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Experimental program on hardened properties of geo polymer concrete by using red soil

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Abstract*—The manufacturing of Ordinary Portland Cement (OPC) imparts 5-7 % of Greenhouse emissions. It manducates gargantuan quantum of energy. Ergo it betides indispensable to perceive surrogate to OPC. Ground granulated blast furnace slag (GGBS) is a cementitious stuff, upshot of Iron procured from Blast furnaces. In this thesis, Red soil & GGBS are used to churn out Geo Polymer concrete.*
Geo polymer concrete is a modish and climate friendly building stuff and a surrogate to OPC. Use of Geo polymer concrete truncates the demand of OPC which is accountable for high Carbon-di-oxide emission. Geo polymer is a stuff repercussioned from the reaction of a provenance stuff that is prosperous in silica & alumina. GPC is utterly cement free concrete. In GPC, Red soil & GGBS portrays as an activator. GGBS & alkaline activator go through Geopolymerisation action to churn out alumina silicate gel. Alkaline solution utilized in current interpretation is amalgamation of sodium hydroxide & sodium silicate with a proportion 1:1 and the molarity of sodium hydroxide is kept as 6M, 8M & 10M.

Keywords—Geopolymer,Ground granulated blast furnace slag (GGBS),Red soil, Alkaline Activated solutions, Ambinent curing.

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I. INTRODUCTION

The effect of globalization has been very evident within the discipline ofinfrastructure development. In up-to-date research carried out on world demandwithin the concrete and cement market, a steeping 990 billion is the expecteddemand forecasted by the end of 2020. In view of the above inference, concreteis regarded to be essentially the most broadly used Cementitious material and itstands second in the market for construction across the world. The principalapplicationofconcretewithintheconstructionsubjectcomparabletoinfrastructure,habitationandtransportatio nhasinfluencedtheeconomic progressand the standard of living of developed as well as developing nations vastly.Nevertheless,extremeindustrializationanddevelopmentalactivitieshave resultedin huge quantity of production of concrete which is ideally made up of clay andlimestone which are geologically irrecoverable and produces carbon dioxide,whichmajorlycontributestowardglobalwarmingandenvironmentaldegradation. Among the greenhouse gases, it's estimated that CO2 contributesabout 65% of global warming. The cement producing industries are contributorsofCO2totheenvironment.Itisrealthatexposureofordinaryconcretetosevereenvironmental conditions, leads to deterioration of its force over an interval oftime. Any construction with ordinary cement substances is borne to cracks andcorrosion. Concrete also reacts to acid assault, forming calcium salts, whichmakesittocorrodefully.Thus,discoveringanalternativestrategytothisobstacleresolvestoidentifyalternative bindingsubstances.

II. MATERIALS USED

1) ***RedSoil***

Redsoilisatypeofsoilthatdevelopsinawarm,temperate,moistclimateunder deciduous or mixed forest, having thin organic and organic-mineral layersblackbrownleachedlayerrestingonanilluviumredlayer.Redsoilsaregenerallyderived from the weathering of ancient crystalline and metamorphic rock. Theyare named after their rich red colour, which is due to their high iron content. Itcan also vary from reddish brown to reddish yellowThey are usually poorgrowing soils, low in nutrients and humus and difficult to be cultivated becauseof itslowwaterholdingcapacity.

Red Soil

2) ***Ground granulated blast furnace slag (GGBS)***

Ground-granulated blast-furnace slag (GGBS or GGBFS) is obtainedquenchingmolteniron slag (a by-productof ironandsteel-making) from ablastfurnaceinwaterorsteam,toproduceaglassy,granularproductthatisthendried andgroundintoa finepowder.

Ground granulated blast furnace slag (GGBS)

*3)****FineAggregate(Naturalsand)***

Available sand, free from silt and organic matters was used. Theparticle size of the sand used in this study was such a way that it passed through4.75mmsieveconformingtozoneIIofIS:383-1970. ThespecificgravityofFA used was 2.55, loose Locally density was 15.7 KN/m3, compacted density was 17.1KN/m3 andfinenessmoduluswas2.6.

4)*CoarseAggrigate*

Crushed stone of 20mm maximum size and retained on IS: 480 sieves havebeenused as coarse aggregate. It was obtained by nearby quarry.

