ISSN(Online): 2319-8753
ISSN (Print): 2347-6710

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: www.ijirset.com

Vol. 6, Issue 7, July 2017

Behaviour of Geopolymer Concrete

S. P. Dange [1], S. R. Suryawanshi [2]

P.G. Student, Department of Civil Engineering, ICOR Engineering College, Wagholi, Pune, India[1]

Assistant Professor, Department of Civil Engineering, ICOR Engineering College, Wagholi, Pune, India[2]

ABSTRACT: Geopolymer concrete an innovative material that is characterized by long chains or networks of inorganic molecules is a potential alternative to conventional Portland cement concrete for use in transportation infrastructure construction. It relies on minimally processed natural materials or industrial by products to significantly reduce its carbon footprint, while also being very resistant to many of the durability issues that can plague conventional concrete. However, the development of this material is still in its infancy, and a number of advancements are still needed. This briefly describes geopolymer concrete materials and explores some of their strengths, weaknesses, and potential applications. In this paper we discuss the strength and behaviour of geopolymer concrete.

KEYWORDS: Geopolymer Liquid, Compressive Strength

I. INTRODUCTION

Geopolymers are a group of materials that are manufactured from an alumino silicate mixture and an alkaline solution. They have a wide variety of uses and advantages over OPC. Alternative binders to OPC including geopolymers belong to the Alkali Activated Materials (AAM) group. A major advantage of using geopolymers and AAM over OPC is an increase in durability. Cements analyzed from Egyptian and Roman structures are shown to have crystalline zeolitic phases in addition to the OPC like hydrates. These crystalline phases are one of the reasons why researchers believe that ancient cement was so much more durable to modern cement. This durability comes from the three dimensional polymeric chain and ring structure of the alumino silicates. Unlike cement, water is not used in the reaction of the alumino silicates; instead water is evaporated out during the curing process. Applications for geopolymer cements stem from their high heat tolerance, affordability and reduced environmental impact. Fly ash is a common component used in AAM and geopolymers. The major reasons for the use of this material are due to the reduced CO2 emissions resulting from no cement being used compared to OPC. Due to the fact that they are not a lime based clinker, the direct CO2 emissions are immediately removed. Geopolymers have advantages of an increase of durability and a reduction of environmental impact over OPC; however, there are also some minor barriers to bringing geopolymers into common usage. First, the term alkali has always carried a bad name in the OPC world due to the limits on alkalis in cement to reducing cracking and expansion effects. Another barrier to introducing it to the construction world is the need for the formation of governmental standards regarding geopolymers. Finally, the science behind geopolymers must expand to fulfil all mechanical and economical needs. As geopolymers are made by mixing an alumino silicate mixture and an alkaline solution, it is important to know how to create the alumino silicate mixture and how alkaline the solution should be.

Geopolymer materials represent an innovative technology that is generating considerable interest in the construction industry, particularly in light of the ongoing emphasis on sustainability. In contrast to Portland cement, most geopolymer systems rely on minimally processed natural materials or industrial by products to provide the binding agents. Since portland cement is responsible for upward of 85 percent of the energy and 90 percent of the carbon dioxide attributed to a typical ready-mixed concrete, the potential energy and carbon dioxide savings through the use of geopolymers can be considerable. Consequently, there is growing interest in geopolymer applications in transportation infrastructure.

ISSN(Online): 2319-8753
ISSN (Print): 2347-6710

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: www.ijirset.com

Vol. 6, Issue 7, July 2017

II. LIMITATIONS

- Geopolymer concrete did not harden immediately at room temperature as in conventional concrete.
- Geopolymer concrete specimens took a minimum of 3 days for complete setting without leaving a nail impression on the hardened surface.

These two limitations of geopolymer concrete mix was eliminated by replacing 10% of fly ash by OPC on mass basis with alkaline liquids resulted in Geopolymer Concrete Composite and are considered as drawbacks of this concrete to be used for practical applications.

III. ADVANTAGES

- The price of fly ash is low.
- Better compressive strength.
- Fire proof i.e.; higher resistance to heat.
- Low permeability.
- Eco-friendly.
- Magnificent properties within both acid and salt environments.

IV. MIX DESIGN OF GEOPOLYMER CONCRETE

As there are no code provisions for the mix design of geopolymer concrete, the density of geo-polymer concrete is assumed as 2400 Kg/m3. The rest of the calculations are done by considering the density of concrete. The total volume occupied by fine and coarse aggregate is adopted as 77%. The alkaline liquid to fly ash and GGBS ratio is kept as 0.4. The ratio of sodium hydroxide to sodium silicate is kept as 2.5.The conventional method used in the making of normal concrete is adopted to prepare geopolymer concrete.

