

INVESTIGATE CURING BEHAVIOR OF FLY ASH BASED POLYMERIC FERROCEMENT CONCRETE

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Abstract - This paper represents Investigation of curing behavior of fly ash based polymeric ferrocement concrete. Ferrocement is a form of reinforced concrete that differs from conventional reinforced or prestressed concrete primarily by the manner in which the reinforcing elements are dispersed and arranged. It consists of closely spaced, multiple layers of mesh or fine rods completely embedded in cement mortar. The name geopolymer was formed by a French Professor Davidovits in 1978 to represent a broad range of materials characterized by networks of inorganic molecules. Geopolymer is a new development in the world of concrete in which cement is totally replaced by pozzolanic materials like fly ash and activated by highly alkaline solutions to act as a binder in the concrete mix. In this study instead of cement mortar geopolymer mortar is used. Alkaline activators are also used sodium hydroxide and sodium silicate. In this experiment investigation on behavior of fly ash based geopolymer ferrocement, curing condition such as oven, steam, membrane, accelerated and natural sunlight curing for ferrocement geopolymer mortar, analyse effect of chicken mesh layer on flexural or bending behaviour determined. The wire chicken mesh with thickness of 0.7mm i.e.22 gauge is used. The geopolymer mix is prepared by mixing fly ash and sand with the proportion by weight 1:2. Testing is done by a specially made frame for 500mmx500mm size with thickness 50mm.

Keywords: Ferrocement, fly ash, Geopolymer, mortar, Curing, chicken wire mesh.

1. INTRODUCTION

"Ferro cement is a type of thin wall reinforced concrete, commonly constructed of hydraulic cement mortar, reinforced with closely spaced layers of continuous and relatively small size wire mesh. The mesh may be made of metallic or other suitable materials" Ferro cement or Ferro-cement (also called thin-shell concrete or Ferro-concrete) is a system of reinforced mortar or plaster (lime or cement, sand and water) applied over layer of metal mesh, woven expanded-metal or metal-fibers and closely spaced thin steel rods such as rebar. The metal commonly used is iron or some type of steel.

Ferrocement is a form of reinforced concrete that differs from conventional reinforced or prestressed concrete primarily by the manner in which the reinforcing elements are dispersed and arranged. It consists of closely spaced, multiple layers of mesh or fine rods completely embedded in cement mortar. A composite material is formed that behaves differently from conventional reinforced concrete in strength, deformation, and potential applications, and thus is classified as a separate and distinct material. It is used to construct relatively thin, hard, strong surfaces and structures in many shapes such as hulls for boats, shell roofs, and water tanks. Ferro cement originated in the 1840s in France and is the origin of reinforced concrete. It has a wide range of other uses including sculpture and prefabricated building components. The term "ferrocement" has been applied by extension to other composite materials, including some containing no cement and no ferrous material.

2. LITERATURE REVIEW

V. Sreevidya et al (2012) are investigated "Experimental study on geopolymer ferro cement slab using various wire meshes". The purpose of this experimental investigation is to study the flexural behavior of fly ash-based geopolymer ferrocement elements. Compressive strength of fly ash based geopolymer mortar was found to depend on the strength of the geopolymer binder and excellent bonding between the geopolymer binder and fine aggregate.

S. Nagan et al (2014) are explained in "Behaviour of Geopolymer Ferrocement Slabs Subjected to Impact". This paper presents the experimental investigations of the resistance of geopolymer mortar slabs to impact loading. In all the impact test specimens the damage is found localized, i.e. at the point of impact of load, and the failure is characterized by formation of cracks initially at the bottom surface of the specimen, propagating to the top surface and then widening further.

A. Sofi et al (2016) describes "Geopolymer ferrocement slabs-An experimental investigation "The aim of this research is to examine a potential mix design process for this emerging product. This work is a largely experimental investigation into

mixture proportion and strength relationships, attempting to detail a large amount of data which will be utilized at the core of the process to be investigated.

Swapna S. Yedshikar et al (2015) concluded in their research under title "Comparison of geopolymer and ferrocement mortar with varying volume percentage and specific surface of mesh". Experimental investigation has been carried out to study the effect of different volume fraction % of steel mesh on compressive strength and split tensile strength of ferrocement and geopolymer. Test results show that compressive strength and split tensile strength of geopolymer mortar increases with increase in volume fraction percentage and specific surface of steel mesh as compared to ferrocement mortar.

