International Journal for Innovative Engineering and Management Research
A Peer Revieved Open Access International Journal
www.ijiemr.org

IJIEMR Transactions, online available on 26th Aug 2017. Link :http://www.ijiemr.org/downloads.php?vol=Volume-6&issue=ISSUE-7

Title: **FLEXURAL BEHAVIOUR OF A EQUI PROPORTIONAL FLY ASH AND GGBS FIBER REINFORCED GEOPOLYMER CONCRETE**

Volume 06, Issue 07, Pages: 316-325.

Paper Authors

D.SUGUNA PRIYA ,DR.D.VENKATESWARLU

Godavari Institute of Engineering &Technology (Autonomous),Rajahmundry,A.P,India .

USE THIS BARCODE TO ACCESS YOUR ONLINE PAPER

To Secure Your Paper As Per UGC Guidelines We Are Providing A Electronic Bar Code

International Journal for Innovative Engineering and Management Research
A Peer Revieved Open Access International Journal
www.ijiemr.org

FLEXURAL BEHAVIOUR OF A EQUI PROPORTIONAL FLY ASH AND GGBS FIBER REINFORCED GEOPOLYMER CONCRETE

[1]D.SUGUNA PRIYA , [2]DR.D.VENKATESWARLU

[1]PG Scholar,Dept of Civil Engineering,Godavari Institute of Engineering &Technology (Autonomous),Rajahmundry,A.P,India
[2]Professor & Head of the Department of civil Engineering,Godavari Institute of Engineering &Technology (Autonomous),Rajahmundry,A.P,India

ABSTRACT Manufacture of Portland cement produces large volumes of carbon dioxide and other gases. Releasing these gases causes atmospheric pollution and subsequent environmental degradation. Concrete is widely used and reliable material for construction. Some of challenges in industry are global warming and insufficiency of construction material. One of the methods for replacing concrete constituents is the use of geo-polymer which helps in using very less quantity of cement in concrete. Geopolymer results from the reaction of a source material that is rich in silica and alumina with alkaline liquid. It is essentially cement free concrete. This material is being studied extensively and shows promise as a greener substitute for ordinary Portland cement concrete in some applications. Research is shifting from the chemistry domain to engineering applications and commercial production of geopolymer concrete. It has been found that geopolymer concrete has good engineering properties with a reduced global warming potential resulting from the total replacement of ordinary Portland cement. This project represents study on the flexural behavior of fiber reinforced geopolymer concrete. In this study, geopolymer concrete is produced with fly ash, GGBS and sodium hydroxide and sodium silicate is used as a binder. Fly ash and GGBS are taken in equal proportion to enhance properties of concrete and the fiber used in this project is polypropylene fiber (Recron 3s). For this project, the mix design is carried out for 8M and 16M concentration of sodium hydroxide. Alkaline activator solution ratio of 2.0 is selected for this investigation. The specimen of size 500x100x100mm prisms were casted of M10, M20, M30 and M40 grade of concrete and the specimens of geo-polymer concrete are cured at ambient temperature for 7days and 28 days. The cured specimens were then tested for flexural strength and high strengths are achieved.

Key Words: Sodium hydroxide, Fly ash, GGBs, poly propolene fibers,Flexural strength

1. INTRODUCTION Cement concrete is manmade material which prepared by mixing of cement, water, natural fine and coarse aggregate. The past century developed cement concrete as material for construction work. In 1902 August Perret, first designed building in Paris with structural components beams, slabs and columns. Construction variety of infrastructure and industrial sector by concrete makes it is an essential product. It is widely used manmade material in the globe. It is produced by natural materials, it is reliable material, gives architectural freedom. After water most widely consumed material is concrete as more than ton produced every year for each person in the world. But, the environmental hazard caused by production of concrete material has concerned to make an eco-friendly material for construction. It is been studied that embodied carbon dioxide (ECO2) ranges from 700-800 kg CO_2 for a tone of concrete. The embodied carbon dioxide varies depending upon methods and type of mix design. In cement industry, research has been carried out in collection of latest material and up gradation of technology. In India 93% of cement industry uses dry process technology which is environment friendly. The old dry process technology and semi dry process technology is being used by 7% of cement industry. There is reduction in emission level of CO_2 due to the waste heat recovery in cement plant. After steel and aluminium, cement is the next material which produces high energy. It also uses an ample amount of non renewable materials, e.g. coal, lime stone etc. About 65% of global warming is caused by CO_2. The cement industry is not suitable for sustainable industry since it causes high pollution to the environment. So, there is necessity for alternate material for cement in the concrete which should be eco-friendly, should satisfy mechanical properties and durability characteristics. This new material should be more superior, preferable compared to conventional concrete based on cement.

