IJNRD.ORG ISSN : 2456-4184
INTERNATIONAL JOURNAL OF NOVEL RESEARCH AND DEVELOPMENT (IJNRD) | IJNRD.ORG
An International Open Access, Peer-reviewed, Refereed Journal

STUDYON THE MECHANICAL PROPERTIES OF A GEO-POLYMER CONCRETE BASED ON LOW CALCIUM FLY ASH AND PAPER SLUDGE ASH AS PARTIAL REPLACEMENT

Mr.A.Venkatesan[1], Balasaravanan S[2], Kannan M[3], Kaushigan M[4],KasivishwanathanP[5]

[1]*AssistantProfessor,DepartmentofCivilEngineering,PanimalarEngineeringCollege*
[2,3,4,5]*U.G.Student, Department of Civil Engineering,Panimalar Engineering CollegeCivilvenkat6@gmail.com,kaushigan0601@gmail.com,9443306066,9486029836*

Abstract

The production of Portland cement is an energy-intensive process that emits a substantial quantity of CO2 (about 13500 million tonnes per year). As a result, the Endeavour is centered on finding ways to substitute Portland cement with other ecologically benign cementitious materials. Another type of cementitious material has recently been created,which uses silica and alumina activated with a strong alkali solution and low heat. Geo-polymer or alkali activated Fly Ash cement is a substance that is generally made using fly ash(FA) as a raw material.The purpose of this thesis is to investigate the use of Paper Sludge Ash as a partial replacement for fly ash in geo-polymer concrete. This Fly Ash has a low calcium concentration and is widely utilized in the building industry. It may also be utilized to make high-strength geo-polymer concrete as a source material. A by-product, paper sludge, is utilized as a fuel in a mill boiler, small electricity generating plant, and other purposes. When paper sludge is burned, it has a high amount of silica, which is one of the primary ingredients in geo-polymer production. The amorphous reactive Paper Sludge ash might be created and utilized as pozzolana with correct burning and grinding. The SiO2-rich PSA can also be used to modify the geo-polymer's SiO2 concentration.TheimpactoftheSi/Alratioonthemechanical strength and rate of response of fly ash and Article Sludge ash based GPC is the subject of this paper. PSA was used to replace fly ash in the following proportions: 0%, 2%,4%,6%,8%,10%,12%,14%,and16%.

Keywords:Geo-polymer,flyash, PaperSludge ash,sodiumhydroxide,sodiumsilicate

Introduction

One of the most extensively utilized construction materials is Portland cement concrete. The demand for Portland cement rises in tandem with the demand for concrete as a construction material. Cement output is expected to expand from around 1.50 billion tonnes in1995 to 2.20 billion tonnes by 2010. (Malhotra, 1999). Climate change, on the other hand, has become a serious worry as a result of global warming. Human activities release greenhouse gases such as carbon dioxide (CO2) into the atmosphere, causing global warming. CO2 is the most potent greenhouse gas, accounting for around

65 percent of global warming (Mc Caffrey2002). Because the manufacture of 1 tonne of Portland cement emits about 1 tonne of CO2into the atmosphere, the cement industry is considered liable for some of the CO2 emissions (Davidovits,1994; McCaffrey,2002). In this regard, the geo-polymer technology introduced by Davidovits(1978)offers great potential for us alternative Portland cement in the concrete industry. In terms of minimising global warming, geopolymer technology has the potential to cut CO2 emissions from the cement and aggregate sectors by roughly 80%. (Davidovits,1994).

Objective

The thesis'main goal is to construct structural grade geo-polymer concrete(GPC)using various combinations of low calcium fly ash(ClassF)and paper sludge ash.

Geo-polymer

Davidovitscreatedtheterm"geopolymer"in1978.Geopolymerisaninorganicalumino-silicate polymer made mostly of silicon and aluminium components such fly ash,PSA, Metakaolin, and GGBS. To stimulate the silicon and aluminium atoms in the source materials(Flyash)to dissolve and produce gel,alkaline solutions are utilised.The polymerization process can be aided by using heat and then drying it. The loose coarse and fine particlesare bound together by the Geo-polymer gel to make geo-polymer concrete.

