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Flexural behavior of Alkaline solution with equiproportional fly ash and ggbs fiber reinforced geopolymer concrete

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ABSTRACT

Geopolymer concrete is a concrete with sodium hydroxide-silicate binder mechanism.It possesses the benefits of expeditious strength gain, excellent mechanical and durability properties. 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.This project represents study on the flexural behaviour 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 areachieved.

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 (CO_2) ranges from 700-800 kg CO_2 for a ton 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 ecofriendly, should satisfy mechanical properties and durability characteristics. This new material should be more superior, preferable compared to conventional concrete based on cement.

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In 1978 Davidots introduced geopolymer as new material for cement and describes the composition of mineral binder which is similar to zeolites with amorphous microstructure. In order to get inorganic polymer system of alumino silicate by utilizing silica and alumina (Al_2O_3) which are available in metakaolinclay. The ordinary Portland cement does not require silicon silicate hydration process to get homogeneous mix and mechanical properties to get desired strength, there is need of poly condensation of silica and alumina. Geopolymer material and alkaline binder solutions are main constituent to form geopolymer. The geopolymer material should be rich in silicon and aluminium. Fly ash, red mud, GGBS and rice husk ash which are the source materials for geopolymer. To create three dimensional polymeric chain and structure it is necessary to have silica and alumina of fly ash consisting of Si-O. The rate of concentration of solids is higher in aluminium silicate gel during geopolymerisation reaction. The alkaline liquids help to activate minerals containing reactive silicon and aluminium which helps to get inorganic polymeric material. It is found that fly ash and GGBS are best source material for geopolymeric system to get satisfactory strength in geopolymer concrete. The alkaline activator solutions help to activate fly ash, GGBS in concrete, which are easily available in India. The preparation of geopolymer concrete is same as conventional concrete, which uses alkaline activator solution (AAS) instead of water which acts as binder for the concrete.

The following are three basic form of geopolymer:

- Poly (sialate), which has [-Si-O-Al-O-] as the repeating unit.
- Poly (sialate-siloxo), which has [-Si-O-Al-O-Si-O-] as the repeating unit.
- Poly (sialate-disiloxo), which has [-Si-O-Al-O-Si-O-Si-O-] as the repeating unit.

Geopolymer concrete is new material to be developed for use in construction work which should be eco-friendly.The following are the properties of geopolymer concrete:

- Geopolymer concrete sets at room temperature
- It is non toxic
- It has long life
- It is impermeable

- It is a bad thermal conductor and possess high resistance to inorganic solvents

It gives more strength.

1.1. Polymerization

Polymerization is a process of reacting monomer molecules together in a chemical reaction toform polymer chains or three-dimensional networks. In chemical compounds, polymerization occurs via avariety of reaction mechanisms that vary in complexity due to functional groups present in reactingcompound sand their inherent steric effects.Polymerization**,** any process in which relatively small molecules, called monomers, combine
chemically to produce a very large chainlike or network molecule, called a polymer. Usually at least 100monomer molecules must be combined to make a product that has certain unique physical properties suchas elasticity, high tensile strength, or the ability to form fibers that differentiate polymers from substancescomposed of smaller and simpler molecules often, many thousands of monomer units are incorporated in asingle molecule of a polymer.