2. Materials

a) FLY ASH

Fly ash (FA) is a by-product of the combustion of pulverized coal in thermal power plants. It is a fine grained, powdery and glassy particulate material that is collected from the exhaust gases by electrostatic precipitators or bag filters. When pulverized coal is burnt to generate heat, the residue contains 80 per cent fly ash and 20 per cent bottom ash. The size of particles is largely dependent on the type of dust collection equipment. Diameter of fly ash particles ranges from less than 1 µm–150 µm. It is generally finer than Portland cement. Their surface area is typically 300 to 500 m2/kg, although some fly ashes can have surface areas as low as 200 m2/kg and as high as 700 m2/kg. However, the effect of increase in specific surface area beyond 600 m2/kg is reported to be insignificant. In Table 4.1 Chemical composition of fly ash is given.

fly ash

Chemical composition of fly ash

Oxides	Fly ash	Requirements as perIS 3812-2003
SiO_2	63.24%	SiO_2 > 35% Total - > 70%
Al_2O_3	17.35%	
Fe_2O_3	2.63%	
CaO	2.05%	–
Na_2O	0.24%	<1.5%
K_2O	0.32%	
MgO	0.96%	< 5%
LOI	0.95%	<12%

b) GROUND GRANULATED BLAST FURNACE SLAG (GGBS)

Ground-granulated blast-furnace slag (GGBS) is obtained by quenching molten iron slag (a by-product of iron and steel-making) from a blast furnace in water or steam, to produce a glassy, granular product that is then dried and ground into a

International Journal for Innovative Engineering and Management Research
A Peer Revieved Open Access International Journal
www.ijiemr.org

fine powder. GGBS cement can be added to concrete in the concrete manufacturer's batching plant, along with Portland cement, aggregates and water. The normal ratios of aggregates and water to cementitious material in the mix remain unchanged. GGBS is used as a direct replacement for Portland cement, on a one-to-one basis by weight. Replacement levels for GGBS vary from 30% to up to 85%. Typically 40 to 50% is used in most instances. The use of GGBS in addition to Portland cement in concrete in Europe is covered in the concrete standard EN 206:2013. This standard establishes two categories of additions to concrete along with ordinary Portland cement: nearly inert additions (Type I) and pozzolanic or latent hydraulic additions (Type II). GGBS cement falls in the latter category. As GGBS cement is slightly less expensive than Portland cement, concrete made with GGBS cement will be similarly priced to that made with ordinary Portland cement.

GGBS

GGBS is provided by a local supplier who uses the slag of Visakhapatnam Steel Plant. It was tested as per BS: 6699 with 70% GGBS and 30% OPC53 grade. The sand used in the tests, ambient conditions and methods of tests are as per IS 4031 & IS 4032.The product is conforming to BS: 6699 :1992 specification.

