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Experimental Study on Ferro-geopolymer Slab Panels

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Abstract - **Ferrocement has been widely used in construction of various structural elements in the construction industry. It is a highly adaptable material. It gives high performance characteristics in cracking, strength. It is appropriate for units of low-cost roofing, precast units and manhole covers. It is also used for constructions of water tank, boats, domes, silos, folded plates. Geopolymer is an innovative revolutionary green material. An experimental investigation on ferrocement trough panel and folded type panel with geopolymer mortar and mesh has been carried out for one and two layers of Galvanised Iron (GI) and Mild Steel (MS) meshes. The slab panels are tested under flexure by applying single point load. The results are discussed in this paper.**

***Keywords* - Ferrocement, Geopolymer, Mesh, Flexure,**

1. INTRODUCTION

Geopolymer cement is being developed and utilised as an alternative to conventional Portland cement for use in transportation, infrastructure, and construction and off shore applications. The term 'Geopolymer' was coined by David Ovitsin 1978 to represent a geological element in to a link of chain like substance through a polymerization reaction with a help of alkaline solution. Geopolymer has the potential to replace ordinary Portland cement and can produce fly ash-based geopolymer mortar with excellent physical and mechanical properties. Fly ash when in contact with alkaline solutions forms inorganic alumino-silicate polymer product known as Geopolymer. There are two main constituents of geopolymer namely the source materials and the alkaline liquids. The source materials for geopolymer based on alumina-silicate should be rich in silicon (Si) and aluminium (Al). Fly ash is the most abundantly used material and mixture as replacement for cement in mortar.In a geopolymer mortar fly ash is the main ingredient and also it is active participating in the geopolymerisation process. Fly ash is used as the pozzolana in many concrete applications. It is also used as the cement replacement. Ferrocement has been used for various offshore and marine structures, roofing, water tanks, grain silos, boats and biogas plant. It is highly adaptable form of reinforced concrete. It is very suitable for low-cost roofing, precast units and man-hole covers. Ferrocement is highly versatile construction material and possess high performance characteristics and also unique properties such as water tightness, fire resistance, good tensile strength, toughness and resistance to cracking.

II. EXPERIMENAL INVESTIGATION

A. Material Used

Class F fly ash was used and its specific gravity is 2.39 and conforming to IS 3812- 2003 was used in the casting of slabs. Specific gravity of GGBS is 2.84 and also used together with fly ash. River sand is passing through 4.75 mm sieve with a specific gravity of 2.65 and it is conforming to grading zone II as per IS: 383-1970 was used. The solution of sodium hydroxide and sodium silicate are used as alkaline solutions in the present study. Commercial grade sodium hydroxide in pellets form and sodium silicate solution are used. The sodium hydroxide solids are of a laboratory grade in pellets form with 99% purity, obtained from local suppliers. The molarity of NaOH is 8M. The distilled water was used for the preparation of sodium hydroxide solution .To achieve workability extra amount of water was added. The trough shape and folded shape geopolymer slab panels were cast using the mild steel and galvanised iron weld meshes with square opening of sizes 15 × 15 mm and were used in single and double layers and having their thickness is 1.29 mm.

B. Geometry of Panels

Two types of panels were considered namely trough shaped panel and folded type panel. The dimension of trough shape panel is 1000 mm × 350 mm × 30 mm. The panels are composed of geopolymer mortar and wire mesh. The folded shape ferrocement panel is having a dimension of 1000 mm × 400 mm × 30 mm. The geometry of trough shaped panels and folded panels are shown in Figure 1 and Figure 2 respectively.