Table No. 1 Mix Proportions

Sample	Fly ash	GGBS	Sodium hydroxide	Sodium silicate	Fine Agg.	Coarse Agg.
M40	12.87	30.03	7.48	18.69	33.28	55.84
M60	14.85	34.56	8.58	21.57	40.69	64.54
M80	16.83	39.27	9.78	24.44	46.15	72.63
Distilled water: 10% of the total cementious material						

V. EXPERIMENTAL WORK

Fig No. 1 Compression Test

ISSN(Online): 2319-8753
ISSN (Print): 2347-6710

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: www.ijirset.com

Vol. 6, Issue 7, July 2017

Fig No. 2 Tension Test

Table No. 1 Compression Result

Sample	M40	M60	M80
7 days	26.7	36.8	46.5
14 days	32.7	47.2	59.6
28 days	48.9	72.2	83.9

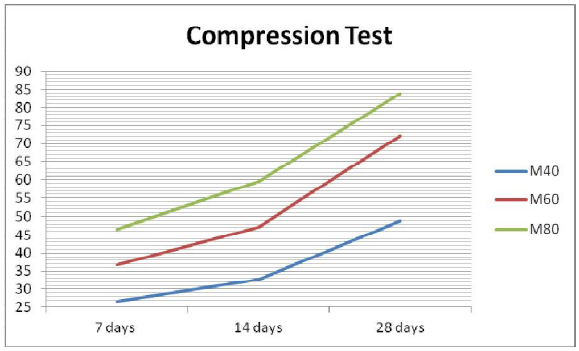

Fig No. 3 Compression Result

Table No. 2 Tension Result

Sample	M40	M60	M80
7 days	3.32	4.13	5.64
28 days	3.97	4.87	6.72

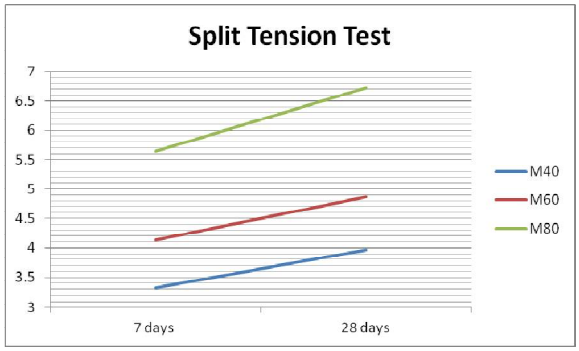

Fig No. 4 Split Tension Test Result

ISSN(Online): 2319-8753
ISSN (Print): 2347-6710

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: www.ijirset.com

Vol. 6, Issue 7, July 2017

Table No. 3 Comparison of compression Result

Sample	M40	M60	M80
Geopolymer Concrete	48.9	72.2	83.9
Conventional Concrete	42.23	66.53	78.65
Percentage Difference	13.64	7.85	6.26

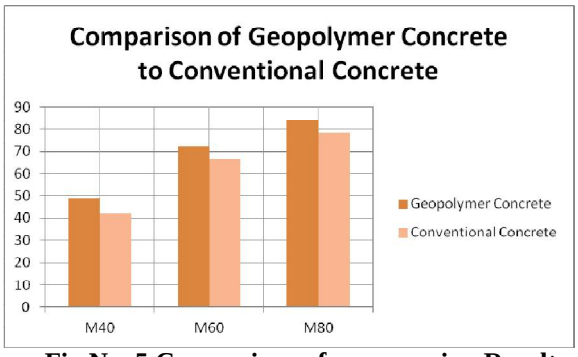

Fig No. 5 Comparison of compression Result

Table No. 4 Comparison of Tension Result

Sample	M40	M60	M80
Geopolymer Concrete	3.97	4.87	6.72
Conventional Concrete	2.97	3.26	5.55
Percentage Difference	25.19	33.06	17.41

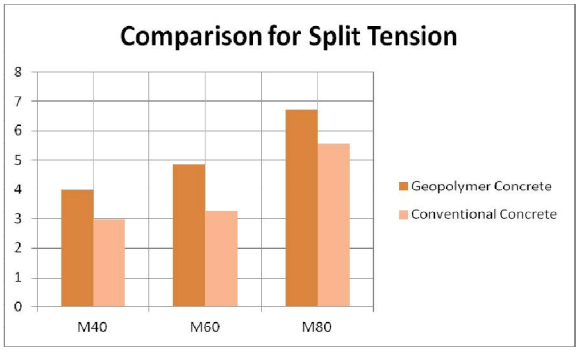

Fig No. 6 Comparison of Tension Result

Table No. 5 Comparison of Flexure Result

Sample	M40	M60	M80
Geopolymer Concrete	2.36	3.12	3.96
Conventional Concrete	1.95	2.16	2.96
Percentage Difference	17.37	30.77	25.25