c) Fine aggregate Natural sand –

fine aggregate resulting from the natural disintegration of rock and which has been deposited by streams or glacial agencies. Crushed stone sand – fine aggregate produced by crushing hard stone. Crushed gravel sand – fine aggregate produced by crushing natural gravel. Fine aggregate which is used for the study is taken from Visakhapatnam and it come under zone

d) Coarse aggregate

Uncrushed gravel or stone which results from the natural disintegration of rock. Crushed gravel or stone when it results from crushing of gravel or hard stone. Partially crushed gravel or stone when it is a product of the blending of above two. The size of aggregate bigger than 4.75mm is considered as coarse aggregate and aggregate whose size is 4.75mm and less is considered as fine aggregate. The aggregate should not contain more than 0.5 percent of sulphates as SO3 and should not absorb more than 10 percent of their own mass of water. Coarse and fine aggregate are batched separately. The coarse aggregate used for the study is taken from a provider at Visakhapatnam.

e) SODIUM HYDROXIDE (NaOH)

Generally the Sodium Hydroxides are available in solid state by means of pellets and flakes. The cost of the Sodium Hydroxide is mainly varied according to the purity of the substance. Since our Polypropylene Fibre Reinforced Geopolymer Concrete is homogeneous material and its main process to activate

International Journal for Innovative Engineering and Management Research
A Peer Revieved Open Access International Journal
www.ijiemr.org

the Sodium Silicate so it is recommended to use the lowest cost i.e. up to 94% to 96% purity. In this investigation the Sodium Hydroxide pellets were used. Sodium hydroxide is used in many industries, mostly as a strong chemical base in the manufacture of pulp and paper, textiles, drinking water, soaps and detergents and as a drain cleaner. Worldwide 5 production in 2004 was approximately 60 million tonnes, while demand was 51 million tonnes. Gloves should be used while handling sodium hydroxide. . Whose physical property are given by manufacturer are as follows for solid Sodium Hydroxide.

Picture of NaOH flakes

Table 4.3 Physical Properties of Sodium Hydroxide

Colour	Colour less
Specific gravity	2.13
Ph	14

f) SODIUM SILICATE (Na2SiO3)

Sodium silicate is the common name for compounds with the formula Na2(SiO2)nO. A well-known member of this series is sodium metasilicate, Na2SiO3. Also known as waterglass or liquid glass, these materials are available in aqueous solution and in solid form. The pure compositions are colourless or white, but commercial samples are often greenish or blue owing to the presence of ironcontaining impurities. 6 They are used in cements, passive fire protection, textile and lumber processing, refractories, and automobiles. Sodium carbonate and silicon dioxide react when molten to form sodium silicate and carbon dioxide:

$$Na_2CO_3 + SiO_2 \rightarrow Na_2SiO_3 + CO_2$$

Anhydrous sodium silicate contains a chain polymeric anion composed of corner-shared {SiO4} tetrahedral, and not a discrete SiO3 2−ion. In addition to the anhydrous form, there are hydrates with the formula Na2SiO3·nH2O (where n = 5, 6, 8, 9) which contain the discrete, approximately tetrahedral anion SiO2(OH)2 2− with water of hydration. For example, the commercially available sodium silicate pentahydrate Na2SiO3·5H2O is formulated as Na2SiO2(OH)2·4H2O and the nonahydrate Na2SiO3·9H2O is formulated as Na2SiO2(OH)2·8H2O.

In industry, the various grades of sodium silicate are characterized by their SiO2:Na2O weight ratio (weight ratios can be converted to molar ratios by multiplication with 1.032), which can vary between 2:1 and 3.75:1. Grades with this ratio below 2.85:1 are termed alkaline.

Those with a higher SiO2:Na2O ratio are described as neutral. The following data of sodium silicate used in this experimental investigation is provided.

Composition and properties of sodium silicate

PHYSICAL PROPERTY	VALUES
Composition of SiO_2	32.15
Composition of Na_2O	15.85
Colour	Transparent white
Solid	48
Water	52
Specific Gravity	1.56
Bommae	53^o

g) WATER

Water is an important ingredient of concrete as it actively participates in the chemical reaction with cement. Since it forms the strength giving cement gel, the quantity and quantity of water is to be looked into very carefully. Since quality of water affects the strength, it is necessary for us to go into the purity and quality of water The water used for mixing of materials was potable water collected from the laboratory taps conforming to IS 456-2000.