ReviewofLiteratures

GeopolymerConcretebasedonflyash.Flyash-basedconcretepropertiesanduses.MaterialsForumVolume30-2006,byB.Vijayarangan,DjwantororHardjito,SteenieE.Wallah, and M.J.sumajouw. The Fly ash-based Geopolymer concrete has outstandingcompressive strength and is acceptable for structural applications, according to this article. Themost important elements affecting the characteristics of fresh and hardened concrete have beendiscovered. Water content, new concrete setting time, curing temperature, and curing time areall factors to consider. The fly ash-based geopolymer concrete is also resistant to sulphateattack, has a low creep rate, and has minimal drying shrinkage**.** On the creation of geopolymerconcrete based on fly ash. ACI Materials Journal, by B.Vijayarangan, Djwantoro Hardjito,Steele E.Wallah, and M.J.Sumajouw (2004). The higher the concentration (in terms of molar)of Sodium Hydroxide solution, the higher the compressive strength of Geopolymer Concrete,according to thisstudy.The compressive strength of Geopolymerconcrete increases as theratio of sodium silicate to sodium hydroxide liquid ratio by mass increases. The compressivestrength of Geopolymer concrete improves as the curing temperature rises from 30 to 900degreesCelsius.Geopolymerconcretewithalongercuringperiod(between6and96hours)has a higher compressive strength. Paper Sludge Ash Concrete, Paper Mill Ash Reuse in PlasterBlends Saveria Monosi, Daniela Sani*, and Maria Letizia Ruello contributed to this piece. TheOpen Vaiste Management Journal 2012 is a publication dedicated to open source management.This study investigates the use of lightweightash from the paper mill sector in the productionof plaster mixtures. During the de-inking sludge combustion process, light ash is formed.Lightweight ash is an effective element in the creation of cement mortars and/or pozzolanicmortars for use as plaster, according to studies. The efficiency of the ash as it is, as a substituteforextremelyfine sand,wasinvestigatedinthis studyonashvalorization.

Materials

The materials employed in this study were chosen based on their specifications, which metthe criteria of suitable Indian standards as well as the research's aims. Fly ash and Paper Sludgeash were employed as starting materials in this experiment. Fly ash is a byproduct of coalcombustion. Paper Sludge ash is made from burning Paper Sludge and includes a lot of silica.The material for the concrete was made out of locally accessible coarse aggregates and fineriversands.NaOH,Na2SiO3,and otheralkaline activatorsare utilised.

The chemical compositions of the fly ash and Paper Sludge ash as determined by chemicalanalysis showninTable

Chemicalcomposition	FA%	PSA%
SilicaasSiO$_2$%	60.54	71.17
AluminaasAl$_2$O$_3$	23.87	16.15
IronasFe$_2$O$_3$	9.64	0.11
CalciumasCaO	1.07	7.04
MagnesiumasMgO	1.52	3.84

PreliminaryInvestigation

Thefollowingtestswereconductedinour concretelaboratory

FigNo.1FlyAsh

Fig No.2.PaperSludgeAsh

CatalyticLiquidSystem(CLS)

The alkaline activator solution (AAS) in GPC concrete is referred to as a catalytic liquidsystem (CLS). The CLS is made up of a solution of sodium silicate, sodium hydroxide, anddistilled water. The function of AAS is to activate the Si and Al source elements found in flyash and Paper Sludge ash. In a solution form, sodium silicate (Grade A53) had 65.50 percentwater, 26.50 percent SiO2, and 8% Na2O. Pellets of sodium hydroxide were employed in thisexperiment.Thesolutionhada 10Molarconcentration.

Property	Coarseaggregate	Fineaggregate%	FlyAsh	PaperSludge Ash
Specificgravity	2.65	2.63	2.17	2.12
Fineness modulus	2.60	2.60	9	8
Impact value	22	ZoneII	-	-

MixDesignofGeo-polymerConcrete-(10Molar)

Thefollowingparametersareconsideredformixdesign Massofalkalin eliquid/flyash =0.38

(Range0.30to0.45)

RatioofNa$_2$SiO$_3$Solution/NaOHsolution=2.10 **(Range2to2.50)Materials**	**Perk g/cum**
Flyash	394.29
Fine aggregate	554.40
Coarseaggregate	1293.60
NaOH	50.88
Na2SiO3	106.84

Mixproportion1:1.40:3.28

Fly ash was substituted by Paper Sludge ash for varied percentages in thesemixproportions ((i.e., 0 percent , 2 percent , 4 percent , 6 percent , 8 percent , 10 percent , 12percent,14percentand16percent)