Prof (Dr). S.K Patra et al describes "Ferrocement-A review" Ferrocement element can be used as a plate or walling units or as a fire resisting unit. Though there have been many experiments done on the strength (basically Flexural, compressive) by taking different section of ferrocement plates as well as beams, this paper has given an importance on the shear behavior of ferrocement elements.

Sakthivel, P.B. et al (2013) under title "Ferrocement Construction Technology and its Applications – A Review" This paper attempts to review the literature on ferrocement and bring out the salient features of construction, material properties and the special techniques of applying cement mortar on to the reinforcing mesh. This study brings out the importance of using ferrocement in swimming pools and water tanks, silos, corrugated roofs, shell and dome structures, and also in the repair of old/ deteriorated RCC structures.

Nagesh M. Kulkarni et al (2013) analyzed in their paper titled "Analysis and design of ferrocement panels an experimental study" This paper describes the various experiments conducted on ferrocement panels in literature review and the conclusions and remarks drawn by the authors. The results obtained are going to help in the project work to investigate the behavior of ferrocement panels for various parameters and loading.

N Ranjith Kumar et al (2016) concluded that under title "Behaviour of geopolymer concrete with ferrocement" This paper presents the experimental investigations of the resistance of Geopolymer mortar slabs to impact loading for the specimens of size 200mmx210mmx100mm.

K. Sasiekalaa et al (2012) studied "A Review Report on Mechanical Properties of Ferrocement with Cementitious Materials" This paper focuses on the materials, advantages, mechanical properties, practical design parameters, recommendations, research and development in ferrocement.

M. I. Abdul Aleem et al (2012) analysed "Geopolymer concrete- a review" Flyash is rich in silica and alumina reacted with alkaline solution produced aluminosilicate gel that acted as the binding material for the concrete. It is an excellent alternative construction material to the existing plain cement.

3. MATERIAL AND METHODS:

Materials used: - Materials used: -In this investigation material are employed in work such as Fine aggregate, Fly ash, Sodium Hydroxide (NaOH), Sodium Silicate (Na₂SiO₃), Wire chicken mesh, Water, Lime.

1. Fine aggregate: -

Locally available river sand conforming to grading zone II of IS: 383 – 1970 was used as fine aggregate. Fine aggregate used is the ordinary river sand passing through sieve no.8 (2.36 mm) with a specific gravity of 2.72, dry density of 1.6 g/cc and having a fineness modulus of 2.56 as per I.S: 383-1970.

2. Fly ash: -

Pozzocrete 60 is a high efficiency pozzolonic material, used as cement component with Portland clinker (i.e. as a partial replacement of Portland cement). It is obtained by selection, processing and testing of power station fly ash resulting from the combustion of coal used at electricity generating power stations. It conforms to IS 3812-Part 1 fly ash and its low loss-on-ignition is an advantage. It is subjected to strict quality control.

3. Sodium Hydroxide:

Generally, Sodium hydroxide is available in solid state by means of pellets and flakes. It is highly soluble in water. When dissolved in water or neutralized with acids liberates substantial heat. Higher concentration of NaOH solution resulted in higher flow for alkaline solution to fly ash ratio of 0.35-0.5.

4. Sodium Silicate:

Sodium silicate also called as water glass or liquid glass. Sodium silicates are stable in neutral and alkaline solution. In acidic solution the silicate ions react with hydrogen ions to form silicate acids, which tend to decompose into hydrated silicate gel.

5. Wire chicken mesh reinforcement: -

The wire woven chicken mesh with thickness of 0.7mm i.e.22 gauge is used. Ultimate strength of chicken meshes 270 N/mm².

6. Water: -The fresh potable water is used

7. Lime: -

Lime is calcium containing inorganic mineral composed primarily of oxides and hydroxides, usually calcium oxide and /or calcium hydroxide. Lime used in building materials is broadly classified as “pure”, “hydraulic”, and “poor” lime.

Preparation of sodium hydroxide solution:

The sodium hydroxide (NaOH) solids were dissolved in water to make the solution. The mass of NaOH solids varied depending on the concentration of solution in terms of molar, M.

NaOH solution for with a concentration of 13M consisted of $13 \times 40 = 520$ grams of NaOH per liter of the solution, where 40 molecular weight of NaOH. The sodium silicate solution and sodium hydroxide solution were mixed together at least one day prior to use to prepare the alkaline liquid.