h) SUPERPLASTICIZER

(Conplast SP 430) Super plasticizers constitute a relatively new category and improved version of plasticizer. They are chemically different from normal plasticizers. Use of super plasticizers permits the reduction of water to the extent upto 30 percent without reducing workability in contrast to the possible reduction up to 15 percent in case of plasticizers. The use of plasticizers is practiced for production of flowing, self levelling, self-compacting and for the production of high strength and high performance concrete. The super plasticizer used is Conplast SP 430 manufactured by Fosroc Chemicals Pvt. Ltd. Conplast SP430 is a chloride free, super plasticising admixture based on selected sulphonated naphthalene polymers. It is supplied as a brown solution which instantly disperses in water. The data regarding it is obtained. The quantity of this material used is 1.5% of Ground granulated blast furnace slag by mass

Properties of Conplast SP 430

Properties	Values
Specific gravity	1.220 to 1.225 at 300C
Chloride content	Nil to IS:456
Air entrainment	Approx. 1% additional air is entrained

i) POLYPROPLENE FIBER (RECRON 3S)

Recron 3s fiber was used as a secondary reinforcement ma- terial. It arrests shrinkage cracks and increases resistance to water penetration, abrasion and impact. It 8 makes concrete homogenous and also improves the compressive strength, ductility and flexural strength together with improving the ability to absorb more energy. Use of uniformly dispersed Recron 3s fibers reduces segre- gation and bleeding, resulting in a more homogeneous mix. This leads to better strength and reduced permeability which improves the durability. The used Recron 3s Fiber's test results are given in

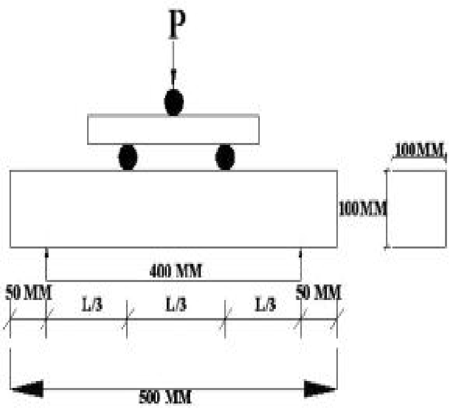
International Journal for Innovative Engineering and Management Research
A Peer Revieved Open Access International Journal
www.ijiemr.org

Polyprolene Fibers

3. TESTS CONDUCTED

Flexural Strength Test

Flexural strength is a measurement that indicates the resistance of a material to deformation when placed under load. The beam specimens were 100 x 100 x 500 mm in cross-section. The geometry of the beam specimen is shown in Figure 4.5



TWO POINT LOADING SETUP IN FLEXURE TEST

Two point loading setup in flexural test

The test specimen was mounted in a universal testing machine of 1000 KN capacity. The load was applied on two points from centre of the beam towards the support. The flexural strength of the specimen shall be expressed as the modulus of rupture fb .The photographic view of the experimental facility used to test the flexural strength is shown in Figure 4.6. Equation (4.3) and (4.4) represents the formula for calculating flexural strength

When a < 13.3, then

$$F_b = \frac{(3P \times a)}{[illegible]} \quad ...(4.3)$$

when a >13.3, then

$$F_b = \frac{(P \times l)}{[illegible]} \quad ...(4.4)$$

4. RESULTS AND DISCUSSIONS

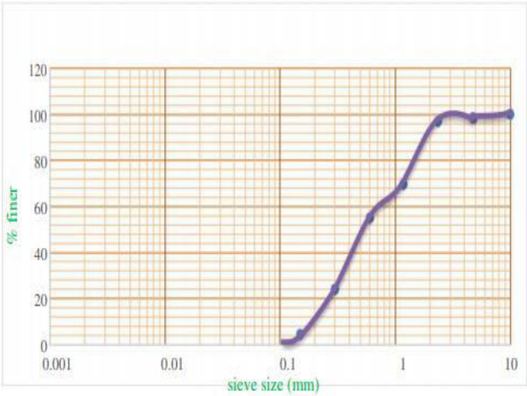
Sieve analysis of fine aggregate

The sieve analysis performed on fine aggregate showed that it belongs to zone II. A plot between the percent finer and sieve size is shown below in the Figure 5.1. The sieve analysis of fine aggregate resulted out that it belongs to zone II.