InGeopolymerizationsystem,alkalineoptionsplayafundamentalrole.Therearetwo forms of alkaline resolution that getting used on this study. A combinationof sodium hydroxide (NaOH) and sodium silicate (Na2SiO3) solution is beingchosen asthe alkalinesolution.

5)Alkaline solution

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Sodium silicate Sodium hydroxide

III. DESIGN OF GEOPOLYMER CONCRETE

1) ***MIX1***

DesignparameterforMortarCube:

Mixingand specimenpreparation:

Red soil and mixture of alkaline activators namely sodium silicate hydroxide(NaoH) solution with a alkaline activator/soil ratio 0.4 were used to prepare a redSoil-based geopolymer with a various sodium hydroxide concentration such as 8M,10M.red soil to fine aggregates ratio was maintained at 1:3. The ratio of sodiumSilicate And sodium hydroxide taken as 1:1. The sodium silicate and the sodiumHydroxide Solution were mixed together at least 24 hours prior to casting of thespecimen.

The fresh Geopolymer mortar was used to cast cubes of size (70.6x70.6 x 70.6) mm todetermine its compressive strength. Each cube specimen was cast in three layers bymanual compaction as well asbyusingvibrating table.Eachlayer received 25-30 strokes of compaction by rod, followed by further compaction by usingVibrating.

CuringofTestSpecimens:

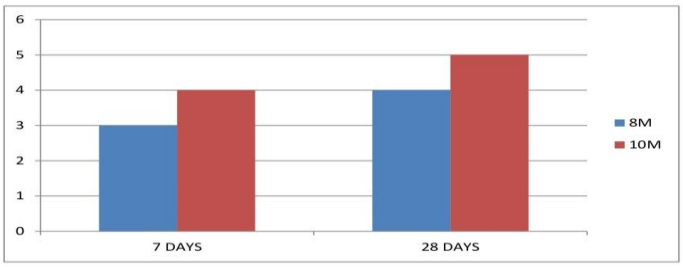
Aftercastingthespecimenswereallowedtosetfor24hoursinmoulds.then,theSpecimenswere removedfromthemouldsandthespecimenswerecuredinroomtemperatureuntil theyReachedthe 7^{th} and 28^{th} daysofage.TestCarried Out

Compressive Strength: The compressive strength test of concrete is one of the mostimportant and useful properties of concrete. In most structural applications concrete isemployedprimarilytoresistthecompressivestresses.Thecompressivestrengthisfrequently used as a measure of these properties. Mortar cube specimen(70.6x70.6x70.6) mmwerecast with adifferentpercentageand concentration ofbinder.Afteraspecified

period, specimens are subjected to compression test by using universal testingmachineof100Tcapacity ataloadingrateof140kN/min.

The result of Compressive strength at 7 and 28 days obtained for mortar cubes arereportedinTable1.

Alkaline liquid to red soil ratio	8M		10M	
	7 days (kn/mm^ 2)	28 days (kn/mm^ 2)	7 days (kn/mm^ 2)	2days (kn/mm^ 2)
0.5	3.76	4.82	3.85	5.39



The Compressive strength at 7 and 28 days obtained for mortar cube

2) ***MIX2***

Designofgeopolymerconcrete mixdesign.

There isnostandard mixdesign arenot yetavailable for geopolymer concrete.While the strength of cement concrete is known to be well related to its water cementratio, such as simplistic formulation may not holds good for geopolymer concrete.Somixdesign forthisgeopolymermixis doneby trialanderrormethod.

showed that geopolymer paste binds the coarse aggregates, fine aggregates andother unreacted materialstogether to form the GPC (Geo Polymer Concrete), andas usual concrete technologymethodstoproduceGPCmixescanbeoftenemployed. As in the Portland cement concrete, the aggregates occupy the largestvolume (about 75-80% by mass) in GPCs are anew class ofconstruction materialsandthereisnostandard mix designapproachesareyetavailableforGPCs.

While GPCs involve more constituents in its binder (GGBS, NaOH,Na_2SiO_3andwater)whoseinteractionandfinal structureandchemicalcompositionareunderintense research where as the chemistry of Portland cement and itsstructureandchemicalcomposition(beforeandafter hydration) are wellestablished duetoextensive research carried outover morethan thecentury,whilestrengthifcementconcreteisknown tobewellrelatedtoitswatercementratio.soforthisgeopolymerconcretemixtrialanderrormethodwasdone.