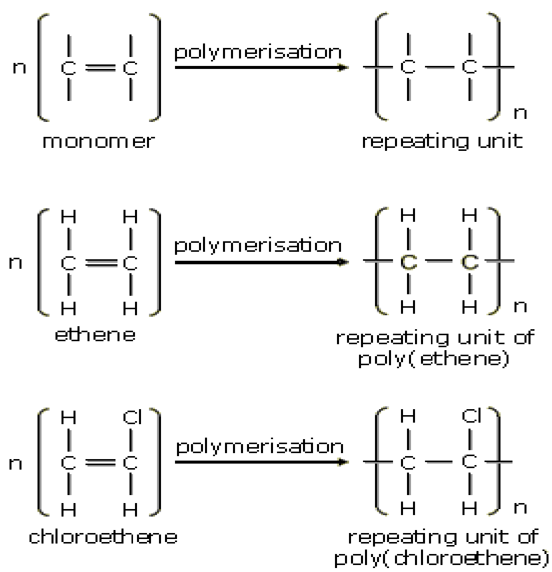

Figure 1 Polymerization Equation

2.RESULTS AND DISCUSSIONS

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2.1 INTRODUCTION

In this chapter the results based on experimental work are presented and discussed. The Reinforced geopolymer concrete prisms made were tested in laboratory according to the procedures of the tests as explained in previous chapter. The tests are carried out on the concrete cubes on 7 days and 28 days of curing. The results obtained from experimental work include sieve analysis, specific gravity, unit weight of aggregate and flexural strength.

2.2 RESULTS

2.2.1 RESULTS OF MATERIALS

Tests conducted on fly ash

Specific gravity = **2.7**

Tests conducted on GGBS

Specific gravity = **2.9**

Tests conducted on Coarse aggregate

Specific gravity = **2.7**

Unit weight in loose condition = **1.55 g/cc**

Unit weight in dense condition = **1.70 g/cc**

Tests conducted on fine aggregate

Specific gravity = **2.65**

Unit weight in loose condition = **1.36 g/cc**

Unit weight in dense condition = **1.57 g/cc**

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 2.1 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

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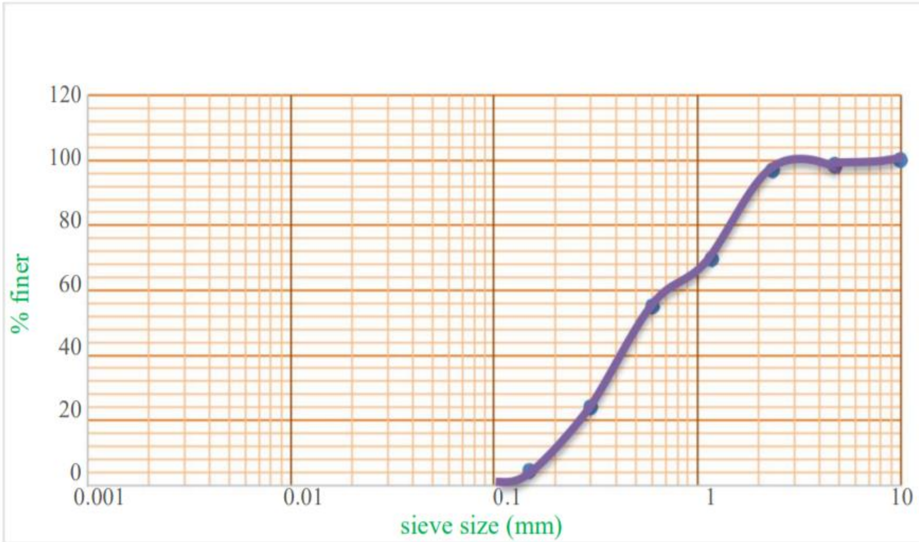