Methodology

GeopolymerConcreteMixing Process

Amount of sodium hydroxide solution required is made. Before casting the cubes andcylinder,thesodiumhydroxideandsodiumsilicatesolutionsaremixedtogetherandmaintainedfor24h ours.(Forexample,intheGPCconcretemixproportionsabove,NaOH=49Kgs, Na2SiO3=103Kgs. The determined amount of fly ash, as well as coarse andfineaggregate,isnowcombined.PaperSludge ashwasto be usedin place offlyashinvaried

ratios.(i.e.,0%,2%,4%,6%,8%,10%,14%,16%,17%,16%,17%,14%,16%,17%,16%, 17%,17%,17%,17%,17%,17%,17%,17%,17%,17%,17%,17%,17%,1TomakeGeopolymer concrete,acombinedsolutionofsodiumsilicateandsodiumhydroxideisgentlypouredintothe mixtureandagitatedforafewminutes.

Casting andCuring

Cubesofdimension100x100x100mmandcylindersofdimension75mmdia150mmheights werecastimmediatelyaftercasting,

FigNo.3sodiumsilicateandsodiumhydroxide **FigNo.4Casting**

The samples are covered to avoid the loss of water due to evaporation, after 4 hours ofcuring, the specimens were demoulded. The demoulded specimens were again cured in anoven at a specified temperature of 60^0C for a period of 12 h .At the end of curing period thecubes, cylinders and prisms are removed from the oven. The specimens are then left to air dryatroomtemperature,untiltheyareloadedincompressiontestingmachineatthespecifiedage.

FigNo.5CompressionTestingMachine

FigNo.6CuringTestP

rocedure

Concretesampleswereretestedforcompressiveandtensilestrengthusingacompressiontestingequipmentinaccordancewith IS516.Fortheaforementionedmixproportions Geopolymer concrete (10Molar) for varied (percent) of replacements, 180 cubes,180 cylinders, and 180 prisms were cast. The cubes, cylinders, and prisms were put to the testforsevendays,fourteendays,andtwenty-eightdays.

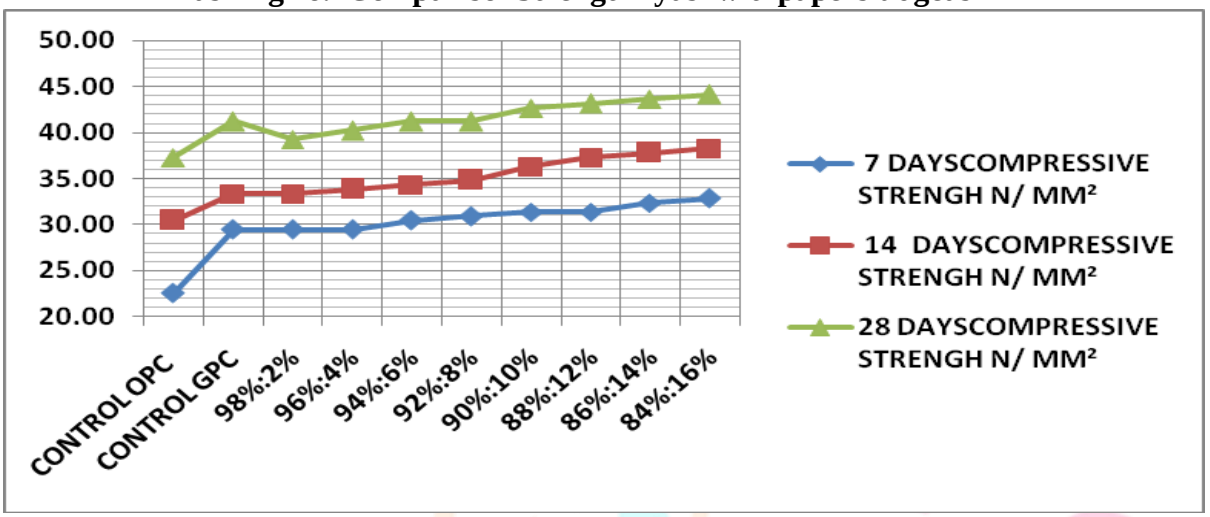
CompressiveStrength

Flyash:papersludgeash	**Compressive strength N/mm2 (7days)**	**Compressive strengthN/mm2(14days)**	**Compressive strengthN/mm2(28days)**
controlopcconcrete	22.56	30.41	37.28
controlgpc100%:0%	29.43	33.35	41.20
98%:2%	29.43	33.35	39.24
96%:4%	29.43	33.84	40.22
94%:6%	30.41	34.34	41.20
92%:8%	30.90	34.83	41.20
90%:10%	31.39	36.30	42.67