Table 5.1 Results of sieve analysis

Sl.no	IS Sieve size (mm)	% Passing
1	10	100
2	4.75	98.8
3	2.36	96.5
4	1.18	69.6
5	0.6	55.0
6	0.3	28.0
7	0.15	6

International Journal for Innovative Engineering and Management Research
A Peer Revieved Open Access International Journal
www.ijiemr.org



Logarithmic graphs for sieve analysis of fine aggregate

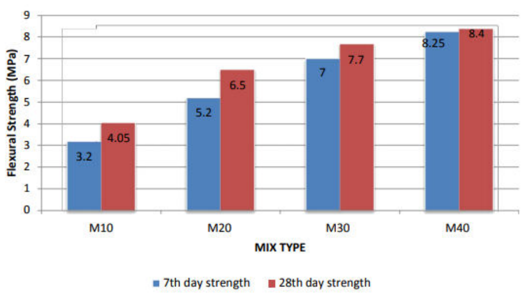
FLEXURAL STRENGTH TEST

he standard sized prisms of dimensions 500mm x 100mm x100mm were tested. The test results are tabulated for 8 molar and 16 molar mixes separately. Simple graphs are plotted from this data and are presented.

16 molar

molar mixes 7th-day and 28th-day strength

Mix Type	Strength on 7th day (MPa)	Strength on 28th day (MPa)
M10	3.2	4.05
M20	5.2	6.5
M30	7.0	7.7
M40	8.25	8.4

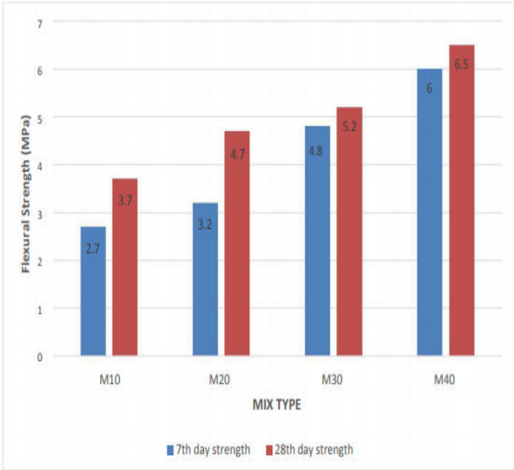


Variation of 7th day and 28th day flexural strength for 16 Molar

8 Molar

Table: 8 molar mixes 7th-day and 28th-day strength

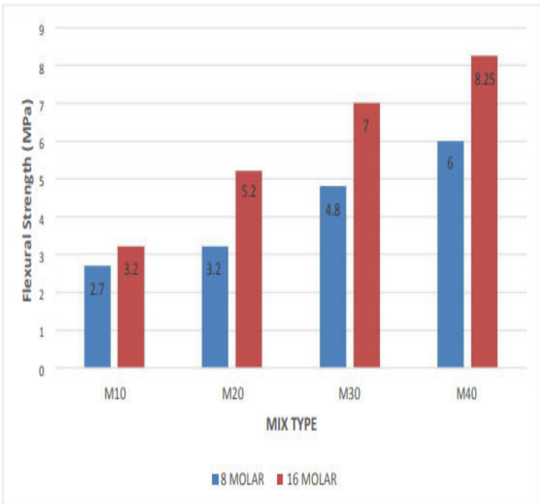
Mix Type	Strength on 7th day (MPa)	Strength on 28th day (MPa)
M10	2.7	3.7
M20	3.2	4.7
M30	4.8	5.2
M40	6.0	6.5



