete by trial and error method. A new Design procedure was formulated for Geopolymer Concrete which was relevant to Indian standard (IS 10262-2009). The applicability of existing Mix Design was examined with the Geopolymer Concrete. Two kinds of systems were considered in this study using 100% replacement of cement by ASTM class F flyash and 100% replacement of sand by M-sand. It was analyzed from the test result that the Indian standard mix design itself can be used for the Geopolymer Concrete with some modification. Proportion:

Molority = 10M
Fly ash = 1 (500/500)
F.A = 0.9 (446.22/500)
C.A = 1.8 (891.66/500)
ratio =1 : 0.9 : 1.8
W/C = 0.45

Strength test

- ✓ Compressive strength
- ✓ Split tensile strength
- ✓ Flexural strength

1.Compressive strength test

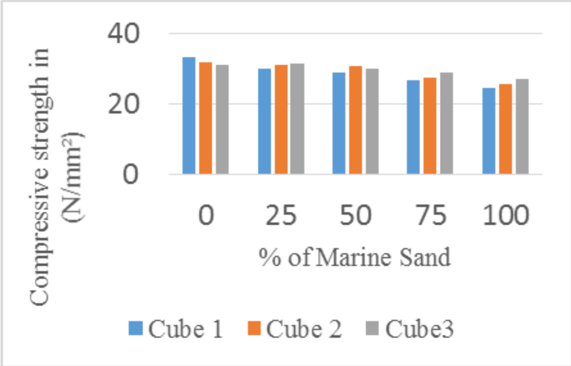
Compressive strength is one of the important properties of concrete.The specimen is then placed in the machine in such a manner that the load shall be applied.The maximum load at failure was taken and compressive strength is calculated using the equation.

Compressive strength = P/A (N/mm^2)

Where,
P = Ultimate load (KN)
A = Area of specimen (mm^2)

Compressive Strength Test Results

% of Marine sand	Name of the specimen	Load in (KN)	Compressive strength (N/mm^2)	Mean Strength (N/mm^2)
0	1	730	32.44	31.84
	2	720	32	
	3	700	31.1	
25	1	650	28.8	29.89
	2	690	30.67	
	3	680	30.22	
50	1	680	30.22	30.96
	2	700	31.11	
	3	710	31.55	
75	1	600	26.7	27.69
	2	620	27.5	
	3	640	28.4	
100	1	550	24.4	25.76
	2	580	25.78	
	3	610	27.11	



2. Split Tensile Test

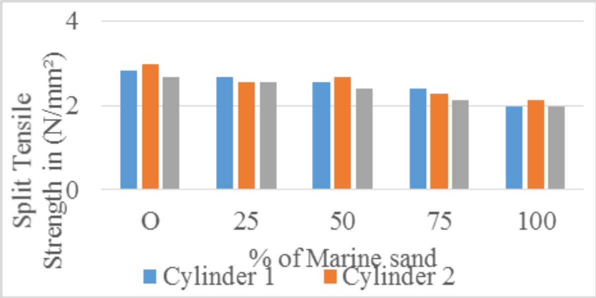
Splitting tensile strength is generally greater than direct tensile strength used to find the tensile strength of cylinder by subjecting the cylinder to a compressive force.The specimen is then placed in the machine in such a manner that the load shall be applied by placing the specimen horizontal.The maximum load at failure was taken and split tensile strength is calculated using the equation.

Split tensile strength = 2P/πdl

Where,

P = Maximum load at failure (N)
d = Diameter of cylindrical specimen (mm)
l = Length of cylindrical specimen (mm)

% of Marine sand	Name of the specimen	Load in (KN)	Split Tensile Strength (N/mm^2)	Mean Strength (N/mm^2)
0	1	200	2.82	2.82
	2	210	2.97	
	3	190	2.68	
25	1	180	2.54	2.54
	2	190	2.68	
	3	170	2.4	
50	1	190	2.68	2.58
	2	180	2.54	
	3	180	2.54	
75	1	170	2.4	2.26
	2	160	2.26	
	3	150	2.12	
100	1	140	1.98	2.02
	2	150	2.12	
	3	140	1.98	



3.Flexural strength test

Flexural strength is one measure of tensile strength of concrete. The specimen is then placed in the machine in such a manner that the load shall be applied. The maximum load at failure was taken and flexural strength is calculated using the equation.