Figure 2.1 Logarithmic graph for sieve analysis of fine aggregate

2.2.2 RESULTS OF SPECIMENS

The 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

Table 2.2: 16 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

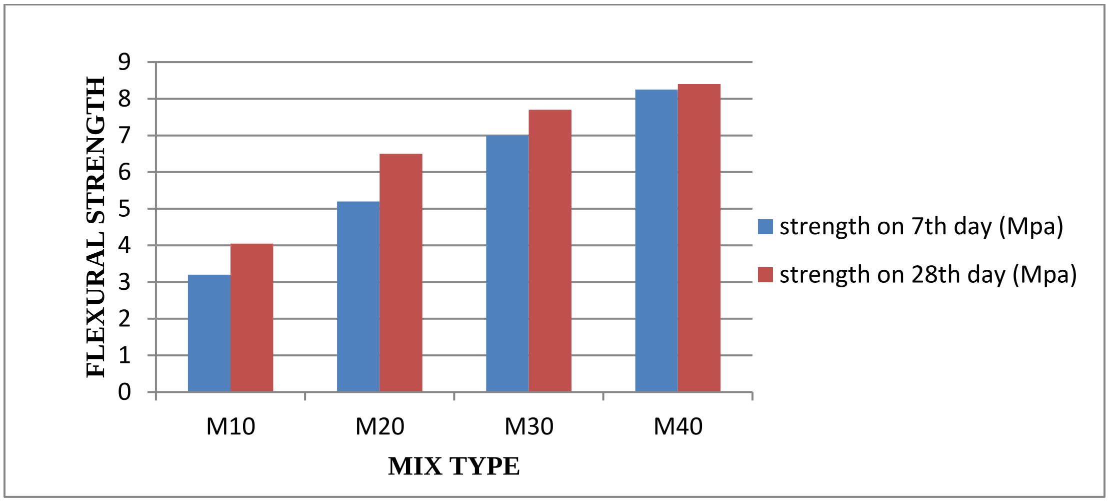

Figure 2.2 Variation of 7th day and 28th day flexural strength for 16 Molar

8 Molar

Table 2.3: 8 molar mixes 7th-day and 28th-day strength

Mix Type	Strength on 7th day (MPa)	Strength on 28thday (MPa)
M10	2.8	3.8
M20	3.1	4.9
M30	4.9	5.2
M40	6.0	`6.8

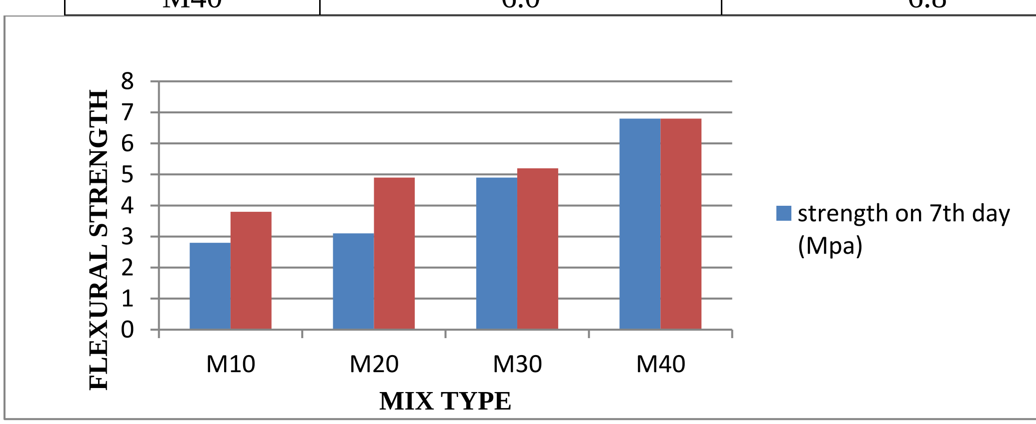

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Figure 2.3 Variation of 7th day and 28th day flexural strength for 8 Molar

2.3 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.