Variation of 7th day and 28th day flexural strength for 8 Molar

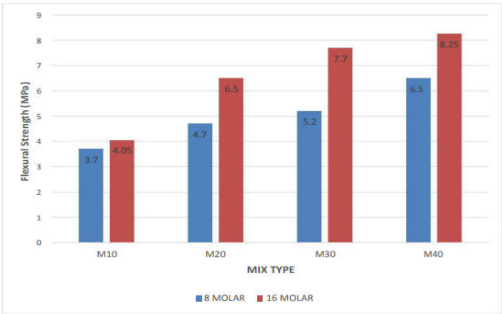
Graphical Representations of Variations

This section presents various graphical representation of variations in strength of concrete on different days of testing of the two different concretes and also compares these two concretes differing in concentration.



Variation of strengths between 8 molar and 16 molar on 7th day testing

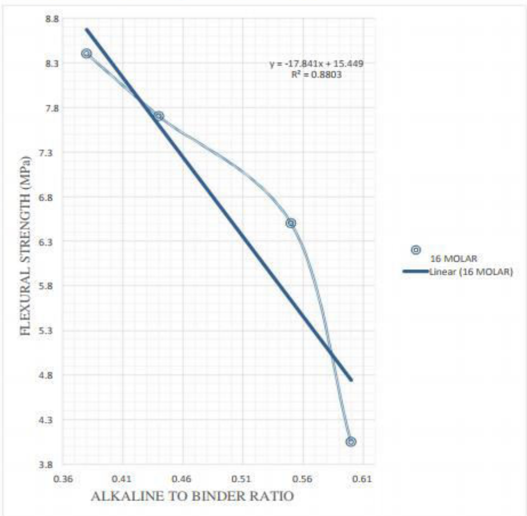
The above graph FIG 5.4 shows that the strength obtained for 16 molar specimens are greater than the strength obtained for 8 molar specimens on 7th day testing.



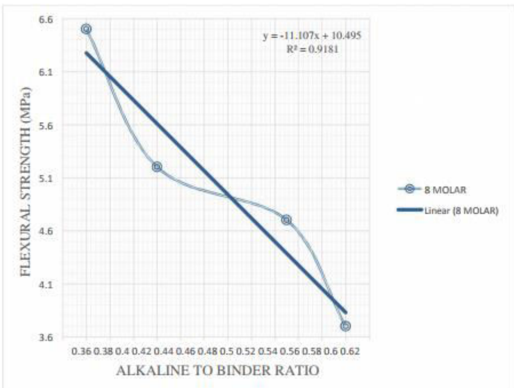
Variation of strengths between 8 molar and 16 molar on 28th day testing

above graph FIG 5.5 shows that the strength obtained for 16 molar specimens are greater than the strength obtained for 8 molar specimens on 28th day testing. A generalised variation of strength with alkaline liquid to binder ratio is plotted and shown for both the concretes of different concentrations in |FIG 5.6 and 5.7.

Generalised curve for 28th day strength for 16 molar



Generalised curve for 28th day strength for 8 molar



5. CONCLUSIONS

1. The flexural strengths obtained on 7thday and 28thday testing of prism specimens of 16 molarity are greater than the 8 molarity in both nominal and design mixes

2. In 8 molarity the highest flexural strength is achieved for Mix4 and the strength is 6.5 MPa obtained on 28th day. The lowest flexural strength is achieved for Mix1and the strength is 2.7 MPa obtained on 7th day.

3. In 16 molarity the highest flexural strength is achieved for Mix4 and the strength is 8.4 MPa obtained on 28th day. The lowest flexural strength is achieved for Mix1 and the strength is 3.2 MPa obtained on 7th day.

4. The generalized curve shows that the lowest ratios of Alkaline liquid to Fly ash and GGBS ratio gives the highest flexural strengths, for both 8 molarity and 16 molarity.

5. Generalized curve obtained for 8 molarity is linear than generalized curve obtained for 16 molarity. 6. It is observed that in 8 molarity flexural strengths increased for 28 days is 1.2 times greater than 7 days, in 16 molarity flexural strengths increased for 28 days is 1.125 times greater than 7 days.

