Alkali Activated GGBS Based Geo-polymer Concrete

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***Abstract*- Geo-polymer concrete an innovative material that is characterized by long chains or networks of inorganic molecules is a potential substitution to ordinary Portland cement concrete for use in transportation infrastructure construction. It relies on minimally processed industrial by products to reduce its carbon footprint, while also being very resistant to many of the durability issues that can plague traditional concrete. However, the development of this material is still in its infancy, and a number of advancements are still required. This briefly describes geo-polymer concrete materials and explores some of their high strengths, weaknesses, durability and potential applications. In this paper we discuss the high strength of geo-polymer concrete.**

1. GEO-POLYMER CONCRETE

Geo-polymers are a group of materials which are manufactured from an alumino silicate mixture and an alkaline solution. It has a wide variety of uses and advantages over OPC. Alternative binders to OPC including geo-polymers belong to the Alkali Activated Materials group. A major advantage of using geo-polymers and AAM over conventional is an increase in durability. Cement 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 main reasons why researchers believe that ancient cement was so much more durable to modern cement. This durability of Geo-polymer comes from the three dimensional polymeric chain and ring structure of the alumino silicates. Like a cement, water is not used in the reaction of the alumino silicates; instead water is evaporated out during the curing process. Applications for geo-polymer liquid stem from their high heat tolerance, affordability and reduced environmental impact. Fly ash is a common component used in AAM and geo-polymers. The major reasons for the use of this material are due to the reduced CO_2 emissions resulting from no cement being used compared to OPC they are not a lime based clinker, the direct CO_2 emissions are immediately removed. Geo-polymers have advantages of an increase of durability and a reduction of environmental impact over OPC; however, there are also some minor barriers to bringing geo-polymers into common usage. Firstly, 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 geo-polymers. Finally, the science behind geo-polymers must expand to fulfill technical mechanical and economical needs. As geo-polymers 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. Geo-polymer materials represent an innovative technology that is generating considerable interest in the infrastructure industry, particularly in light of the ongoing emphasis on sustainability. In compare to Portland cement, most geo-polymer systems rely on minimally processed natural materials or industrial by products to provide the binding agents. Since ordinary port-land cement is responsible for upward of 80 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 geo-polymer liquids can be considerable. Consequently, there is growing interest in geo-polymer applications in road infrastructure engineering.

1.1 Limitations

- Geo-polymer concrete did not harden immediately at room temperature as in ordinary Portland cement concrete.
- Geo-polymer concrete specimens took a minimum of 3 days for final setting without leaving a nail impression on the hardened surface.

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

1.2 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.

2 MIX DESIGN OF GEO-POLYMER CONCRETE

As there are no provisions of codes for the mix design of geo-polymer concrete, the density of geo-polymer concrete is assumed as 2400 Kg/m3. The total volume occupied by fine and coarse aggregate is adopted as 77.00%. The alkaline liquid to fly ash and GGBS ratio is kept as 0.390. The ratio of sodium hydroxide to sodium silicate is kept as 2.49.

Table No. 1 Mix Design

Sample	Fly ash	GGBS	Sodium hydroxide	Sodium silicate	Fine Agg.	Coarse Agg.
M40	12.97	30.03	7.48	18.69	33.28	55.84
M60	14.85	34.56	8.58	21.47	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						

3 EXPERIMENTAL WORK

Figure No. 1 Compression Test

Figure No. 2 Tension Test

Table No. 2 Compression Result

Sample	M40	M60	M80
7 days	26.7	36.8	46.5
14 days	32.7	46.2	59.6
28 days	48.9	72.2	83.9