88%:12%	31.39	37.28	43.16
86%:14%	32.37	37.77	43.65
84%:16%	32.86	38.26	44.15

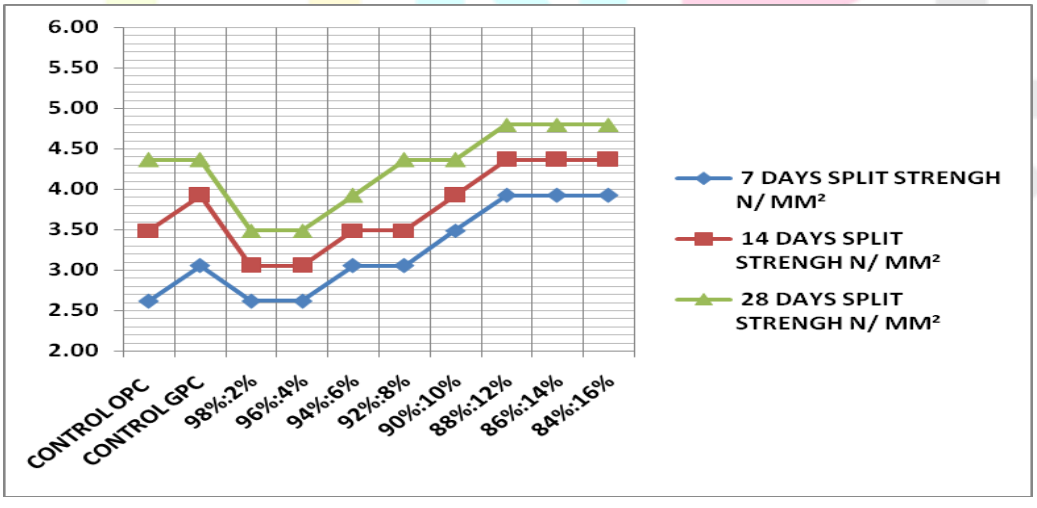
TABLE NO.1 Compressive Strength fly ash with paper sludge

ashFigNo.7ComparisonStrengthflyashwithpapersludgeash



SplitTensileStrength

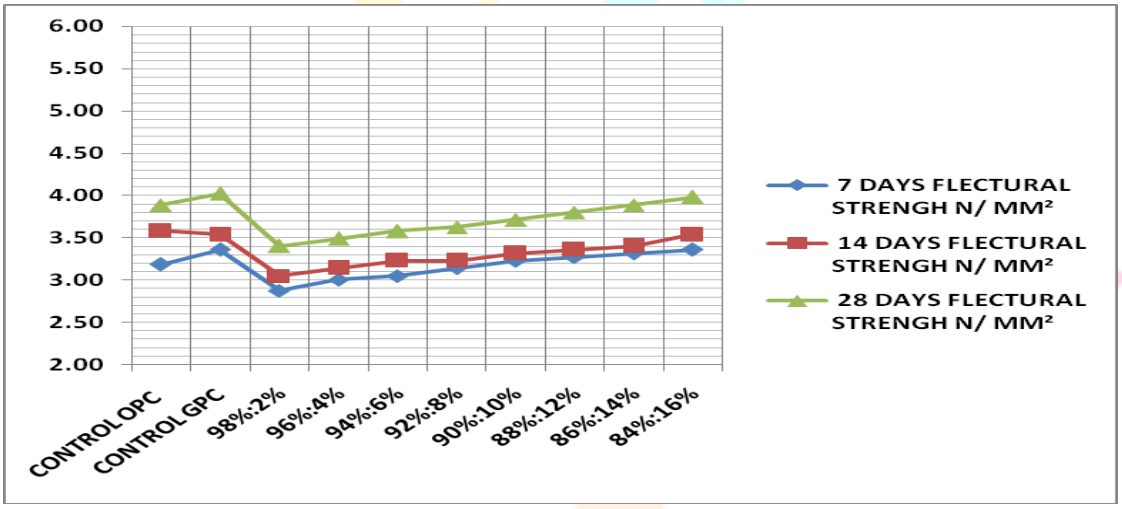
Fly ash:Papersludge ash	Splittensilestrength N/mm²(3days)	Splittensilestrength N/mm²(7days)	Splittensilestrength N/mm²(28 days)
controlOPCconcrete	2.62	3.49	4.36
controlGPC 100%:0%	3.05	3.92	4.36
98%:2%	2.62	3.05	3.49
96%:4%	2.62	3.05	3.49
94%:6%	3.05	3.49	3.92
92%:8%	3.05	3.49	4.36
90%:10%	3.49	3.92	4.36
88%:12%	3.92	4.36	4.80
86%:14%	3.92	4.36	4.80
84%:16%	3.92	4.36	4.80