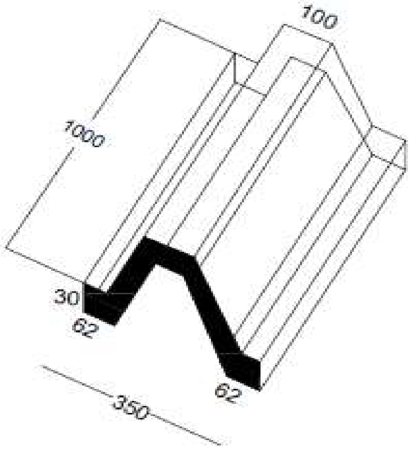

Figure 1. Geometry of trough panel

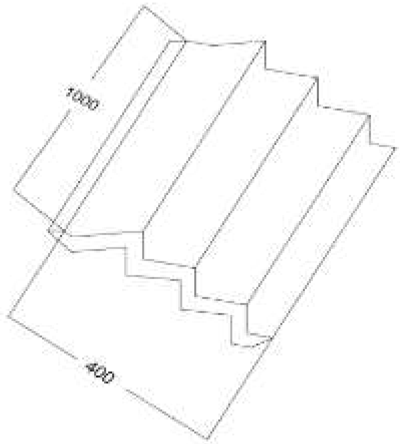

Figure 2.Geometry of folded panel

C. Casting and curing

The required shape of ferrogeopolymer panels was achieved by using steel moulds fabricated to match the shape and size. Special mould was fabricated in metal sheet to match the required geometry of the folded, trough and folded panels. Each sample is cast after fixing the required wire mesh and skeletal steel in its proper position. Slabs were cast with the following materials specifications: Concentration of sodium hydroxide is 8M, Sodium hydroxide to Sodium silicate ratio is 1:2.5 , Ratio of binder to sand ratio is 1:2 and alkaline activator to fly ash ratio is 0.45 .The moulds were coated initially with oil so as to enable easy removal of the moulds.The moulds were supported well on all the sides from outside so as to prevent bulging of the specimen once the geopolymer mortar is poured inside. Fly ash, GGBS and sand were added on to the mixer and thoroughly mixed until a uniform mix was obtained and then the required quantity of alkaline solution along with water is added and mixed thoroughly to form uniform mix. After 28 days curing period the panels were tested.

D. Testing of panels

The specimen ID was given as follows: The first term represents the shape of the panel. 'T' refers to trough shaped panel and 'F' refers to Folded type panel. The next two terms in the ID refers the type of mesh GI refers to Galvanised Iron mesh and MS refers to mild steel mesh. The number in the ID refers to the number of layers namely one and two layers. The slabs were tested in loading frame as shown in Figure 3.

Figure 3.Test setup

The specimens were tested by stimulating simply supported conditions. Loading was applied at the centre of the slab using a hydraulic jack. The load is applied in small increments up to the failure.

III. RESULTS AND DISCUSSIONS

The ultimate load carrying capacity of the slabs was noted and given in Table 1. From the results, it can be seen that as the number of layers increases the load carrying capacity increases. This is applicable for both shapes of panels and for both types of meshes. In general Trough shaped panels are having better load carrying capacity than folded type panels. In the folded type panels, load carrying capacity is higher for slab containing both GI and MS meshes. In the trough type panels, load carrying capacity is higher for slab containing two layers of MS meshes. In trough shaped panels with GI meshes, ultimate load of slab with two layers of mesh is 15.38% greater than that of slab with one layer of mesh. In trough shaped panels with MS meshes, ultimate load of slab with two layers of mesh is 84.6% greater than that of slab with one layer of mesh. In folded panels with GI meshes, ultimate load of slab with two layers of mesh is 44.44% greater than that of slab with one layer of mesh. In folded panels with MS meshes, ultimate load of slab with two layers of mesh is 20% greater than that of slab with one layer of mesh.

Table 1. Ultimate load

S.No.	Specimen ID	Ultimate Load in kN
1.	TGI1	3.9
2.	TGI2	4.5
3.	TMS1	2.6
4	TMS2	4.8
5.	TGIMS	2.5
6.	FGI1	0.9
7.	FGI2	1.3
8.	FMS1	1.5
9.	FMS2	1.8
10.	FGIMS	3.0

IV. CONCLUSIONS

Based on the above experimental results, the following conclusions are arrived:

- Trough shaped panels have high load carrying capacity than folded shaped panel.
- As the number of layers of mesh increases the load carrying capacity increases

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