The investigationwasdoneontheproportion1:1.7:2.6 (GGBS, fine aggregate,coarse aggregates)bypartialreplacing the GGBS thatisredsoilThepercentagesof replacement are 0, 10,20,30,40,50 %. For all the proportions the alkaline solutiontobindertakenis0.5keptasconstant.

Casting,CuringandTestingoftheSpecimens

Castingofspecimens :

GGBS, Fine aggregates and Coarse aggregates were taken in mix proportion 1:1.7:2.6which corresponds to M25 grade of concrete.All theingredientsweremixedindryconditiontillweget homogeneous mixture. To this dry mix required amount of alkaliactivated solution of 6M wasaddedand solution to binder ratio is 0.5 and the entire mix isagain mixedtillwegethomogenousmixture.

This mixed concrete is poured into the moulds at this time the compaction is done in 3layers by handcompactionandthenit keptonthevibratorfor compaction. Afterthe compaction the surface is well levelled andgivensmoothfinishes.After24hoursthespecimenswere demoulded.

4 Curingofspecimens:

The demoulded specimens were placed for curing the curing is done by placing thedemoulded specimens in atmospheric temperature that is sunlight so this type of curingis called as ambient curing. This type of curing eliminates the heat curing of geopolymer.Thesespecimensarecuredfor 7,14,days.

Dry mix of geopolymer concrete

Casting a specimen

Testingofspecimens

The specimens aretestedfor compressive strengthfor cubesof size 150mmx150mmx150mmcastironsteelmoulds.Foreach proportion 3cubed weretested at the age of 7days,14days.

Compressive strengthspecimensofdimensions150mmx150mmx 150mmwhichwaspreparedaretestedin1000KNcapacity compression testing machine.The compressive strengthiscalculated by usingtheequation,

$$F=P/A$$

Where,

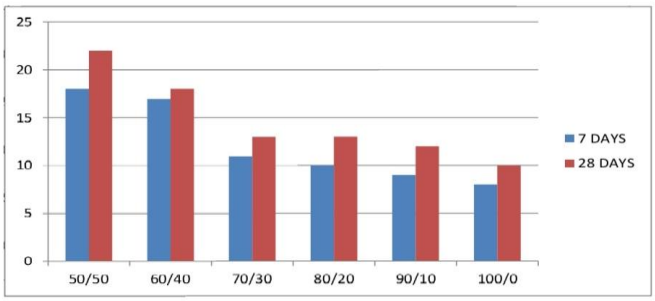
F= Compressive stress

P=MaximumLoad in N

A=Cross sectional areain mm.

The average compressive strength of various proportions is givenintable2.

GBS/RED SOIL (%)	7DAYS (kn/mm^2)	14 DAYS (kn/mm^2)
50/50	18.51	22.60
60/40	17.88	18.44
70/30	11.01	13.83
80/20	10.24	13.55
90/10	9.86	12.51
100/0	8.95	9.98



The Compressive strength at 7 and 28 days obtained for concrete cube

Compressive strength of concrete

CONCLUSION

The inference of the present work is represented on this chapter. The followingconclusions can also be drawn with the experimental gain of knowledge of onGeopolymer.

- ThisresearchhaspavedthewayfortheincorporationofpromisingGeopolymer concrete in structural applications and has led to the totalelimination of cement from concrete which ultimately becomes "GreenConcrete".
- It was observed that Geopolymer concrete produces a substance that iscomparable to or better than traditional concrete with respect to mostproperties.
- Geopolymer concrete eliminated the conventional way of water curing, asitwas curedat ambienttemperature.
- It was observed that the compressive strength increased with the increaseintheGGBS content ofthe concrete.
- As the demand and the cost of the sodium silicate is high in the industrialmarket , we were successfully able to reduce the consumption of thesodium silicate in the geo polymer concrete , without altering the strengthcharacteristics oftheGeopolymerconcrete.
- As the Geopolymer concrete has less permeability, less porous , and haslessvoidratiowhichresultsinhighdurabilityoftheGeopolymerconcrete,thusGeopolymerconcretehashighdurabilityaspectthantheconventionalconcrete.
- As the geo polymer concrete doesn't require water curing, as it requireambient curing it can easily cure under ambient temperature. The waterscarcityfacedinthesiteregardingcuringpurposeiscompletelyeliminated.

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