ISSN(Online): 2319-8753
ISSN (Print): 2347-6710

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: www.ijirset.com

Vol. 6, Issue 7, July 2017

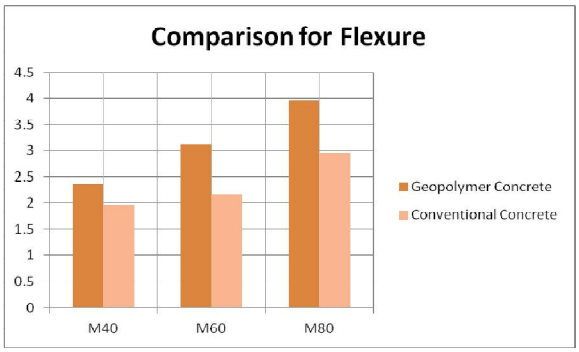

Fig No. 7 Comparison of Flexure Result

VI. CONCLUSION

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. The results from studies on mix design development to enhance workability and strength of geopolymer concrete. The influence of factors such as, curing temperature and regime, aggregate shape, strengths, moisture content, preparation and grading, on workability and strength are presented.

Based on the results obtained in the experimental investigation, the following conclusions are drawn.

1. The geopolymer concrete gained strength within 24 hours at ambient temperature without water curing.
2. The necessity of heat curing of concrete was eliminated by incorporating GGBS and fly ash in a concrete mix.
3. The strength of geopolymer concrete was increased with increase in percentage of GGBS in a mix.
4. It was observed that the mix M80 gave maximum compressive strength of 83.9N/mm2.

REFERENCES

[1] Ana María Aguirre-Guerrero, Rafael Andrés Robayo-Salazar, Ruby Mejía de Gutiérrez," A Novel Geopolymer Application: Coatings To Protect Reinforced Concrete Against Corrosion", Applied Clay Science, 2016
[2] B. Vijaya Rangan, "Geopolymer Concrete For Environmental Protection", Future Concrete.
[3] G.B. Maranan, A.C. Manalo, B. Benmokrane, W. Karunasena, P. Mendis, "Evaluation Of The Flexural Strength And Serviceability Of Geopolymer Concrete Beams Reinforced With Glass-Fibre-Reinforced Polymer (GFRP) Bars" Engineering Structures, Vol. 101, Pp. 529–541, 2015.
[4] Iftekhair Ibnul Bashar, U. Johnson Alengaram, Mohd Zamin Jumaat, Azizul Islam, Helen Santhi, Afia Sharmin, "Engineering Properties And Fracture Behaviour Of High Volume Palm Oil Fuel Ash Based Fibre Reinforced Geopolymer Concrete", Construction and Building Materials, Vol. 111, Pp. 286–297, 2016.
[5] L.Krishnan, S.Karthikeyan, S.Nathiya, K. Suganya, "Geopolymer Concrete An Eco-Friendly Construction Material", IJRET: International Journal of Research in Engineering and Technology.
[6] M.S.H. Khan, Arnaud Castel, A. Akbarnezhad, Stephen J. Foster, Marc Smith, "Utilisation Of Steel Furnace Slag Coarse Aggregate In A Low Calcium Fly Ash Geopolymer Concrete", Cement and Concrete Research, Vol.0 89, Pp. 220–229, 2016.
[7] Pradip Nath, Prabir Kumar Sarker,"Flexural Strength And Elastic Modulus Of Ambient-Cured Blended Low-Calcium Fly Ash Geopolymer Concrete", Construction and Building Materials, 2016.
[8] Sara Rios, Catarina Ramos, António Viana da Fonseca, Nuno Cruz and Carlos Rodrigues," Colombian Soil Stabilized With Geopolymers For Low Cost Roads" Procedia Engineering, Vol. 143, Pp. 1392–1400, 2016.
[9] Vinh Duy Cao, Shima Pilehvar, et. al ," Microencapsulated Phase Change Materials For Enhancing The Thermal Performance Of Portland Cement Concrete And Geopolymer Concrete For Passive Building Applications" Energy Conversion and Management, Vol. 133, Pp. 56–66, 2017.
[10] Xiaochun Fan , Mingzhong Zhang," Experimental Study On Flexural Behaviour Of Inorganic Polymer Concrete Beams Reinforced With Basalt Rebar", Composites, Vol. 93 Pp. 174-183, 2016.