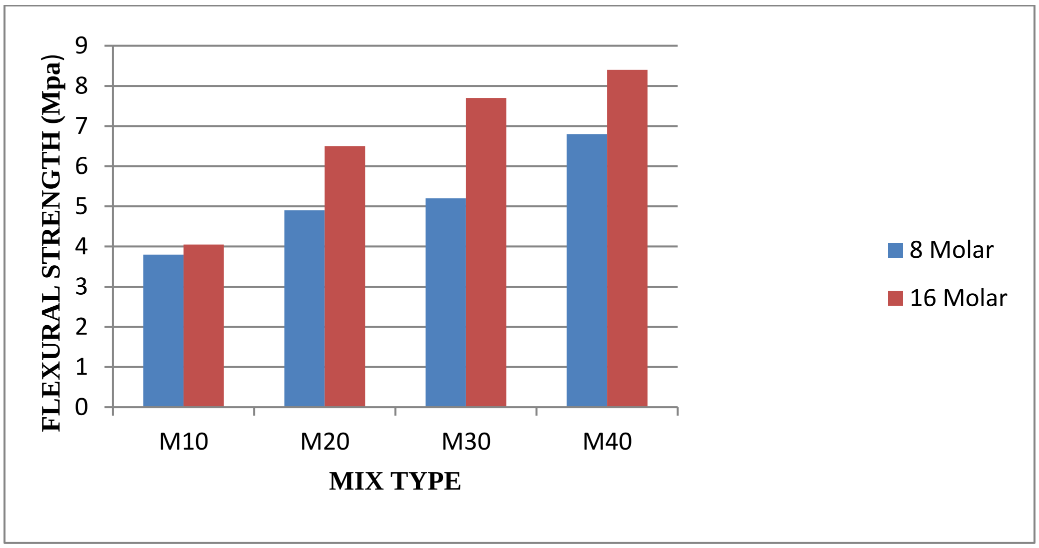

Figure 2.4 Variation of strengths between 8 molar and 16 molar on 7th day testing

The above graph FIG 2.4 shows that the strength obtained for 16 molar specimens are greater than the strength obtained for 8 molar specimens on 7th day testing.

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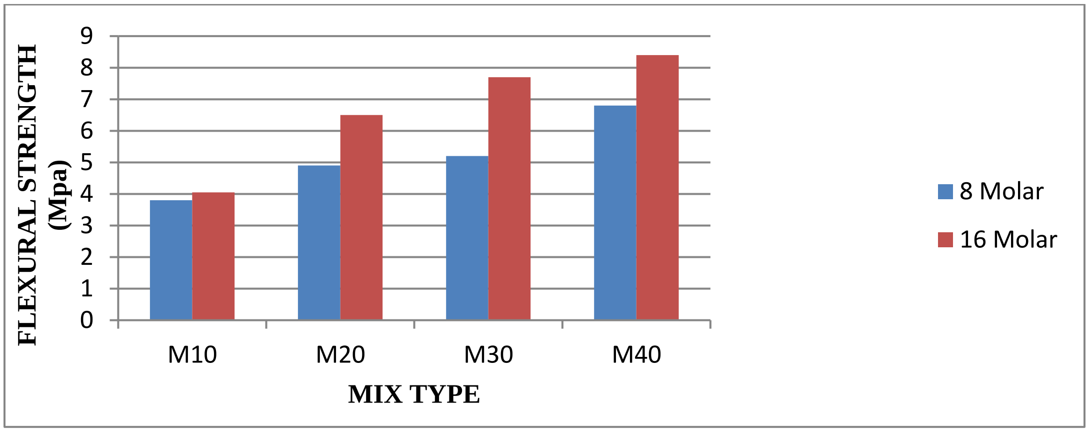

Figure 2.5 Variation of strengths between 8 molar and 16 molar on 28th day testing

The above graph FIG 2.5 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 2.6 and 2.7.