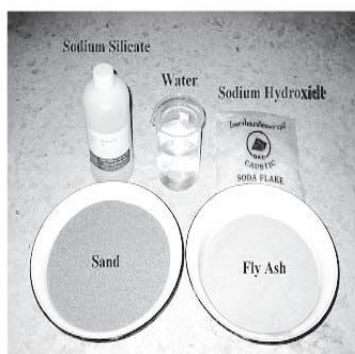
Geopolymer mortar: -

Geopolymer is a combination of the following compounds,

- Pozzolans (fly ash)
- Fine aggregate
- Activator solution (Hydroxides and Silicates of sodium or potassium)
- Distilled water.

The pozzolan used here is the low calcium fly ash of Pozzocrete P60, the chemical composition of fly ash as shown in table below, the geopolymer mortar used in this study is composed of fly ash and alkaline solution composed of sodium hydroxide, sodium silicate combinations.

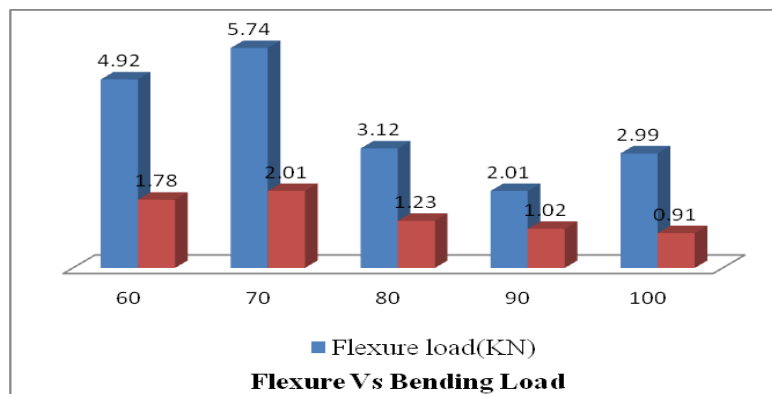
In order to avoid the effect of unknown contaminants in the mixing water the sodium silicate pellets were dissolved in distilled water. The activator solution was prepared at least one day prior to its use.



4. RESULT AND DISCUSSION: -

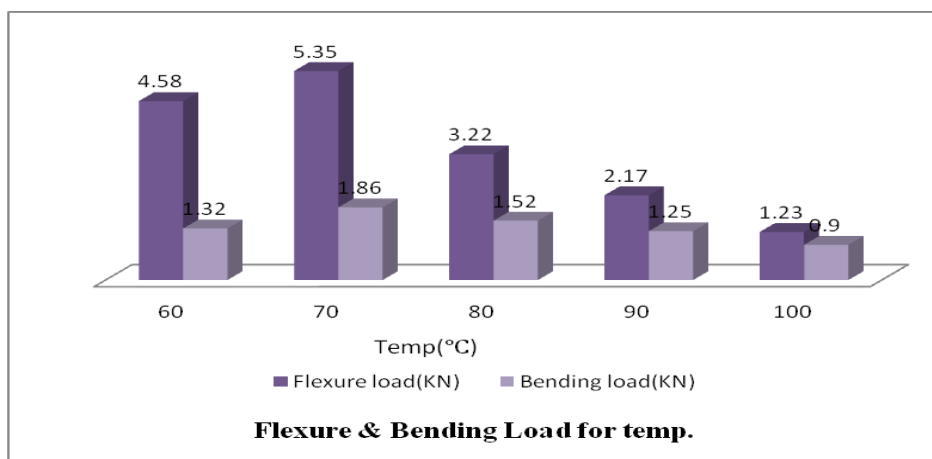
Flexure and bending load for oven curing

Temperature (°C)	Flexure		Bending	
	Average load	Displacement	Average Load	Displacement
60	4.92	0.82	1.78	1.82
70	5.74	0.94	2.01	2.4
80	3.12	0.74	1.23	1.7
90	2.01	0.72	1.02	1.52
100	2.99	0.65	0.91	1.25