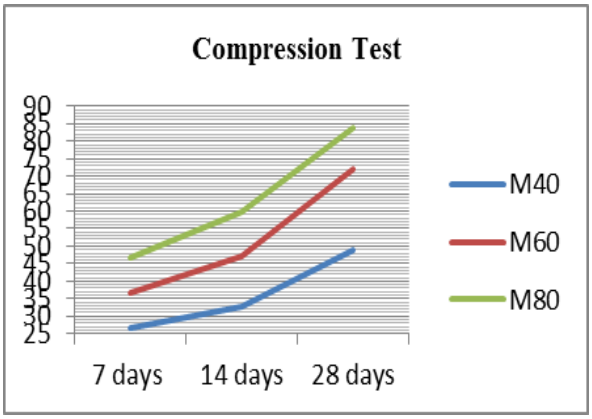

Figure No. 3 Compression Result

Table No. 3 Tension Result

Sample	M40	M60	M80
7 days	3.34	4.13	5.64
28 days	3.97	4.87	6.82

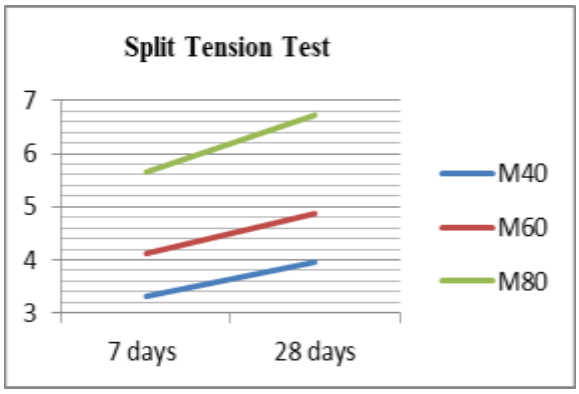

Figure No. 4 Compression Result

Table No. 4 Comparison of compression Result

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

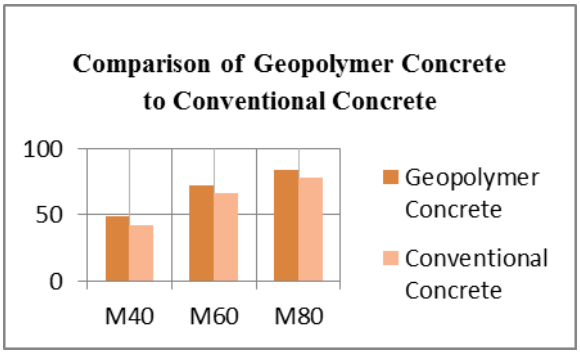

Figure No. 5 Comparison of compression Result

Table No. 5 Comparison of Tension Result

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

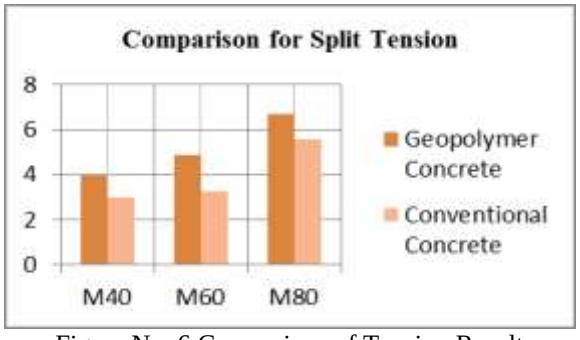

Figure No. 6 Comparison of Tension Result

Table No. 6 Comparison of Flexure Result

Sample	M40	M60	M80
Geo-polymer Concrete	2.36	3.22	3.96
Conventional Concrete	1.95	2.16	2.96
Percentage Difference	17.37	30.77	26.25

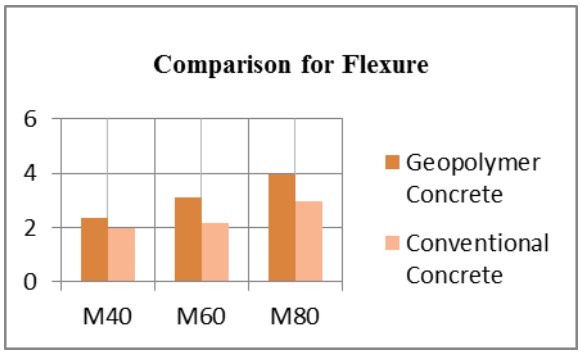

Figure No. 7 Comparison of Flexure Result

4 CONCLUSION

Geo-polymer results from the reaction of a source material that is rich source of silica and alumina with alkaline liquid. It is totally cement free concrete. This material has been 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 technical applications and commercial production of geo-polymer concrete. It has been found that geo-polymer concrete has good engineering properties with a reducing 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 geo-polymer concrete. The influence of factors such as, curing temperature and regime, aggregate shape, durability, 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 geo-polymer concrete gained strength within 24 hours at ambient temperature without any 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 geo-polymer concrete was increased with increase in percentage of GGBS and Fly ash in a mix.
4 It was observed that the mix M80 gave maximum compressive strength of 83.9N/mm2.

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