Generalised curve for 28th day strength for 16 molar

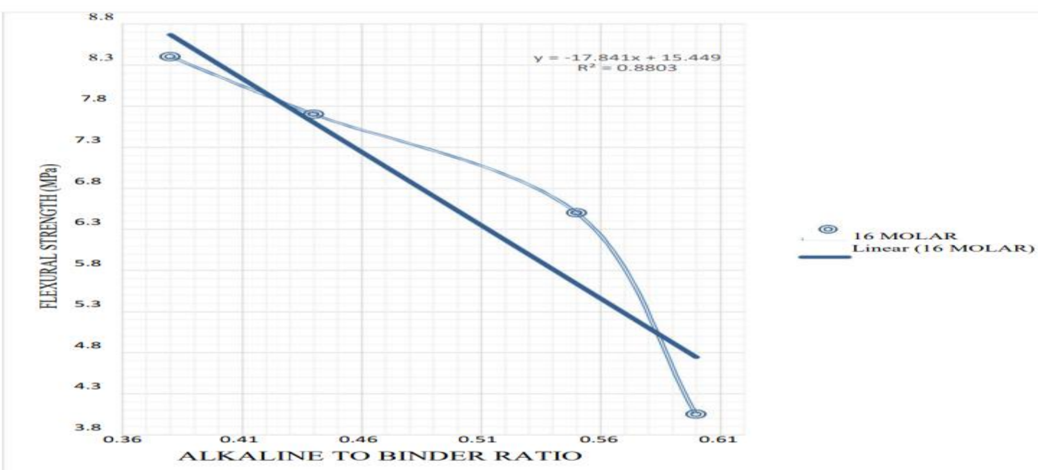

Figure 2.6 Generalised curve for 28th day strength for 16 molar

Generalised curve for 28th day strength for 8 molar

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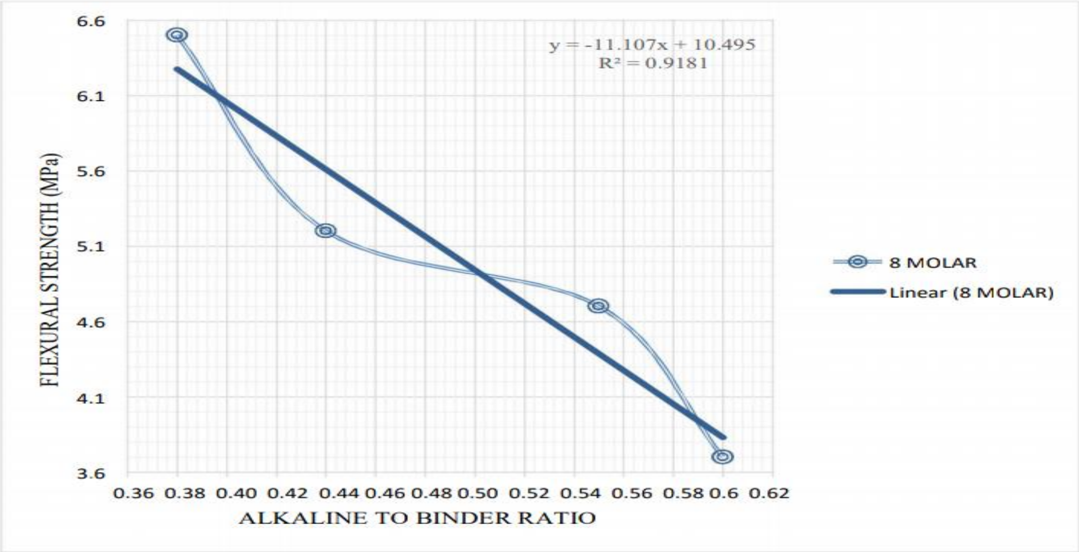

Figure 2.7 Generalised curve for 28th day strength for 8 molar

3.CONCLUSION

- The flexural strengths obtained on 7th day and 28th day testing of prism specimens of 16 molarity is greater than the 8 molarity in both nominal and design mixes.
- In 8 molarity the highest flexural strength is achieved for M40 and the strength is 6.5 MPa obtained on 28th day. The lowest flexural strength is achieved for M10 and the strength is 2.7 MPa obtained on 7th day.
- In 16 molarity the highest flexural strength is achieved for M40 and the strength is 8.4 MPa obtained on 28th day. The lowest flexural strength is achieved for M10 and the strength is 3.2 MPa obtained on 7th day.
- 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.
- Generalized curve obtained for 8 molarity is linear than generalized curve obtained for 16 molarity.
- 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.

REFERENCES

- BehzadKalantari, 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 EngineeringVol 3, pp 3.

- VijayaRangan, B, DodySumajouw, SteenieWallah, wantoroHardjitoDj, (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.

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p-ISSN: 2348-795X
Volume 05 Issue 22
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- V. Supraja, and M. KantaRao "Experimental study on Geo-Polymer concrete incorporating GGBS" ISSN:2277-9477, Volume2