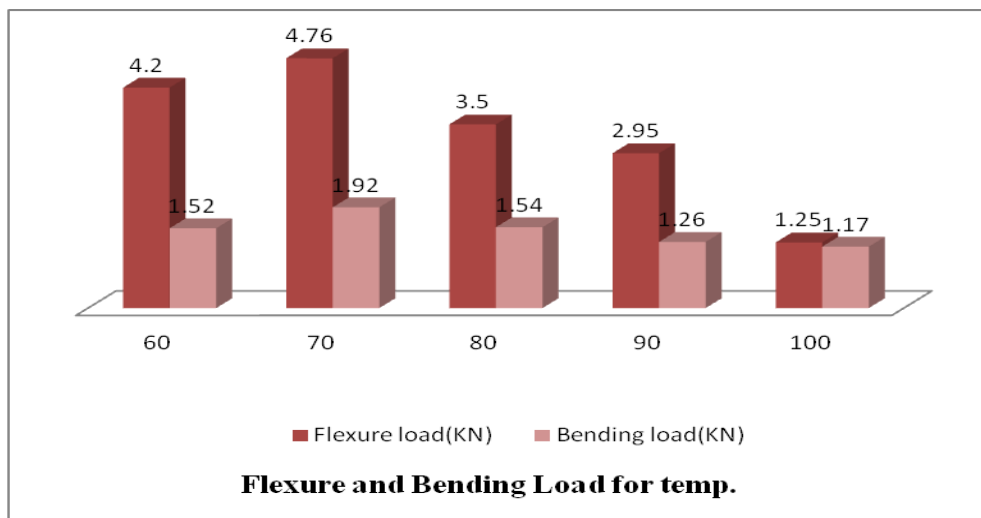
Flexure and bending for membrane curing,

Temperature (°C)	Flexure		Bending	
	Average load	Displacement	Average load	Displacement
60	4.58	0.73	1.32	1.95
70	5.35	0.87	1.86	2.52
80	3.22	0.57	1.52	1.8
90	2.17	0.45	1.25	1.56
100	1.23	0.34	0.9	1.35

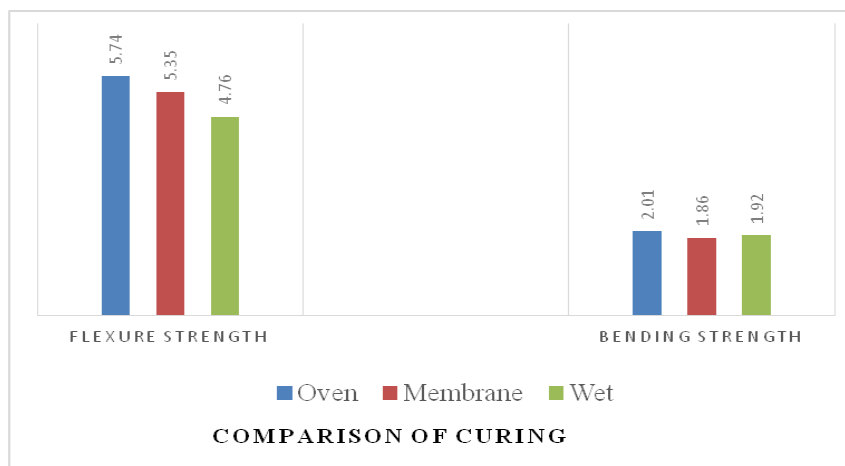


Flexure and bending for wet curing,

Temperature (°C)	Flexure		Bending	
	Average load	Displacement	Average load	Displacement
60	4.2	0.94	1.52	1.74
70	4.76	1.002	1.92	1.97
80	3.5	0.89	1.54	1.69
90	2.95	0.77	1.26	1.54
100	1.25	0.69	1.17	1.205



Comparison of curing:-



Conclusions: -

From experiment

1. Curing i.e. oven curing gives temperature variation, which has 90°C temperature recorded.
2. Strength goes on increasing with increasing number of layers of meshes i.e. single layer and double layer.
3. Fully replaced means 100% fly ash slab panel does not give strength in 13 molar and 16molar solution.
4. Variation and fixation of different parameter should affect the behavior of geopolymer concrete.

5. Geopolymer concrete for taking process of polymeric reaction degree of heating required.
- 6.50% fly ash replacement gives rise to optimum strength result for variation in temperature.
7. Crack pattern also check and studied for various results getting optimum strength.
8. Failure pattern are observed and same failure pattern obtained for some slab panel.
9. Due to use of fly ash in slab panel environmental pollution decreases.
10. Using chicken mesh in geopolymer ferrocement increases strength as increasing layer such single and double.

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BIOGRAPHIES

I am PG Student, completed this project under guidance of Dr.S.L.Hake.



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