ACKNOWLEDGEMENT

I am grateful to my guide Dr.D. VENKATESWARLU, Head of the Department, for having given me the opportunity to carry out this project work. I take this opportunity to express my profound and whole heartfelt thanks to my

International Journal for Innovative Engineering and Management Research
A Peer Revieved Open Access International Journal
www.ijiemr.org

guide, who with her patience, support and sincere guidance helped me in successful completion of the project. I would like to thank Dr.D. VENKATESWARLU, Professor and Head of the Department of CIVIL ENGINEERING, for valuable suggestions throughout my project which have helped in giving definite shape to this work. I would like to express my deep sense of gratitude to Dr.D.V. RAMA MURTHY Principal, for providing me a chance to undergo the course in the prestigious institute. I am very much obliged to Dr.L.S. GUPTA, Director and Dr.M.VARA PRASADA RAO, Dean of Godavari Institute of Engineering and Technology for giving opportunity to undergo this project. Finally I would like to thank all the faculty members and non teaching staff from Department of Civil Engineering, GIET for their direct and indirect help during the project work. I owe my special thanks to the MANAGEMENT of our college for providing necessary arrangements to carry out this project. 18 The euphoria and satisfaction of completing this project will not be completed until I thank all the people who have helped me in the successful completion of this euthusiastic task. Lastly I thank my parents for their ever-kind blessings. DANDANGI SUGUNA PRIYA

DECLARATION

I, Dandangi Suguna Priya, hereby declare that the project entitled "FLEXURAL BEHAVIOUR OF A EQUI PROPORTIONAL FLY ASH AND GGBS FIBER REINFORCED GEOPOLYMER CONCRETE"under the guidance of Dr.D. VENKATESWARLU, submitted in partial fulfillment of the requirements for the award of the degree of Master of Technology in Structural Engineering is a record of bonafide work carried out by me and the results embodied in the project have not been reproduced. The results embodied in this project have not been submitted to any other university or institution for the award of any degree. DANDANGI SUGUNA PRIYA

REFERENCES

TECHNICAL PAPERS

- Behzad Kalantari, Arun Prasad and Bujang B. K. Huat, (2011) "Use of cement,
- Polypropylene fibers and optimum moisture content values to strengthen peat"
- International Journal of Physical Sciences Vol. 7(8), pp. 1276 – 1285.
- P.Eswaramoorthi and G.E. Arunkumar (2014) " Fibers Study On Properties Of
- Geopolymer concrete With Polypropylene " Volume 3, Issue 2 (February
- 2014), PP.60-75
- Deotale.R.S, Sathawane S. H, Narde A.R, (2005)"Effect of Partial
- Replacement of Cement by Fly Ash, Rice Husk Ash with Using Steel Fiber in
- Concrete", Vol 3, pp 6.
- Siva Konda Reddy, B, Varaprasad, J and Naveen Kumar Reddy, K, (2009),"
- Strength and workability of low lime fly-ash based geopolymer concrete",

- Indian Journal of Science and Technology Vol.3, pp 12.
- Fareed, Ahmed, Memon, Muhd, Fadhil, Nuruddin, Samuel, Demieand, (2011)
- “Effect of Curing Conditions on Strength of fly ash-based Self Compacting
- Geopolymer Concrete”, International Journal of Civil and Environmental
- Engineering Vol 3, pp 3.
- Vijaya Rangan, B, Dody Sumajouw, Steenie Wallah, wantoro Hardjito Dj,
- (2006),”Reinforced low calcium fly ash-based geopolymer concrete beams and
- columns”, Journal of Engineering Science and Technology Vol 4,pp16-17.
- Vijai.K, Kumuthaa.V and Vishnu ramb T.B, (2003) “Effect of inclusion of
- steel fibres on the properties of geopolymer concrete composites”,
- International journal, Vol 7, pp 1-5.
- V. Supraja, and M. Kanta Rao “Experimental study on Geo-Polymer concrete
- incorporating GGBS” ISSN:2277-9477, Volume2