Flexural strength $=3PL/2BD^2$

Where,

P = Maximum Load at failure

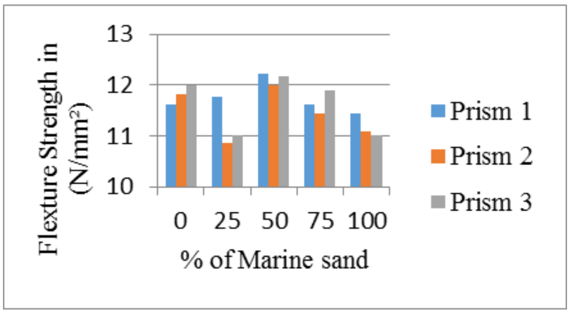
L= Length of the specimen

B= Breadth of the specimen

D= Depth of the specimen

Flextural Strength Test Results

% of Marine sand	Name of the specimen	Load in (KN)	Flexture strength (N/mm^2)	Mean Strength (N/mm^2)
0	1	15	11.62	11.82
	2	15.8	11.85	
	3	16	12.00	
25	1	15.7	11.78	11.2
	2	14.4	10.80	
	3	14.7	11.02	
50	1	16.3	12.22	12.12
	2	16	12.00	
	3	16.2	12.15	
75	1	15	11.62	11.64
	2	15.3	11.47	
	3	15.8	11.85	
100	1	15.3	11.47	11.21
	2	14.8	11.10	
	3	14.7	11.06	



Conclusion

The geopolymerConcrete are environment friendly, since the usage of fly ash which is the waste material and reduction in the green house gases due to the complete cement replacement. Because comparing with the control specimen, the compressive strength of the geopolymer concretespecimen was increased.

- The Geopolymer concrete attain the high strength while comparing normal concrete.
- In this Research Marine sand is successfully replacement of normal sand.
- As compare geopolymer concrete 50% of marine sand replacement is achieve good strength.
- Through out the research Heat curing will achieve high strength.
- Heat curing plays a vital role to reduces the time and increase the strength.
- In this experiment concludes 10 molarity is preferable for usage it achieve the optimum strength.
- The Geopolymerconcrete produce ultimate compressive strength of heat curing in 24 hrs.

References

1. Dr. V.Ravindra,(1) Anil Kumar Buraka(2) et al (2016)***"Mechanical properties of Concrete with Marine sand as Partial replacement of Fine aggregate"*** International Journal of Engineering Research and Applications Volume.6 Issue 2 (Part -2) February 2016 . PP.08-11.
2. Shahul Hameed, M., Sekar, ASS., (2009) ***"Quarry dust as replacement of fine aggregates in concrete"*** New construction Materials, PP:52-56.
3. K. Sandeep Dutt(1), K. Vinay Kumar(1), I. Siva Kishore(2), Ch. MallikaChowdary(2) et al (2016)***"A Case Study on Fly ash based Geo-Polymer Concrete"*** International Journal of Engineering Trends and Technology Volume 34 Number 2- April 2016.
4. Sameer Ul Bashir et al(2015)***"Effect of Alkali Materials on Geo Polymer Concrete"*** International Journal of Civil Engineering and Technology Volume .6 Issue 1, January (2015).PP.01-13.
5. Shankar H. Sanni,(1)Khadiranaikar, R. B(2) et al (2012) ***"Performance of Geopolymer Concrete under severe Environmental conditions"***International Journal of Civil and Structural Engineering Volume .3 No.2. 2012.
6. L.Krishnan,(1)S.Karthikeyan,(2)S.Nathiya,(3) K. Suganya(4) et al ***"Geopolymer Concrete***

an eco-friendly construction material” International Journals of Research in Engineering and Technology pISSN:2321-7308

7. Vikram R. Khajekar, Prof. A.W.Yerekar et al (2016)***“Design of Geopolymer Concrete (gpc) by using 13 Molarity”*** International Journal for Scientific Research & Development Vol.4 (2016).
8. RobinaKouserTabassum, AnkushKhadwal et al (2015) **“A Brief Review On Geopolymer Concrete”** International Journal of Advanced Reseach in Education Technology Volume.2 (2015).
9. S.Jaydeep[(1)], B.J. Chakravarthy[(2)] et al (2013) ***“ Study on Fly Ash Based Geo-polymer Concrete Using Admixtures”*** International Journal of Engineering Trends and Technology Vol.4 (2013).
10. M.Karthikeyan[(1)]&V.Nagarajan[(2)] et al (2015) ***“Feasibility study on utilization of marine sand in concrete for sustainable development”*** International Journal of Geo Marine Science. Vol.45(2) PP:313-318.
11. R. Aruradha, V. Sreevidya, R. Venkatasubramani, and B.V. Rangan et al (2011) ***“Modified Guidelines for Geopolymer Concrete Mix Design”***Using Indian Standard (2011)
12. KandagaddalaRevanth Kumar, GunupudiYalamesh, Ramakrishnan K et al (2015) ***“Study of Strength of Concrete by Partially Replacing Fine Aggregate with Bottom Ash and Marine Sand”*** International Journal of Chem Tech Research(2015).
13. Shahul Hameed, M., Sekar, ASS, (2009), ***“Properties of green concrete containing quarry rock dust and marble sludge powder as fine aggregate”,*** ARPN journal of Engineering and applied Science, Vol.4(4), PP:83-89.