FigNo.8SplitTensileStrengthflyashwith papersludgeash

FlexuralStrength

Fly ash:Papersludge ash	Flexural strengthN/ mm^2(7days)	Flexural strengthN/mm^2(14days)	Flexuralstrength N/mm^2 (28days)
ControlOPCconcrete	3.18	3.58	3.89
ControlGPC 100%:0%	3.36	3.54	4.02
98%:2%	2.87	3.05	3.40
96%:4%	3.00	3.14	3.49
94%:6%	3.05	3.23	3.58
92%:8%	3.14	3.23	3.62
90%:10%	3.23	3.31	3.71
88%:12%	3.27	3.36	3.80
86%:14%	3.31	3.40	3.89
84%:16%	3.36	3.54	3.98



FigNo.8 FlexuralStrengthflyashwithpapersludgeash

ResultsAndDiscussions

Thefindings of thecompressivestrength tests inthefigureareforoven curing,followed by ambientcuring.When 16 percentof thefly ash is replaced with Paper Sludgeash, the peak strength of 44 Mpa is achieved after 28 days. A replacement study is nowunderway.

Conclusions

On the basis of the findings and discussions, the following conclusions are reached.Paper sludge ash is a novel substance that may be used to substitute cement in buildingprojects, allowing construction companies to save money while maintaining environmentalquality. Fly ash and Paper Sludge ash, in combination with NaOH and Na2SiO3, can be usedas a cement substitute. The compressive strength of geo-polymer concrete diminishes as themass ratio of water to geo-polymer particles rises. The government can take the necessaryprocedures to extract NaOH, Na2SiO3 Solution from waste materials generated by chemicalbusinesses,loweringthecostof thegeo-polymersolution.Highperformanceandgreenmaterials can save money in terms of raw material usage, CO2 emissions, and global warmingpotential,accordingtoenvironmentalcalculations.Accordingtoresearch,flyashmaysecurelysubstitute16percentofpapersludgeashingeo-polymerconcrete.GPChas1.18,1.01, and 1.02 times the compressive, split, and flexural strength of controlled concrete,respectively.

References

1.ConcreteTechnology,Theoryand Practice -M.S.Shetty
2. IS:456-2000,Codeofpracticefor plainandReinforcedConcrete.3.IS:10262-2003,ConcreteMixproportioning-Guidelines.
4.IS:3812-2003,Specificationforflyashuseaspozzolanaand admixture.
5.IS: 383-1970, Specification for coarse and fine aggregates from natural sources for concrete.6.B.Vijayarangan, Djwantro Hardjito, Steenie E Wallah and M.J.Sumajouw, Properties

andapplicationsofflyashbasedGeopolymerConcrete,MaterialsForumVolume30-2006.(Instituteofmaterials EngineeringAustraliaLtd.,)
7.B.Vijayarangan,DjwantroHardjito,SteenieEWallahandM.J.Sumajouw,OntheDevelopmentofflyash basedGeopolymerConcrete,ACIMaterialsJournal(2004).
8.MixDesignandProductionofFlyashbasedGeopolymerconcretebyProf.B.VijayaRangan.,TheIndian ConcreteJournal,May2008.
9.Development and properties of Low- Calcium Fly ash – Based Geopolymer Concrete by D.HardjitoandB.VijayaRangan,Curtinuniversityoftechnology,Australia(2005).
10.B.Vijayarangan,LowCalciumFly-Ash-BasedGeopolymerConcrete,Taylor&FrancisGroup,L.I.C(2008)
11.K.Vijai,R.KumuthaandB.G.Vishnuram,Effectoftypesofcuringonstrengthofgeopolymerconcrete,I nternationalJournalofphysicalsciences (2010).
12. Djwantro Hardjito, Steenie E Wallah, Dody M.J.Sumajouw and B.Vijayarangan, FactorsInfluencingthecompressivestrengthofflyashbasedGeopolymerConcrete,CivilEngineeringDim ension.(2004).